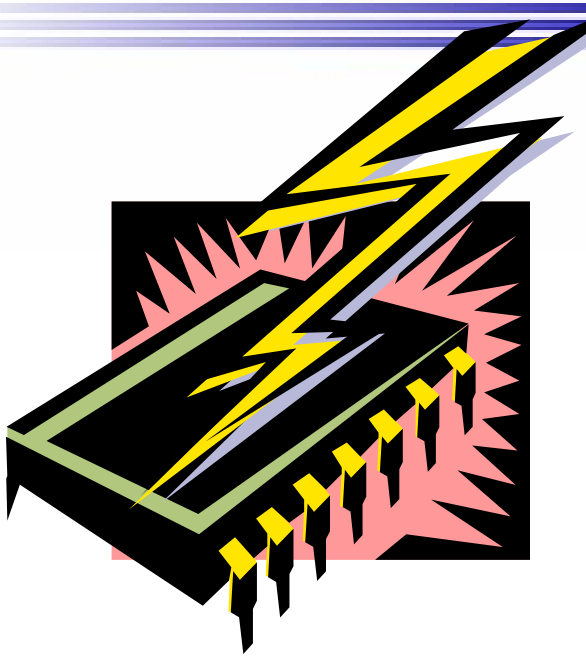
DESCO

ESD BASICS

Basic Concepts in ElectroStatic Discharge (ESD)



Introduction

ESD Control Training

- Per ANSI/ESD S20.20 Training Plan Requirement, "Initial and recurrent ESD awareness and prevention training shall be provided to all personnel”
- Use PowerPoint with Desco 06821 ESD Awareness Guide

Safety

Safety First - Concern WHEN Working Around High Voltage

As important as ESD control is, it is of secondary importance compared to employee safety

When working with voltages over 250 VAC, ESD personnel grounding should not be used including Wrist Straps, ESD Footwear & Garments

Ground fault circuit interrupters (GFCI) and other safety protection should be considered wherever personnel might come into contact with electrical sources.

Introduction

The written ESD Control Plan should be in accordance with ANSI/ESD S20.20

- 100 volt Human Body Model limit as a large majority of the ESD products greater than 100 volt sensitivity
- ESD Association wrote commercial version of MIL-STD-1686 for US Department of Defense which has adopted it

ESD training should be repeated as specified in the company's written ESD Control Plan

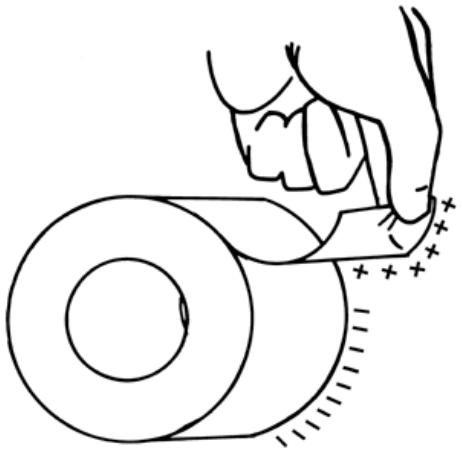
Quizzes in Awareness Guide could be "objective evaluation technique to ensure trainee comprehension and training adequacy."

Static Electricity OR Electrostatic Charge

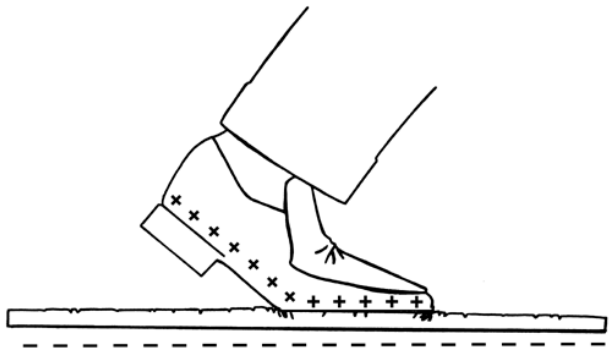
Defined as Electric charge at rest

All Materials Tribocharge

ElectroStatic Charge Generation or Tribocharging



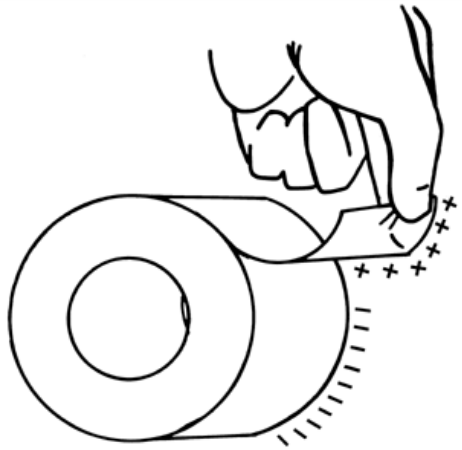
- When 2 surfaces contact then separate.
- Some Electrons move or are given up to the other surface, causing an imbalance.
- Electrons are Negative.
- Protons are Positive.

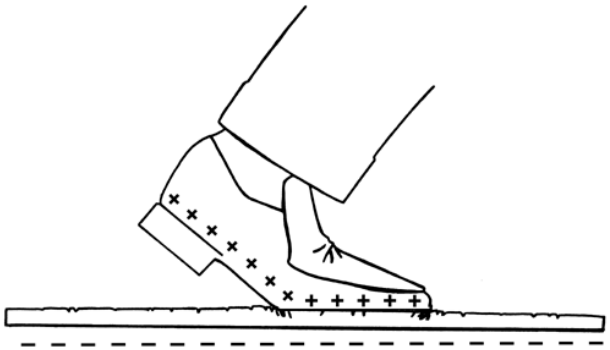


All Materials Tribocharge

ElectroStatic Charge Generation:

- Opening plastic bag, combing hair, unrolling tape, etc.
- Build up charge walking on carpet, sliding across car seat.
- Charge greater when weather is cold and dry.
- ESD is when the charge moves.





Charge Generation or Tribocharging

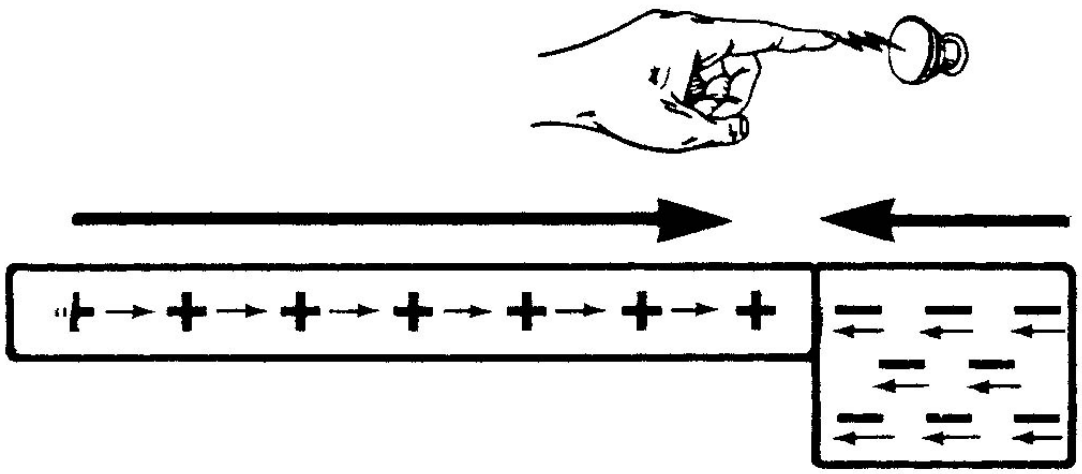
When two materials make contact and are then separated, a transfer of electrons from one material to the other may take place.

