



ESD Control Program

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Agenda

- Purpose
- What is Electro-Static Discharge
- Cause and Effects of ESD damages
- ESD Prevention program
- ESD Floor Options and comparison
- Personal grounding requirements
- Equipment and storage requirements
- Operational processes

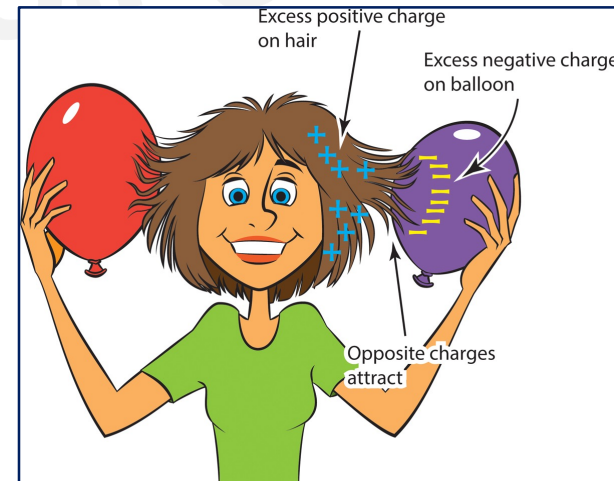
The purpose of this document is to provide administrative and technical requirements for establishing, implementing, and maintaining an ESD control program for organisations involved in manufacturing of electronic products.



Electrostatic Static Discharge

Electrostatic discharge (ESD) is a sudden and momentary flow of electric current between two electrically charged objects caused by contact, an electrical short or dielectric breakdown.

A build-up of static electricity can be caused by electrostatic induction. The ESD occurs when differently-charged objects are brought close together or when the dielectric between them breaks down.



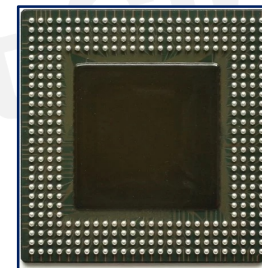
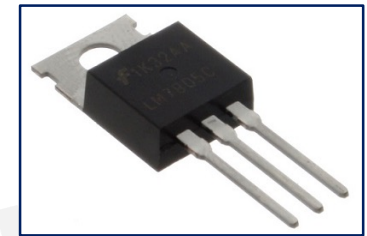
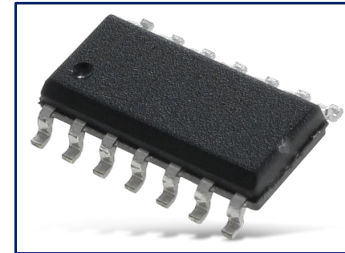
Static Generation Voltage Levels

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
Polybag picked up from the bench	20,000V	1,200V
Chair with urethane foam	18,000V	1,500V

Component damage can occur even <100V

ESD Sensitive Components

- MOSFET Transistors, used to make Integrated circuits (IOC's)
- CMOS IC's (Chips)
- PCBA's
- TTL Chips
- Laser Diodes
- LED's
- High precision resistors



When in doubt, treat the component as ESD sensitive component.

ESD Component Sensitivity Classification

ESDS Component Sensitivity Classification -
Human Body Model
(Per ESD STM5.1-1998*)

Class	Voltage Range
Class 0	< 250 volts
Class 1A	250 volts to < 500 volts
Class 1B	500 volts to < 1,000 volts
Class 1C	1000 volts to < 2,000 volts
Class 2	2000 volts to < 4,000 volts
Class 3A	4000 volts to < 8000 volts
Class 3B	> = 8000 volts

ESDS Component Sensitivity Classification -
Machine Model
(Per ESD STM5.2-1999*)

Class	Voltage Range
Class M1	< 100 volts
Class M2	100 volts to < 200 volts
Class M3	200 volts to < 400 volts
Class M4	> or = 400 volts

ESDS Component Sensitivity Classification -
Charged Device Model
(Per ESD STM5.3.1-1999*)

Class	Voltage Range
Class C1	<125 volts
Class C2	125 volts to < 250 volts
Class C3	250 volts to < 500 volts
Class C4	500 volts to < 1,000 volts
Class C5	1,000 volts to < 1,500 volts
Class C6	1,500 volts to < 2,000 volts
Class C7	=>2,000 volts

