



Electro Static Discharge Training

Nokia Siemens Networks HWS

Balázs Hegyi

04.2010

Commonly used abbreviations



- ESD (ElectroStatic Discharge)**, transfers of charge between bodies at different electrostatic potentials caused by direct contact or induced by electrostatic field.
- EOS (Electrical OverStress)**
- ESDS (ElectroStatic Discharge Sensitive Device)**, discrete device, integrated circuit or assembly that may be damaged by electrostatic fields or electrostatic discharge. Damage includes all types of deterioration and malfunction.
- EPA (ESD protected area)**, area in which the risk of damage to ESDS resulting from an electrostatic discharge or field is low.

ESD definition



ESD – Electro Static Discharge

- The sudden and momentary electric current that flows between two objects at different electrical potential caused by direct contact or induced by an electrostatic field.
- ESD is a serious issue in solid state electronics, such as integrated circuits. Integrated circuits are made from semiconductor materials such as silicon and insulating materials such as silicon dioxide. Either of these materials can suffer permanent damage when subjected to high voltages; as a result there are now a number of antistatic devices that help prevent static build up.

Resistance values



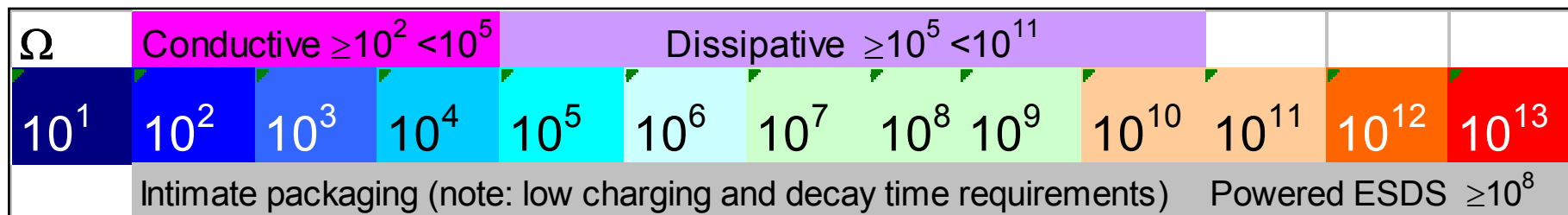
Unit of resistance is ohm = Ω

•Conversion table

- 1 k Ω = kilo-ohm = 1000 Ω = $10^3 \Omega$
- 1 M Ω = megaohm = 1000 000 Ω = $10^6 \Omega$
- 1 G Ω = gigaohm = 1000 M Ω = 1000 000 000 Ω = $10^9 \Omega$

Classification of materials:




- Conductive
- Dissipative
- Low charging
- Shielding
- Insulating



Example voltage levels



Examples of Static Generation Typical Voltage Levels		
Means of Generation	10-25% RH	65-90% RH
Walking across carpet	35,000V	1,500V
Walking across vinyl tile	12,000V	250V
Worker at bench	6,000V	100V
Poly bag picked up from bench	20,000V	1,200V
Chair with urethane foam	18,000V	1,500V

Sensitivity Level of a Human		
Felt	Heard	Seen
		
> 3 000 V	> 4 000 V	> 5 000 V

What causes ESD?



- ESD usually results when two objects touch, rub or slide together, or are separated. Even two charged objects coming close together--without touching--can cause ESD.
- ESD is often caused by people.
- Your body easily picks up charge (electrons)
- Your skin, hair and body can store relatively large amounts of static charge.
- You can transfer (discharge) this electrical charge to components or assemblies - causing ESD Damage.

What causes ESD?



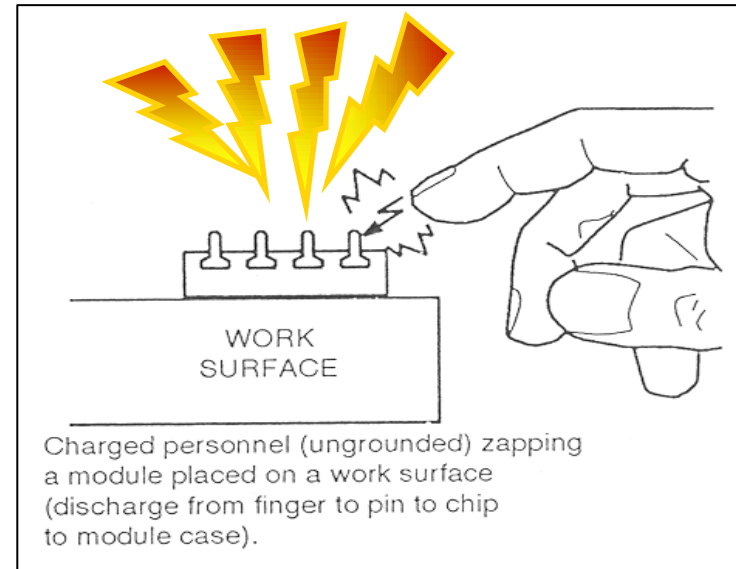
The most common causes of ESD damage:

- Hand coverings
- Ungrounded operators walking with ESDs items
- Ungrounded operators walking with ESDs items in open bags, trays and containers
- ESDs items transportation on ungrounded trolleys
- ESDs items on nonESD surfaces
- Aged antistatic packaging
- Conformal coating

What causes ESD?



- Plastic folders
- Cover of equipment
- CDs
- Plastic pens
- Packaging foils, bags
- Papers, documents
- Plastic spray flacons
- Articles for personal use:
 - Purse, sweater, coat, handcream plastic flacon, backpack, bag, etc...

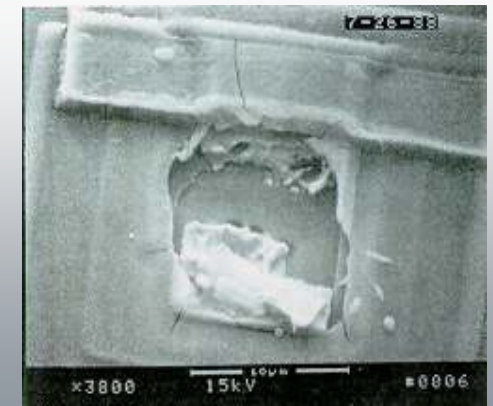
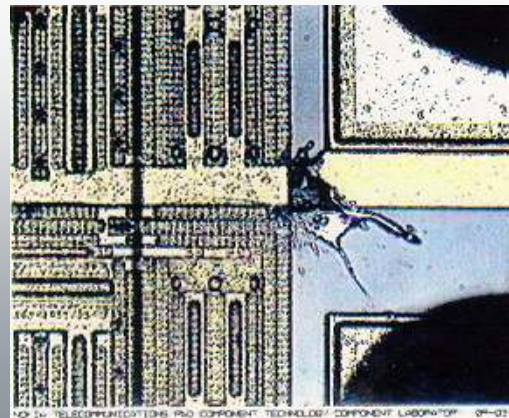
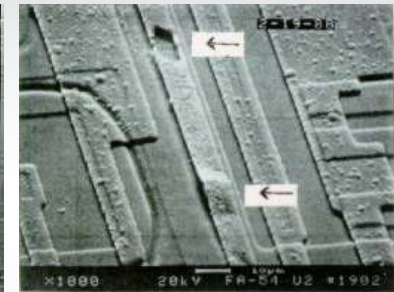
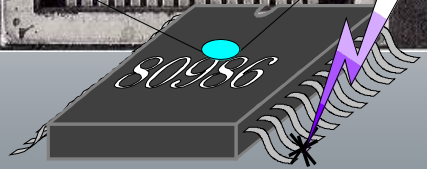
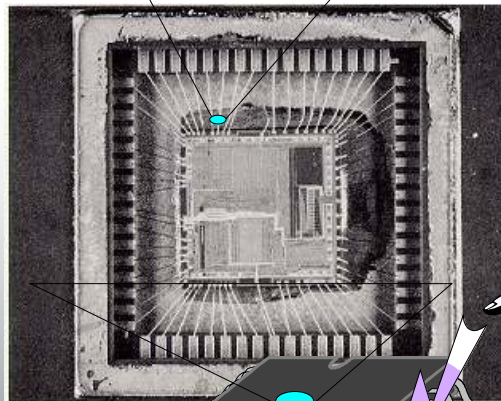


These unnecessary tools and equipments have to be eliminated from the work station!

Damage by discharge



A common paper has a thickness of $100\ \mu\text{m}$. In comparison, the width of the wire inside of a component is about $0,35\ \mu\text{m} = 0,00035\ \text{mm}$. We can easily understand how sensitive a component can be.