The amount of static electricity generated depends upon the materials subjected to contact or separation, friction, the area of contact or separation, and the relative humidity of the environment.

At lower relative humidity, as the environment is drier, charge generation will increase significantly. Common plastics generally will create the greatest static charges.

ESD or ElectroStatic Discharge

- Charges Seek Balance
- Discharge is Rapid
- Creating Heat

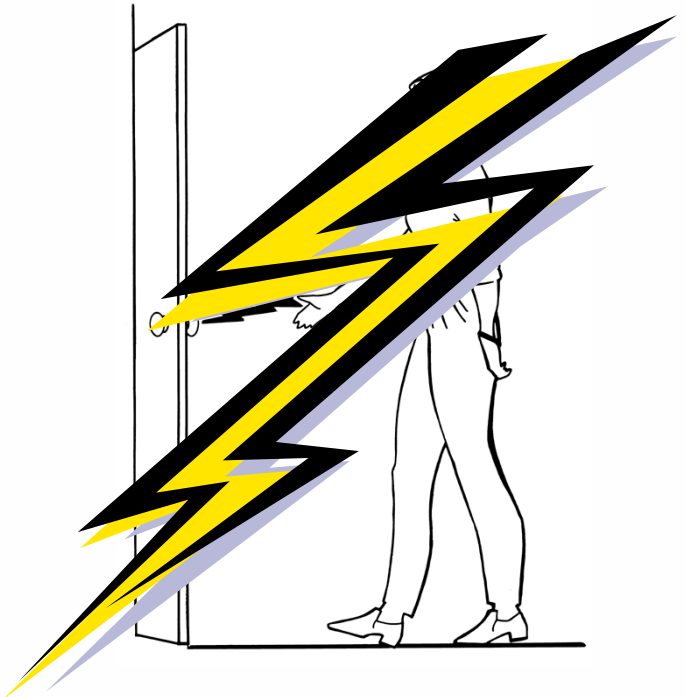


If two items are at different electrostatic charge levels, as they approach one another, a spark or Electrostatic Discharge (ESD) can occur. This rapid, spontaneous transfer of electrostatic charge can generate heat and melt circuitry in electronic components.

Examples Of Electrostatic Discharge or ESD

- **Lightning**

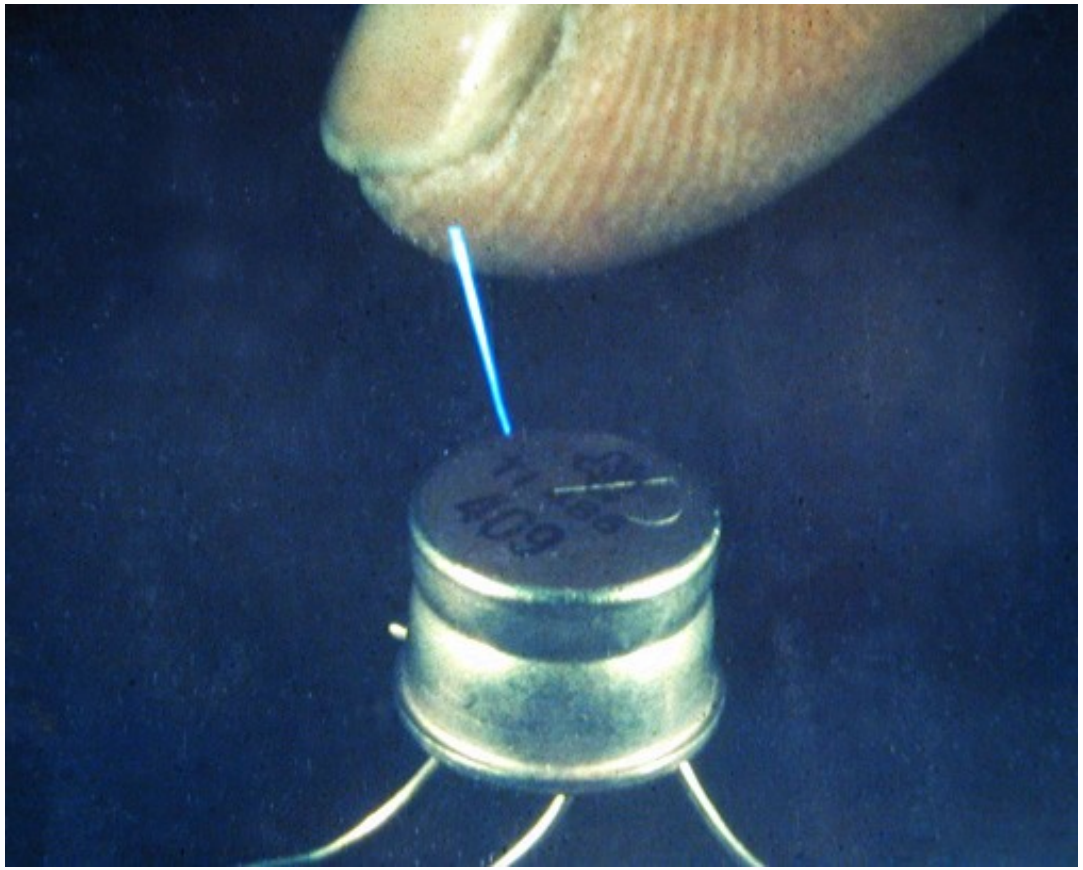
- **Zap from a door**



There are innumerable ESD events occurring which you do not see or feel. ESD is the hidden enemy in a high tech manufacturing environment.