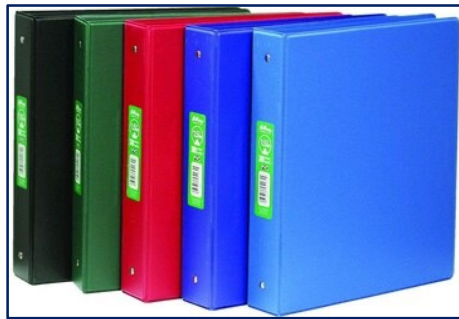
The ESD sensitivity of a device is usually specified in terms of the highest ESD test voltage that it passes and the lowest ESD test voltage that it fails per ESD model.

Common Causes on Shop Floor

Some of the common instances, where the static charge is generated on the shop floor

- Walking on a non ESD floor
- Opening a plastic bag
- Removal of adhesive tapes from the packages
- Movement of boards without ESD trolleys
- PCB Movement on non ESD tables
- Covering PCBA with plastic wraps and removing those wraps

ESD Sources on the Shop Floor



Vinyl Binders



Paper Holders



Bubble Wrap



Sweater



Plastic Wraps



Plastic Bottle



Purse



Papers

ESD Damages

Catastrophic Failures

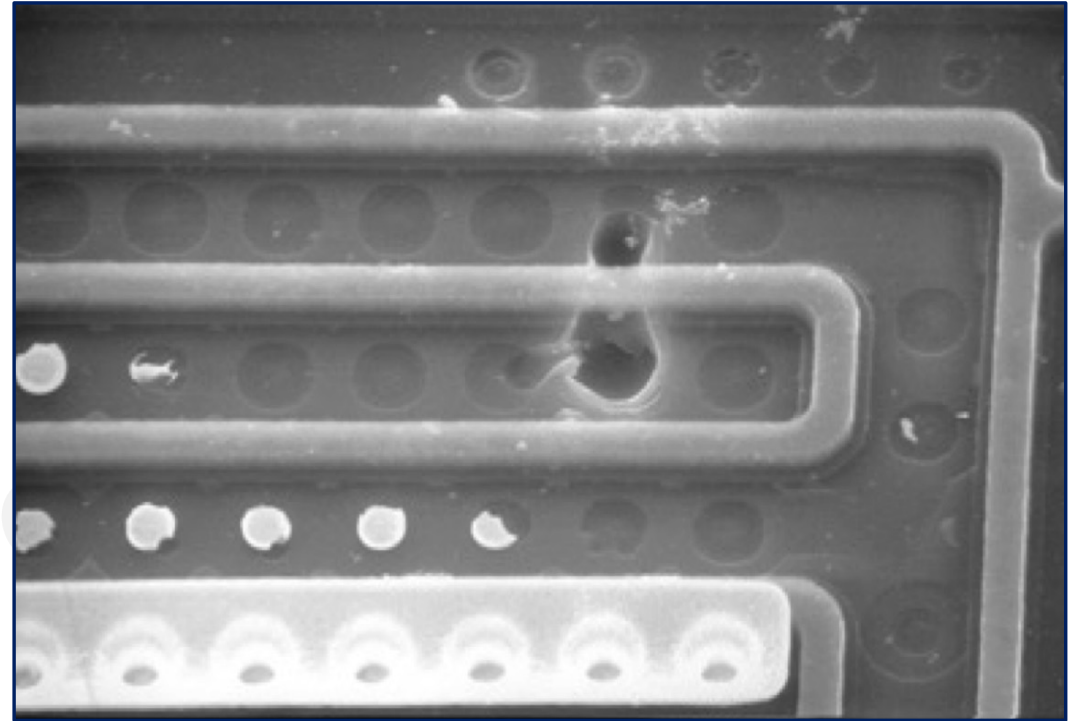
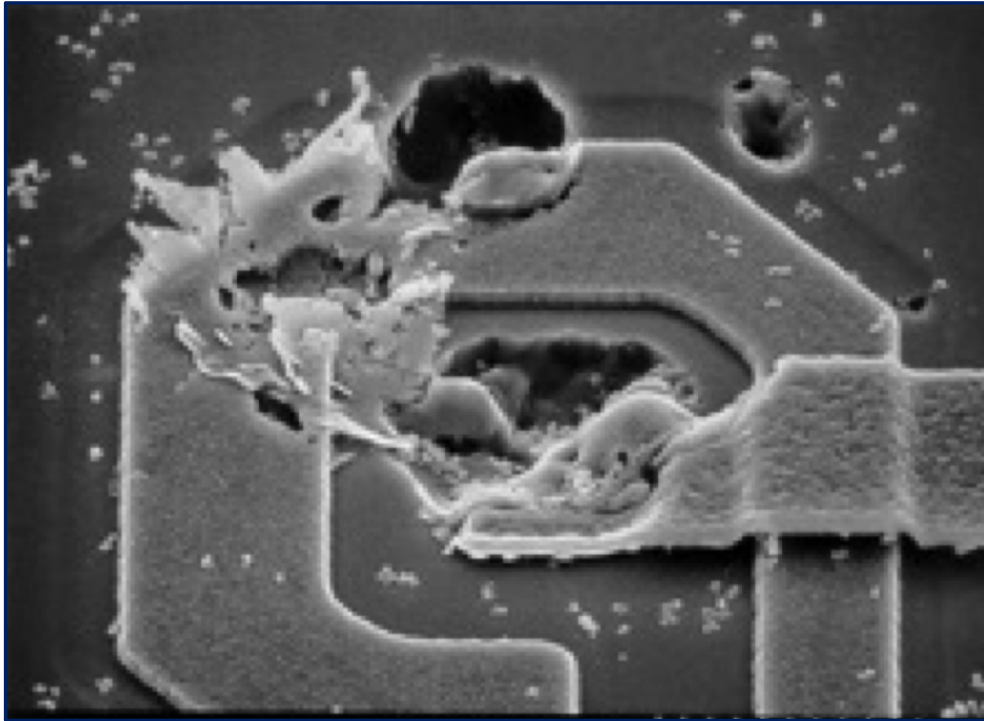
- When an electronic device is exposed to an ESD event, it may no longer function.
- The device's circuitry is **permanently damaged**, causing the device to stop functioning totally or at least partially.
- Such failures usually can be detected when the device is tested before shipment.
- If a damaging level ESD event occurs after testing, the damage will go undetected until the device fails at customer end.