ESD preventive action



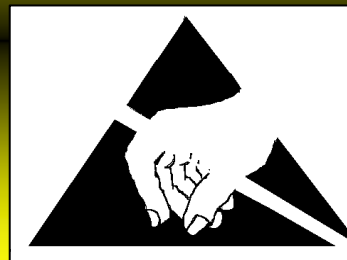
- Monitored ESD protected production floor
- Personal grounding
- ESD sensible material handling



ESD protected area



- A protected work area must be provided wherever ESD sensitive parts, assemblies and equipment are handled. This protected area must be constructed, equipped and maintained with the necessary ESD protective materials and equipment to insure that voltages are below the sensitivity level of the most ESD sensitive item handled in the work place.
- ESD protected area is an area where workers work and deal with ESD sensitive items in a safe environment from harmful electrostatic charges.
- ESD protected area has to be marked according to the standard (e.g. tape on the floor)



ESD protected area



EPA (ESD protected area) including machines

- All conductive and dissipative parts have to be grounded
- Parts to be contacted with ESDS have to be made of static dissipative material
- Non-essential insulating materials excluded
- Minimise the risk due to possible charging of essential insulators for example by ionisation

Transportation

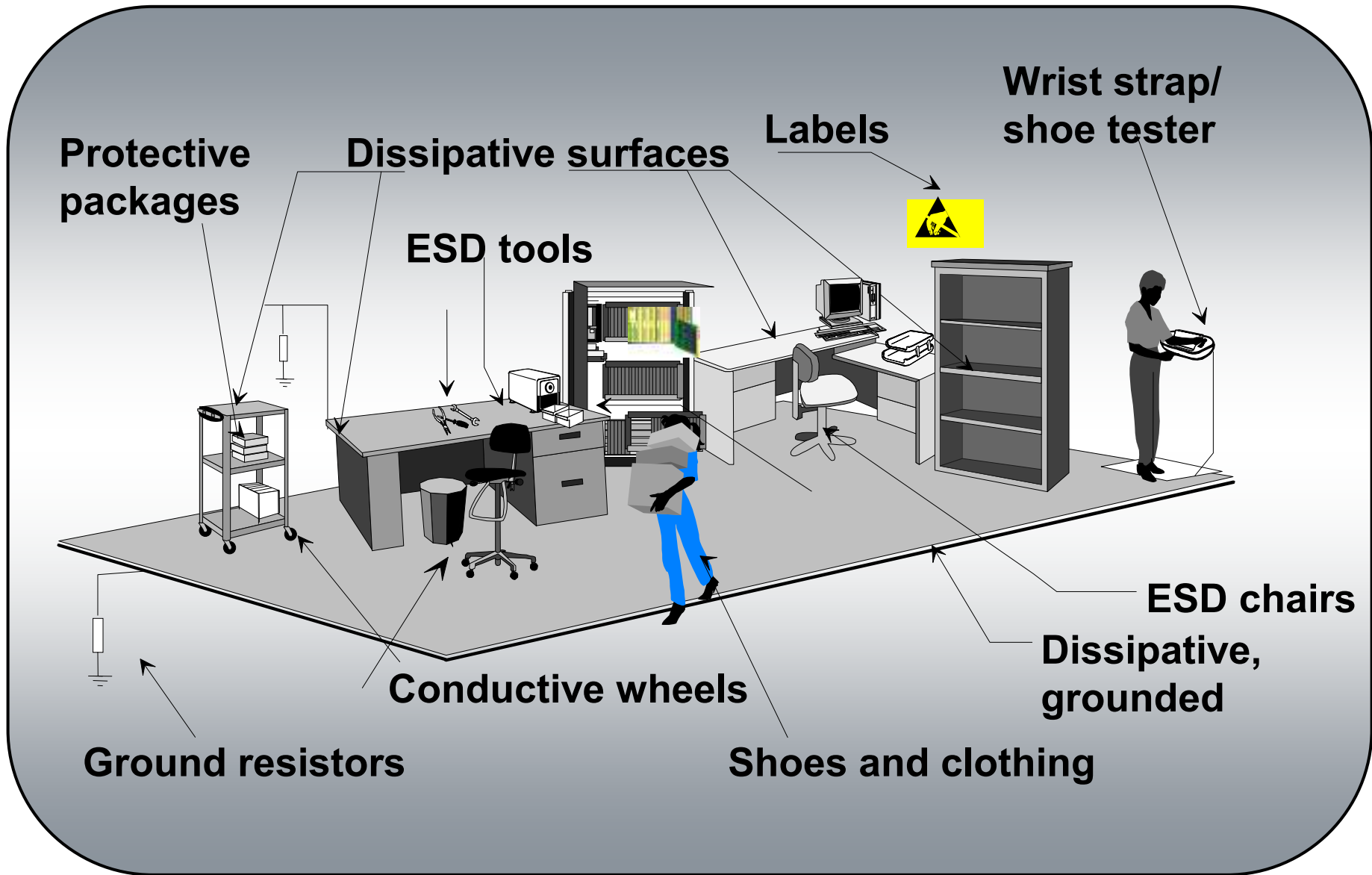
- Protect ESDS with protective packaging when transported outside the EPA