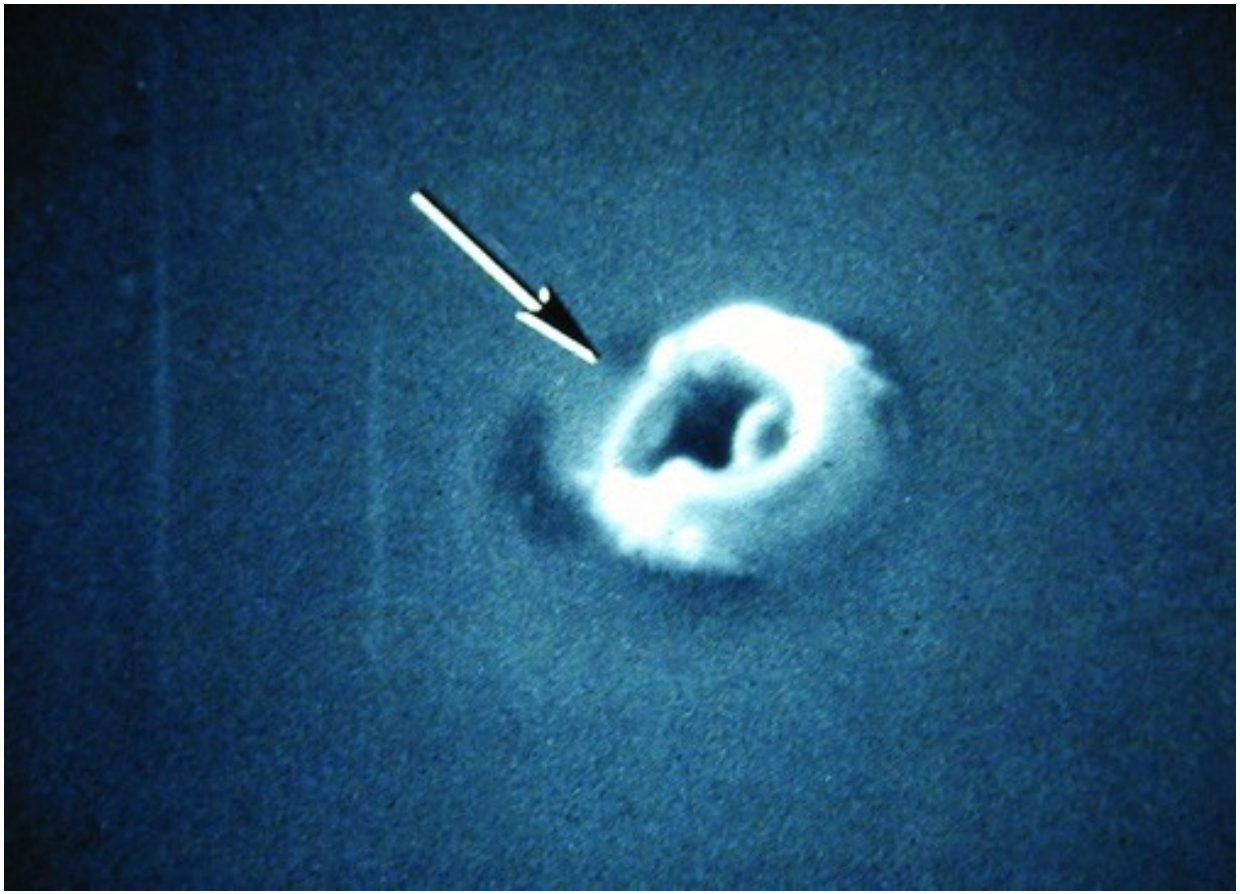
Photo of ESD arcing from finger to component

This is not a computer simulation.
Technician was connected to a small magneto.



Photos courtesy of Hi-Rel Laboratories, Inc., Spokane, WA

Scanning electron micrograph (SEM) image of the ESD damage after removal of the capacitor metallization. Note the characteristic eruption thru the oxide. Magnification is 10,500 times.



Photos courtesy of of Hi-Rel Laboratories, Inc., Spokane, WA

Two Types of Materials
Conductors

- Electrical Current Flows Easily
- So Can be Grounded

  Examples: metals, carbon and people (due to impurities the human body's sweat layer)

Materials that are called dissipative are conductors, able to remove electrostatic charges to ground. The resistance of dissipative materials is the higher portion of the conductive range.

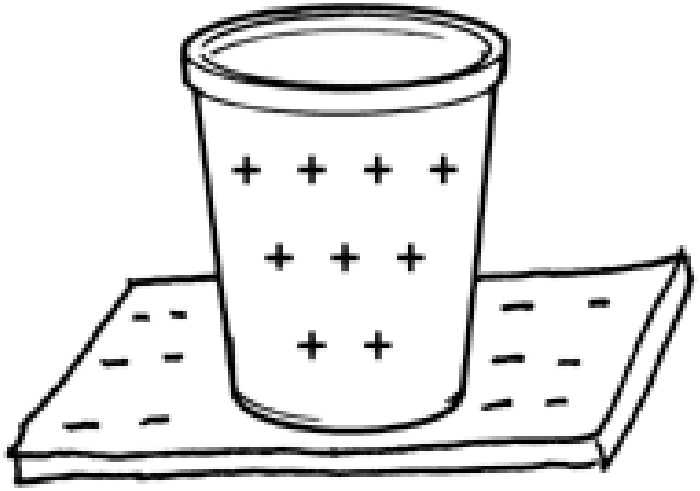
Two Types of Materials
Insulators

Insulators or Non-Conductors

- Electrical Current Does Not Flow Easily
- So Cannot be Grounded

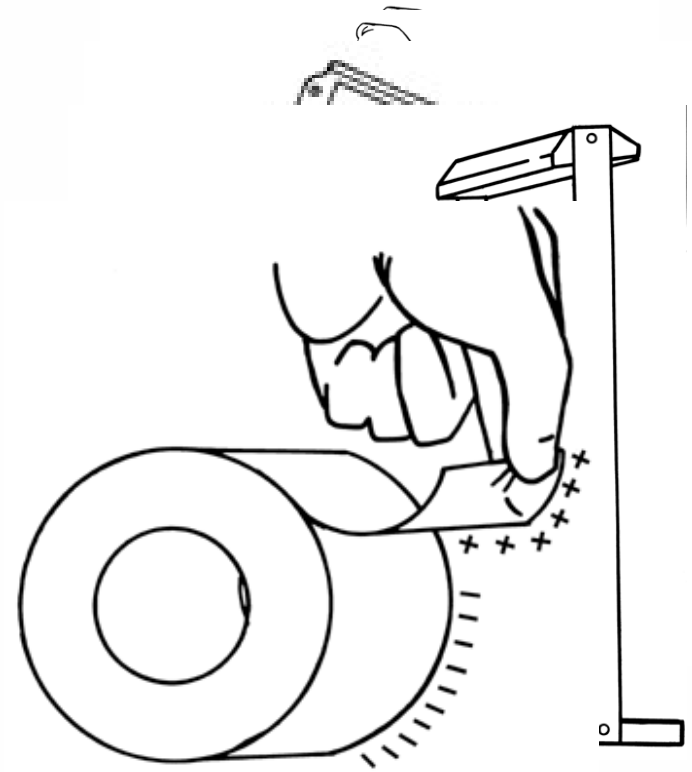
  Example: Plastics, glass, and dry air

Insulators like this plastic cup will hold the charge and cannot be grounded and "conduct" the charge away.