Latent Failures

- The device that is exposed to an ESD event may be **partially degraded** yet continue to perform its intended function.
- Therefore, a latent defect is difficult to identify. Still, the operating life of the device may be reduced.
- A product or system incorporating devices with latent defects may experience premature failure after the user places them in service.
- Such failures are usually costly to repair and, in some applications, may create personnel hazards

ESD Damages

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Images courtesy of JPL Analysis and Test Laboratory

The cost of latent failures is much more compared to immediate failures.

ESD Prevention Program

- ESD Control areas design and implementation
- Personal protection
- Equipment protection
- ESD Procedure generation
- Training and implementation
- Periodic Audits and MIS Reporting
- Operational procedures definition

ESD Area Design and Implementation

- The first step of implementation an ESD program is the ESD floor. There are multiple ways to convert a normal floor to a ESD floor. These are
 - ESD Mats
 - ESD Tiles floor
 - ESD Epoxy floor
- The entry of the shop floor needs to be controlled with an ESD tester at the entrance. There are two ways to do it
 - Manual tester
 - ESD Turnstile gates

ESD Floor Options - Mat



Pro's

- Easy to Install
- Can be replaced in local areas , if there is a damage due to machine movement etc.
- Easy to maintain cleanliness.
- Can be procured along with the table mats. This helps in better price negotiations.
- Low cost solution

Con's

- Aesthetics compromised compared to ESD tiles or Epoxy floor.
- Can be easily damaged during the machine movement, especially if the base floor is uneven.
- Shorter service life

ESD Floor Options - Epoxy



Pro's

- High durability
- High electrostatic discharge performance
- Moderate cost solution
- Great aesthetic look of the shop floor
- Variety of colour options available