Requirements in the EPA



- Generally materials, which can be in contact with ESD sensitive items, must be made of electrostatic dissipative material. This requirement applies work surfaces, trolleys, selves, jigs, support pins and so on.
- Chargeable material in EPA shall be avoided, electrostatic field $< 10\ 000\ \text{V/m}$.
- Work surface, trolleys, floors, machine etc. have to be grounded. Resistance to ground of materials in contact with ESDS has to be between $0.1\ \text{M}\Omega$ and $1000\ \text{M}\Omega$.
- Wrist strap system, $R_g : < 35\ \text{M}\Omega$.
- Flooring/footwear system: $R_g < 35\ \text{M}\Omega$ or $R_g < 1000\ \text{M}\Omega$ and body voltage $< 100\ \text{V}$.
- In many items there is no lower limit for resistance, it could be needed for safety reasons.

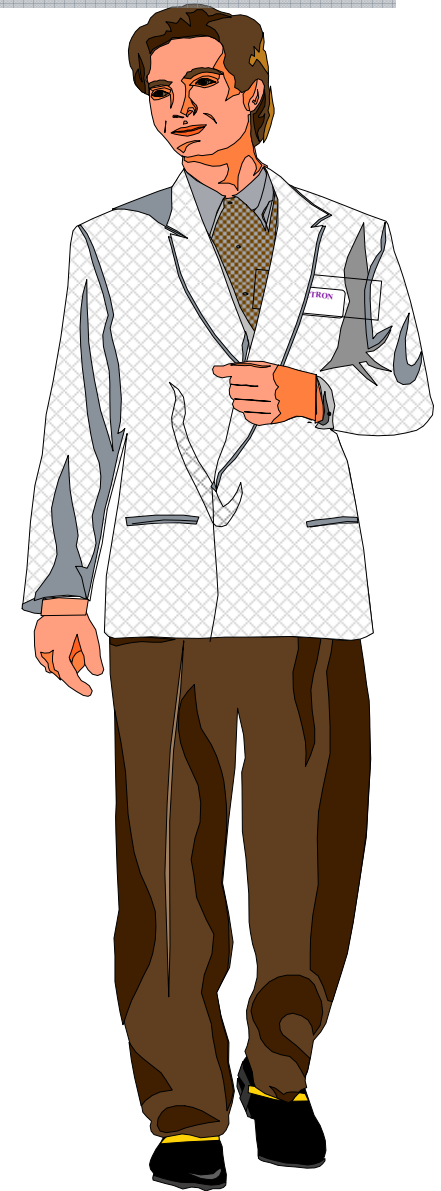
ESD protected area



Personal grounding



- Everyone who enters on ESD area has to wear ESD footwear and wrist strap (in sitting position) and fastened, static control jacket (ESD jacket)
- All kinds of clothing under the jacket must be covered by ESD jacket (hood, collar, shirt-sleeve, mobile phone, etc.)
- Jacket-sleeve has to be contacted with body skin.
- 3 buttons have to be buttoned up at least on the ESD jacket.
- In case of sitting work it is forbidden to put any non ESD material among the ESD jacket and the chair (foam, carton)



Total resistance and potential of person (person + floor)

- When standing
- When sitting
- When sitting, feet not touching the floor
- Same measurements with and without of wrist straps

Personal grounding

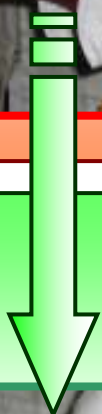
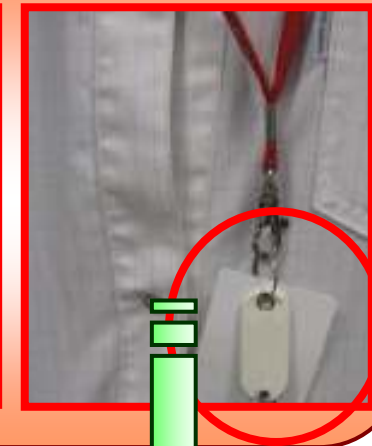


- Requirements for ESD protective clothing
- Electrostatically discharging protective clothing must consist of a one- or two-piece garment which has to cover the wearer's body, arms and legs at all times.
- The clothing has to be designed in a way as to allow the charge through contact of the conducting parts of the fabric with the skin to flow off.
- Turn-ups at the end of the clothes, such as on the sleeves, trouser legs or collar, have to improve the possible contact of the electrostatically conducting material and the skin.
- Metal parts in the ESD protective clothing have to be covered.
- In order to prevent the dangerous discharge of the underclothing this must fully be covered by the overgarments. Thus, the jacket of a two-piece protective suit should be long enough to also cover the waistband when the wearer bends over.