Typical ElectroStatic Voltages

- **Walking across a carpet:**
  1,500 - 35,000 volts
- **Walking over untreated vinyl floor:**
  250 - 12,000 volts
- **Vinyl envelope used for work instructions: 600 - 7,000 volts**
- **Worker at a bench:**
  700 - 6,000 volts
- **Unwinding regular tape:**
  9,000 - 15,000 volts

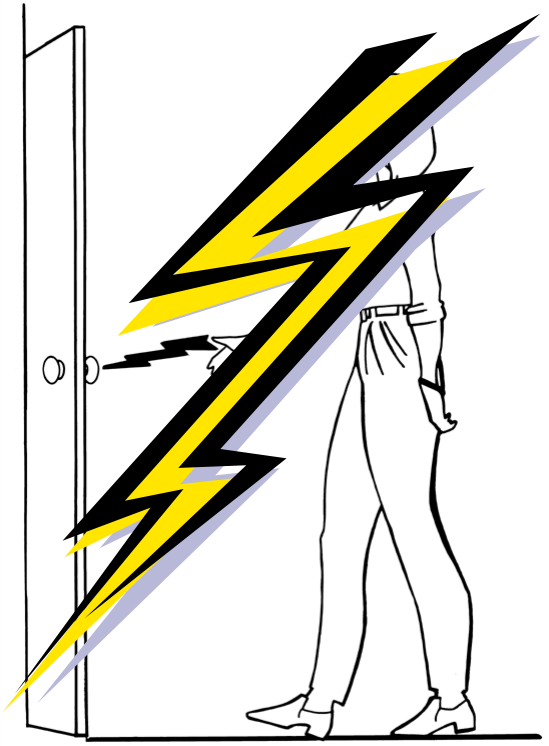


Higher number is generated at low humidity

Costly Effects Of ESD

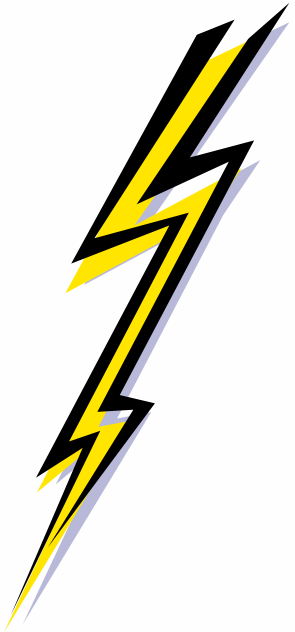
People Discharge Frequently

But to Feel a Discharge it must be about 2,000 volts



ESD That a Person Can’t Feel Can Easily Damage Electronic Components

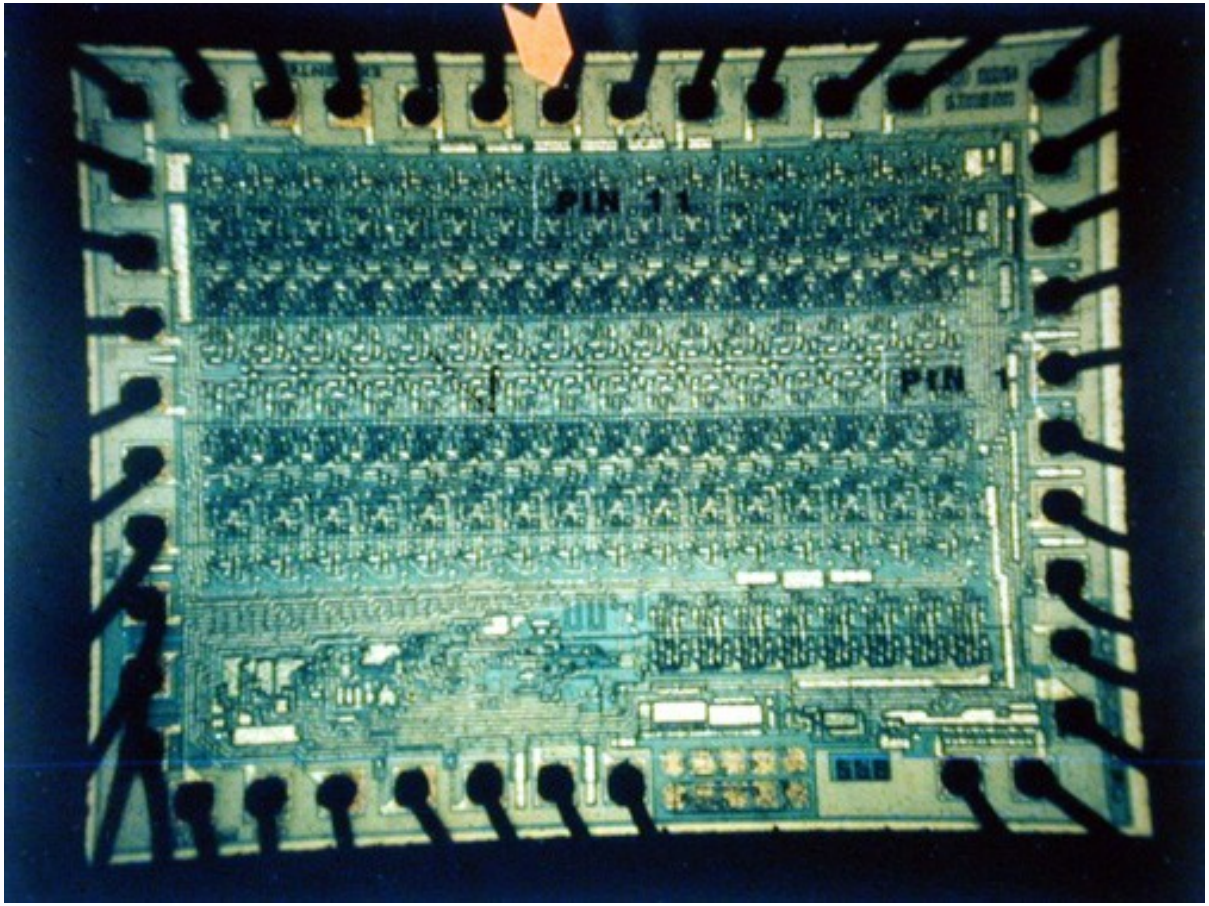
Even less than100 volts might damage a component!