Con's

- Specialised installation process
- Shine cannot be restored once the surface is damaged
- Very difficult to repair if there is a damage in local areas

ESD Floor Options – ESD Conductive Tiles



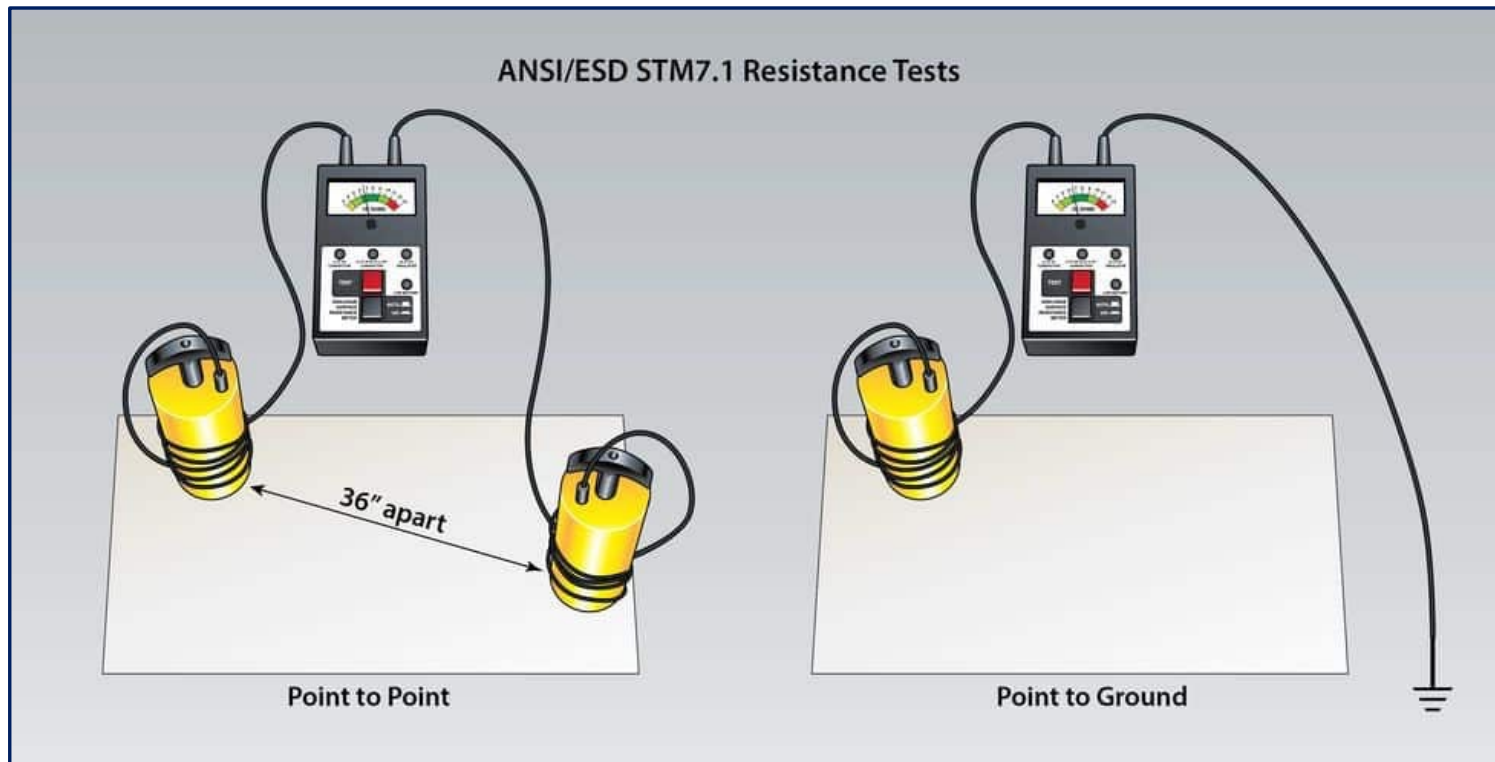
Pro's

- Good aesthetics, variety of options to choose from. Consistent colour through the floor
- Excellent durability
- Surface scratches can be removed using abrasive buffing
- Easy and fast installation
- Moderate cost of maintenance