Examples



False examples



Right examples



Footwear and wrist strap check



- **ESD footwear wrist strap**

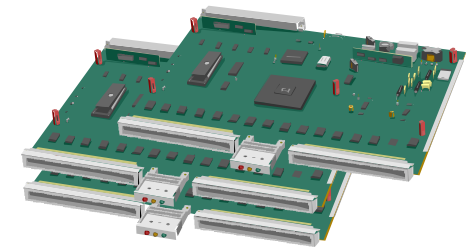
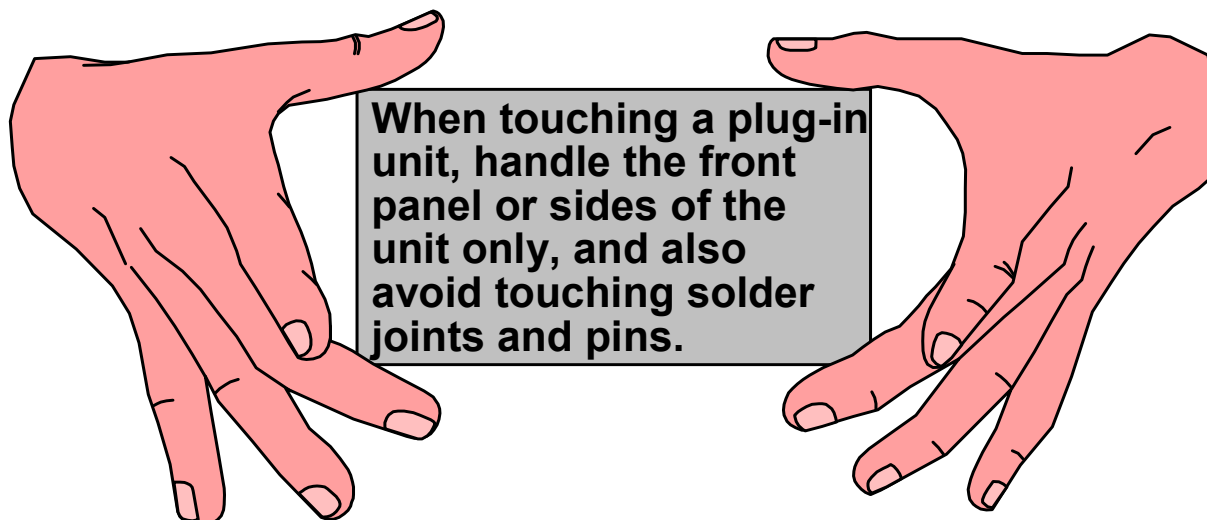
- Everyone who works in EPA has to wear ESD wrist strap and footwear
- Daily checking and subscribing the ESD checklist is obligatory
- Footwear and wrist strap tests have to be done separately



ESDS material handling



- Work environment must be kept clean.
- Charge generating non-conductive materials, which are used in some types of packaging must not be brought into the area.
- The components are kept in their original packaging until needed.
- Removal of components or units from their packaging is done only in ESD protected areas.
- When the parts are taken outside the protected area, they must be transported in protective packaging.



ESD co-ordinator's tasks



- approving usage of the protective materials
- following the standards and the literature
- taking part in the ESD audits
- giving the advice and solving the ESD problems
- arranging the training

Controlling and monitoring



Periodic checks

Item	Responsible person	Daily	Weekly	Monthly Note 1	Year	2 years	
Wrist straps before use and footwear/heel straps before entering the EPA (primary gnd method)	Operator	X					
Visual check as described in visual ESD indicator	Operator	X					
Visual ESD indicator, recommended: Grounding of work surfaces The use of wrist straps and footwear/heel straps Checking of wrist straps/footwear measurements Existence of forbidden material in work area	Operator, named person		X				
Resistance to ground of work surfaces	EPA maintenance or ESD co-ordinator			X			
Resistance to ground of shelves				X			
Resistance to ground of trolleys				X			
Resistance to ground of chairs				X			
Resistance to ground of floors				X			
Resistance to ground of soldering irons				X			
ESD garments				X			
EPA ground facility						X	
Ionizers Note 2)						X	
Calibrations of measuring equipment						X	
ESD-audits						X	

Questions?