ESD is The Hidden Enemy

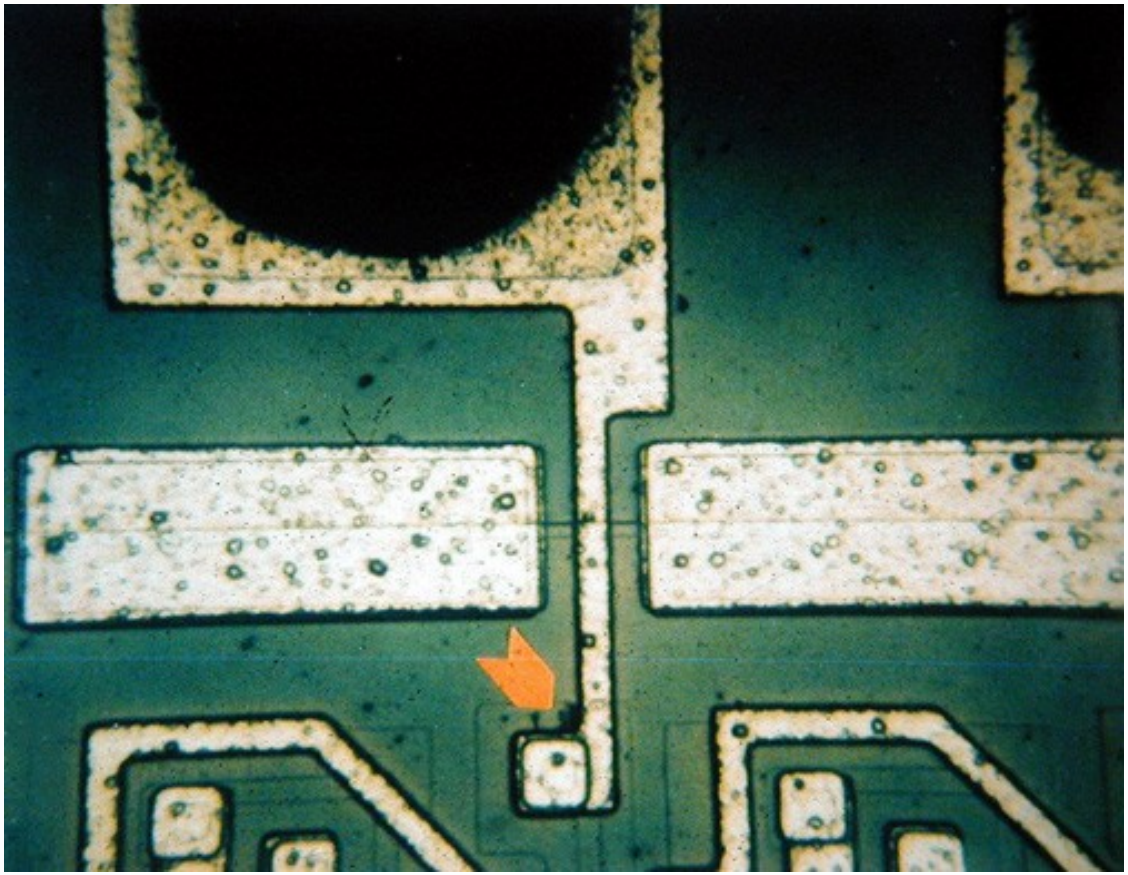
- Consider all electronic components ESD sensitive
- Program may identify classification of sensitivity to ESD damage
- Newer electronic components can have reduced width of circuits and microscopic spacing of insulators within them, increasing their sensitivity to ESD
- ESD damage cannot be seen by the naked eye

Optical photo of a large Integrated Circuit which has experienced ESD damage to the pin noted by the arrow.



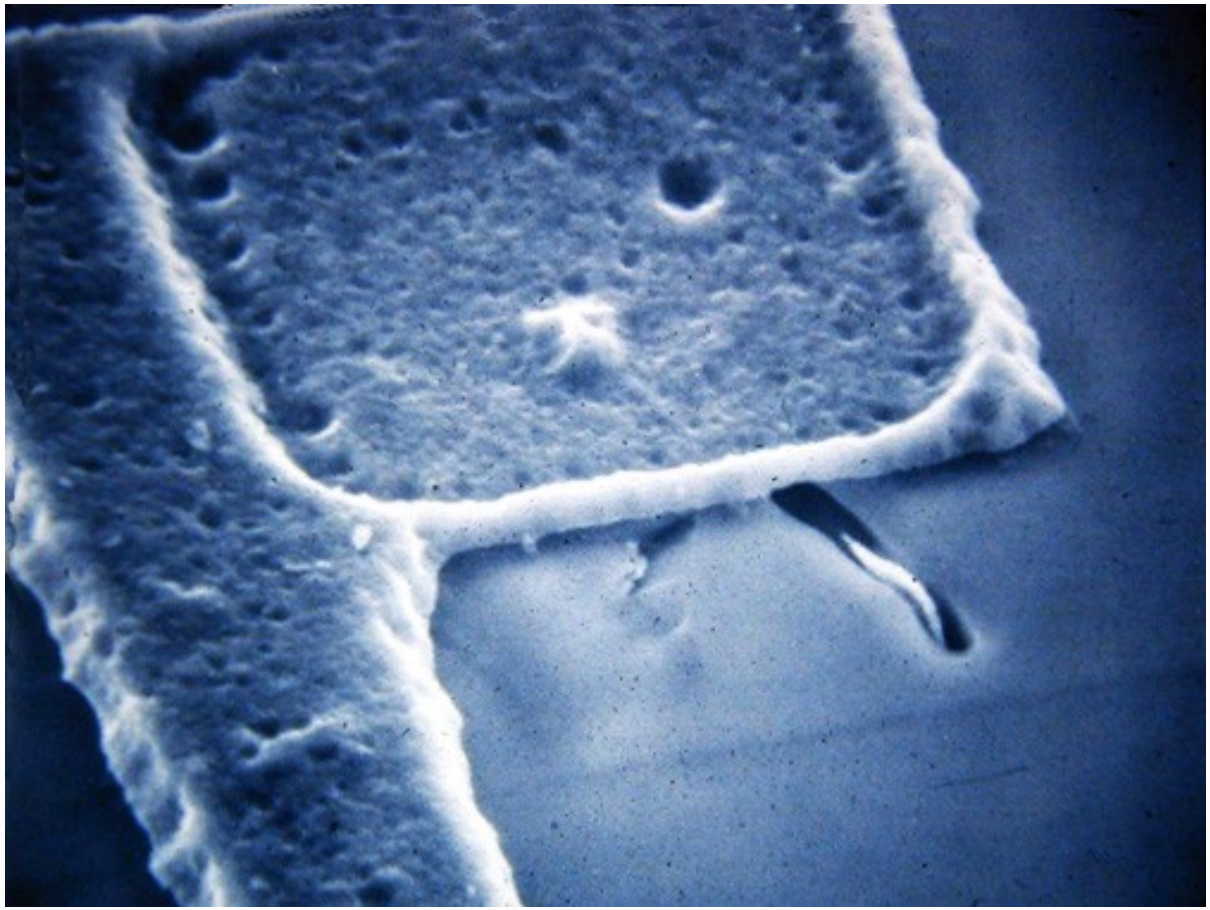
Photos courtesy of of Hi-Rel Laboratories, Inc., Spokane, WA

Higher magnification photo of pin noted by the arrow in the prior slide This taken at 400 times magnification on a 4" X 5" photo. The damage is noted as the "fuzz" at the end of the arrow.



Photos courtesy of of Hi-Rel Laboratories, Inc., Spokane, WA

Now you see it!! Overlying glassivation has been removed and the surface decorated to show the ESD damage at 5,000 times magnification in this scanning electron micrograph.

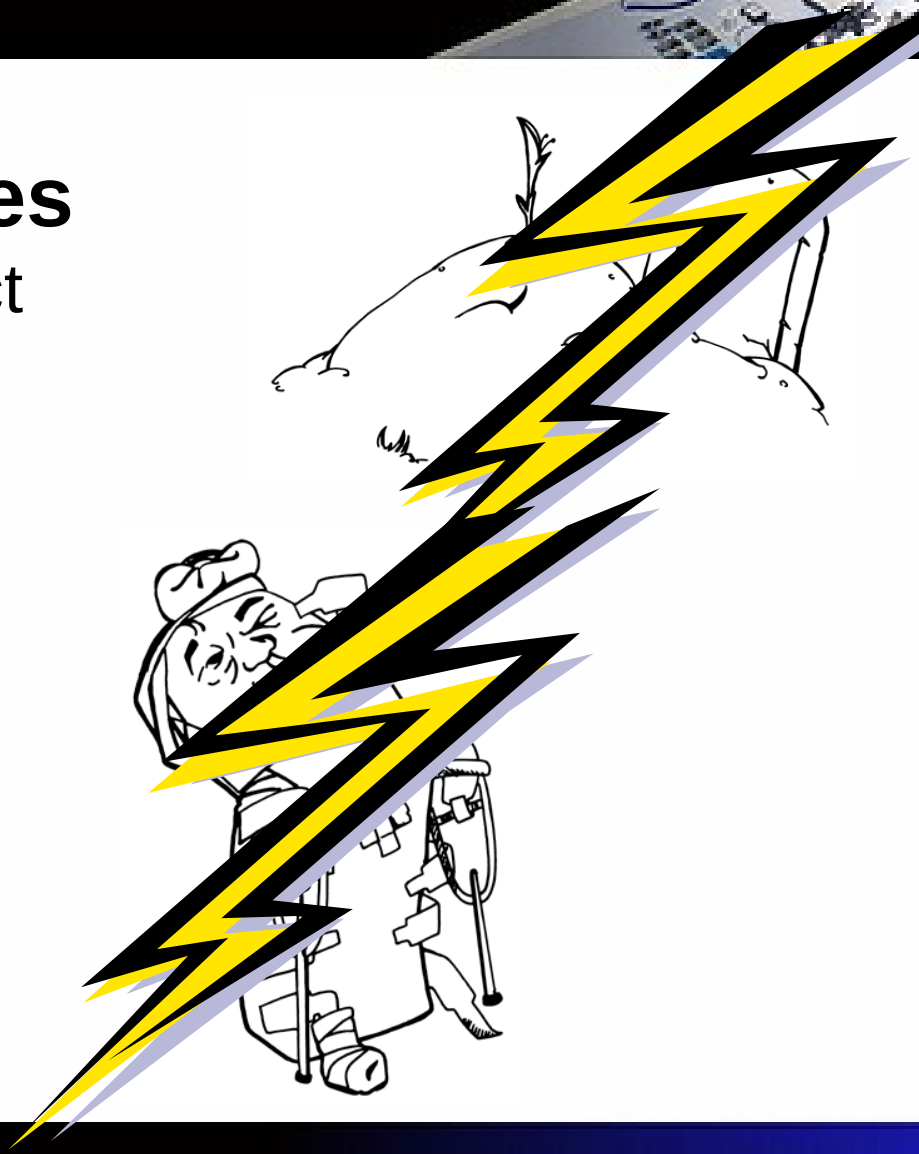


Photos courtesy of of Hi-Rel Laboratories, Inc., Spokane, WA

Types Of ESD Device Damage

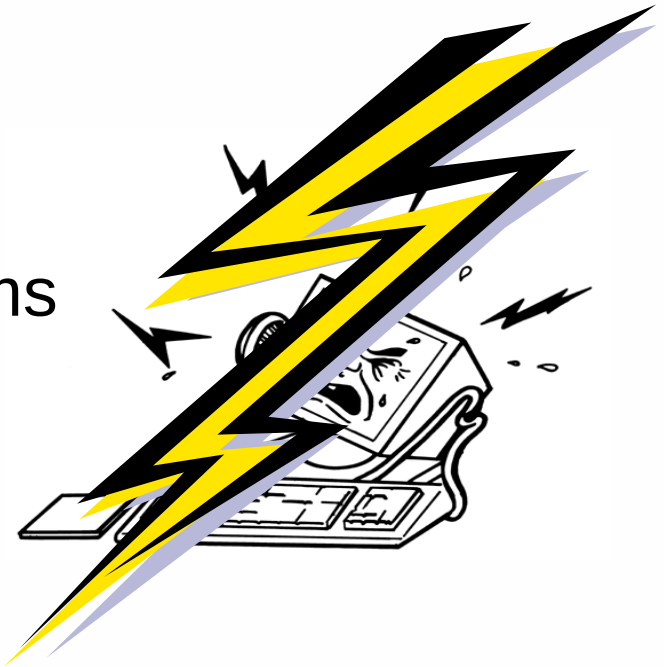
- **Catastrophic Failures**
  Inspection is able to detect failure

- **Latent Defect**
  Component wounded but Inspection passes as good



Latent Defects More Costly

- Sub Assembly passes inspection
- Assembly passes inspection
- Product passes inspection
- Works a while for customer
- Then Upsets & Mysterious Problems
- More Returns
- More Warranty Costs
- Lower Customer Satisfaction



Repair Costs Increase if Failure Detected Later

One study indicated the repair cost to be:
$10 Device
$10 Device in board - $100
$10 Device in board and in system - $1,000
$10 Device and system fails - $10,000

Catastrophic failures are detected during inspection but components with latent defects pass as good

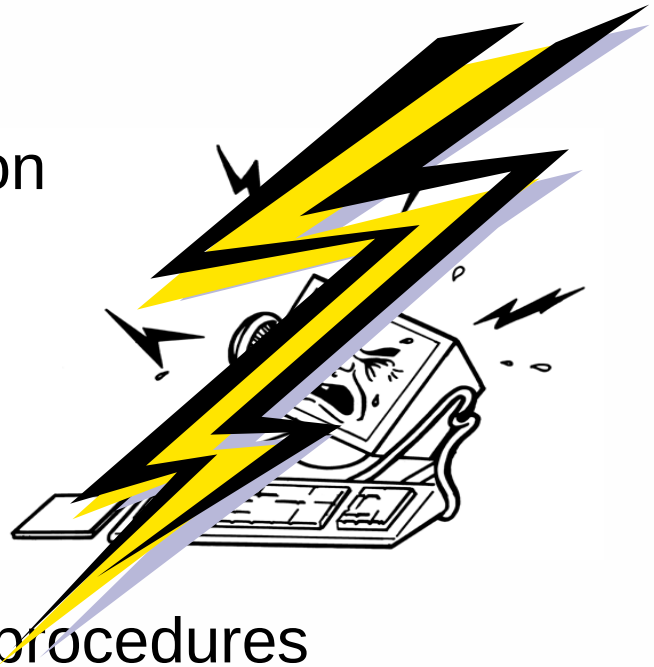
Latent Defects Most Frustrating

- Pass inspection as good
- May fail later
- Cause equipment down time
- Costly field repair work
- Adversely impacting customer satisfaction

Hidden Enemy

ESD damage may occur

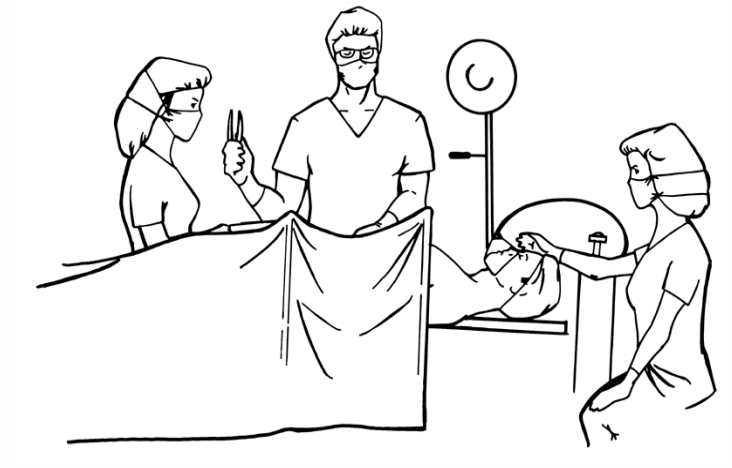
- Cannot be felt
- Cannot be seen
- Not detected through normal inspection procedures



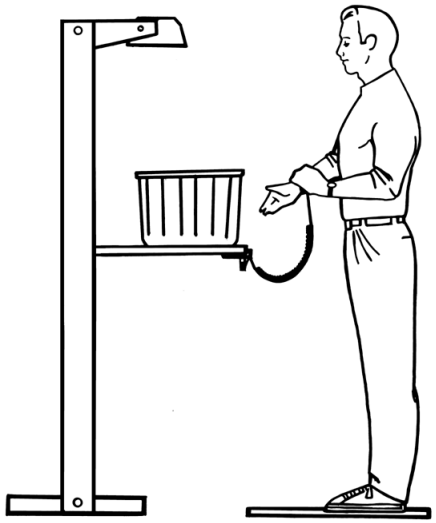
Like Germs, ESD Is The Hidden Enemy

terilization in medicine

Control Germs



Control ESD



You would never consider having surgery in a contaminated operating room, you should never handle electronic assemblies without taking adequate protective measures against ESD

The Prerequisites of ESD Control

- Identify ESD Protected Area
- Identify ESD sensitive items
- Provide ESD control training

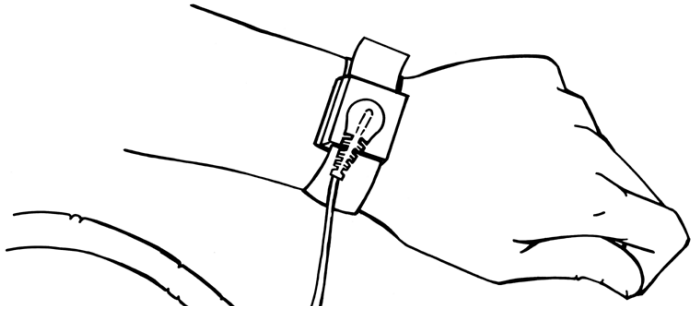
The Basics Of ESD Control

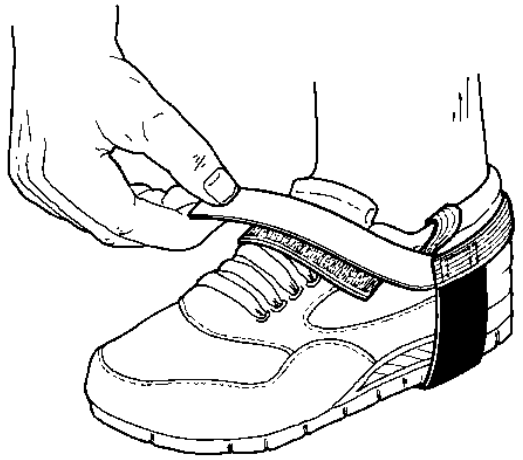
- Ground Conductors
- Remove or Neutralize Insulators with Ionizers
- Shield ESDS when Stored or Transported outside EPA

Ground Conductors
Including People

Personnel Grounding Devices

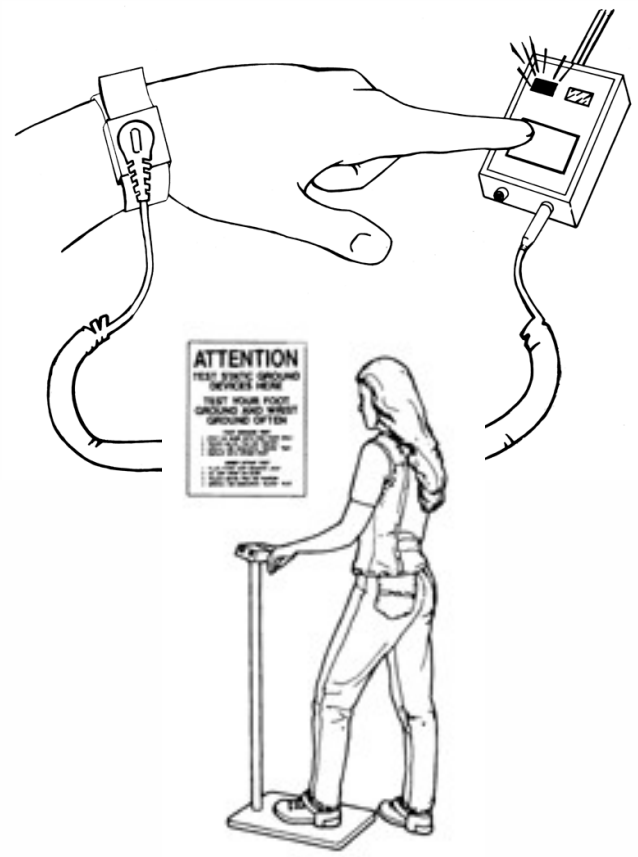
- Wrist Straps
  - Snug on skin
  - Clean
  - Cord connected to ground
- Foot Grounders
  - Grounding tab under foot
  - Worn on both feet
  - Contact to ESD floor



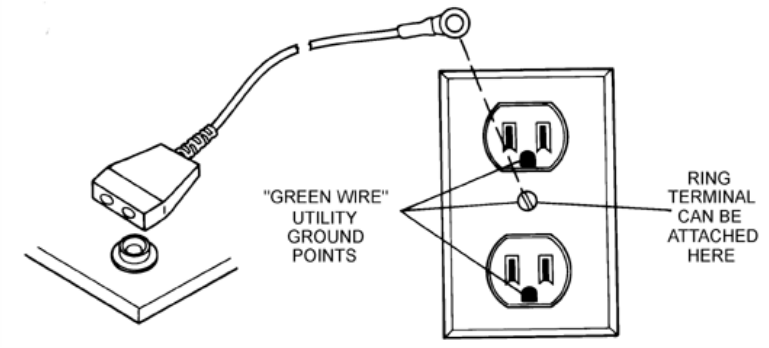


Daily Test Personnel Grounding Devices

- Wrist Straps
- Must work, so test wrist strap daily (or use continuous monitors)
- Foot Grounders
- Must work, so test foot grounder daily

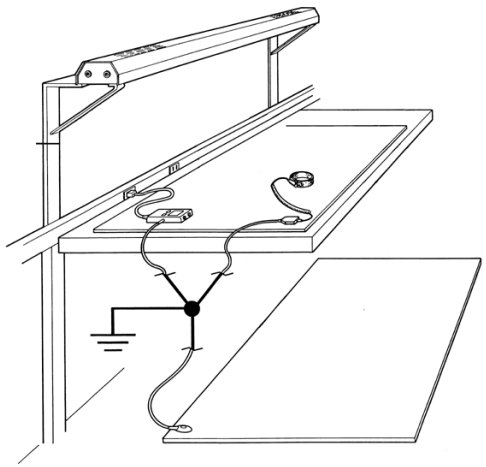


Workstation Grounding Devices



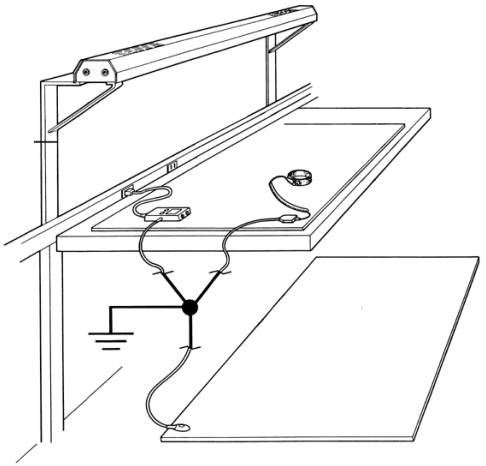
- **Dissipative Worksurfaces**
  - Ground ESD worksurface via ground cord to common point ground to equipment ground

- **Conductive Floor Mats**
  - Ground ESD floor mats via ground cord to equipment ground



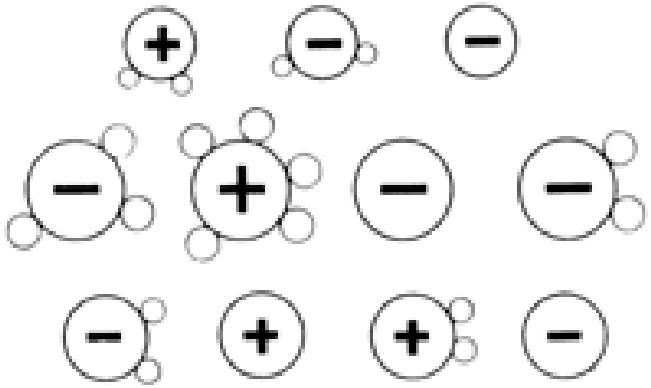
Clean Using Only ESD Cleaners

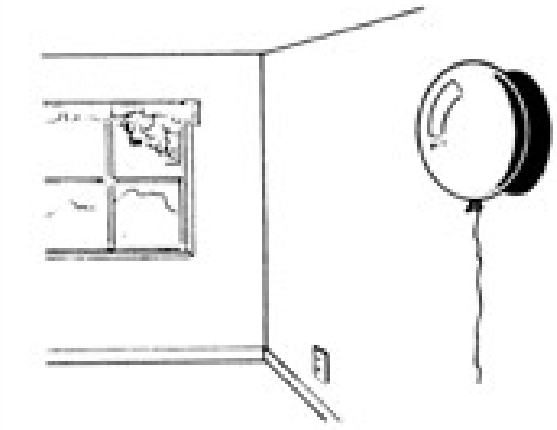
- **Dissipative WorkSurfaces**
  - You should be aware of the type of work surfaces and flooring materials used by your company
  - Be sure to keep your work surface clean, and follow the maintenance procedures recommended by the manufacturer
  - Regular cleaners contain silicone, an insulator



Neutralize Insulators Via Ionization

- Insulators cannot be grounded
- Ionizer air flow floods area with Ions
  - Neutralizing Charge





Direct Ionizer Air Flow to ESD Sensitive Items

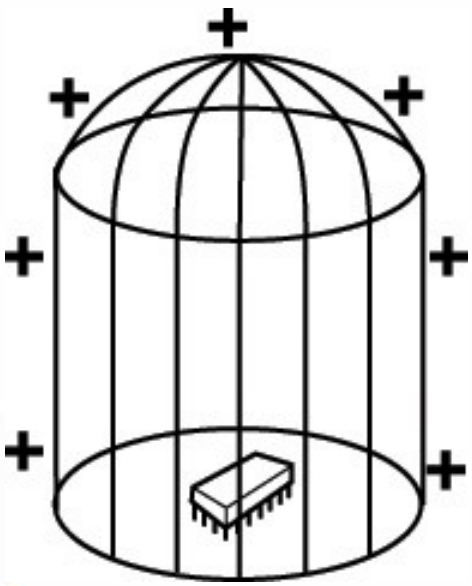
- Ionizers produce positively and negatively charged ions
- Fans airflow to cover the work area
- Ionization can reduce static charges on an insulator or isolated conductors

Types of Ionizers

- Bench Top Ionizers
- Neutralizing Air Nozzles / Hand Gun
- Overhead Ionizers
- Neutralize charges on insulators and isolated conductors
- Ionizers require periodic cleaning of emitter pins
- If out of balance (or voltage offset) they can charge items

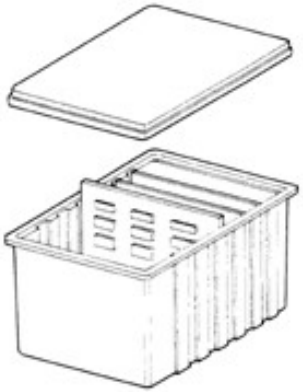
Shield ESD Sensitive Items Outside Protected Area

Faraday Cage effect charges to be conducted on surface of the conductor.



Since like charges repel, charges will rest on the exterior. Charges Kept on Outside of Package:

- Closed Metallized Shielding Bag
- Covered Conductive Tote Box



ESD Packaging

Electrostatic discharge shield "A barrier or enclosure that limits the passage of current and attenuates an electromagnetic field resulting from an electrostatic discharge."

- ESD bags should be closed and containers have lids in place
- ESD packaging only be opened at an ESD protective workstation by properly grounded personnel.

ESD Protected Workstations

An ESD protective workstation is an area that has been established to effectively control electrostatic charges.

- Grounding all conductors (including people)
- Removing all insulators
- Or neutralizing process essential insulators with an ionizer

ESD Protected Products

Best Practice Remove Insulator or Change to ESD Version

- ESD Garments and Gloves
- Conductive Foam & Shunt Bars
- Dissipative Binders & Document Protectors
- Conductive & Dissipative Flooring
- ESD Packaging, bags, boxes, etc.
- Antistatic or Low Charging Tape
- ESD Carpeting, Tiles, etc.
- Dissipative Floor Finishes
- Material Handling Containers

You Are On The Front Lines Fighting The Hidden Enemy

- Only allow trained or escorted people in EPA
- Ground all conductors including people at ESD workstation
- Test wrist straps at least daily, or use continuous monitors
- Test ESD footwear at least

You Are On The Front Lines Fighting The Hidden Enemy

- Visually check all grounding cords to make sure they are connected
- Handle unpacked ESDS items only when grounded
- Keep wristband snug, foot grounder grounding tab in shoe, and ESD smocks buttoned up

You Are On The Front Lines Fighting The Hidden Enemy

- Make sure Ionizers are maintained and air flow directed at ESDS items
- Use shielded packaging for shipping or storing ESD sensitive items outside the ESD Protected Area