Con's

- Comparatively high upfront cost
- Can be damaged in case the ground floor is not laid properly

ESD Floor Verification Process



- ESD Floors needs to be verified periodically using resistance tests
- The areas which are not meeting specifications, needs to be isolated from production and required repair work needs to be performed accordingly
- Test records needs to be maintained as per defined procedures

ESD Personal Grounding - Aprons



ESD Aprons or Smocks

- Everyone entering the ESD safe area, needs to wear ESD aprons before entering the designated area.
- The Aprons sleeves should touch the skin and clothing underneath the Apron must not be visible.
- The front snaps or buttons must be closed all the time at the shop floor.
- The apron can be of any colour. However, some organisations choose to define different colour of different functions like quality, production, visitors etc.

ESD Personal Grounding - Shoes

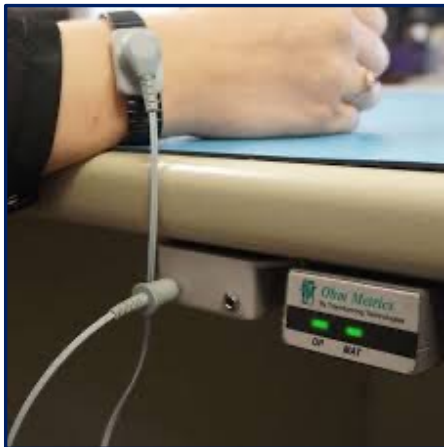


Everyone on the shop floor needs to be grounded all the time. This can be achieved by one of the method as explained below

- ESD Shoes – The person need to remove their own shoes and put on ESD shoes before entering the shop floor.
- Heel Strap or Shoe cover – It can be worn on top of the usual or regular shoes. However, the ESD straps must be inserted in the socks to make a connection with the skin.

Before entering the shop floor , grounding needs to be verified using the ESD tester.

ESD Personal Grounding – Wrist Strap



- While working on the assembly station, it is quite possible that the operator do not keep at least one of their foot on the ground.
- In this case, it is recommended that every operator while working on their assembly station wear a wrist strap. The same wrist strap needs to be grounded as defined.
- As a good practice, it is recommended that every operator verify their wrist band using a tester before entering the shop floor.

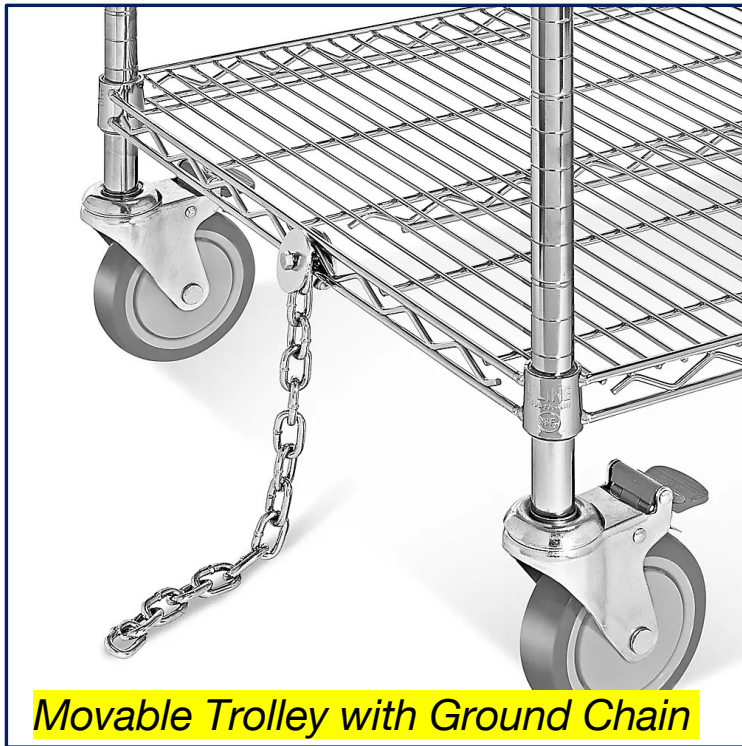
ESD Personal Grounding Testers



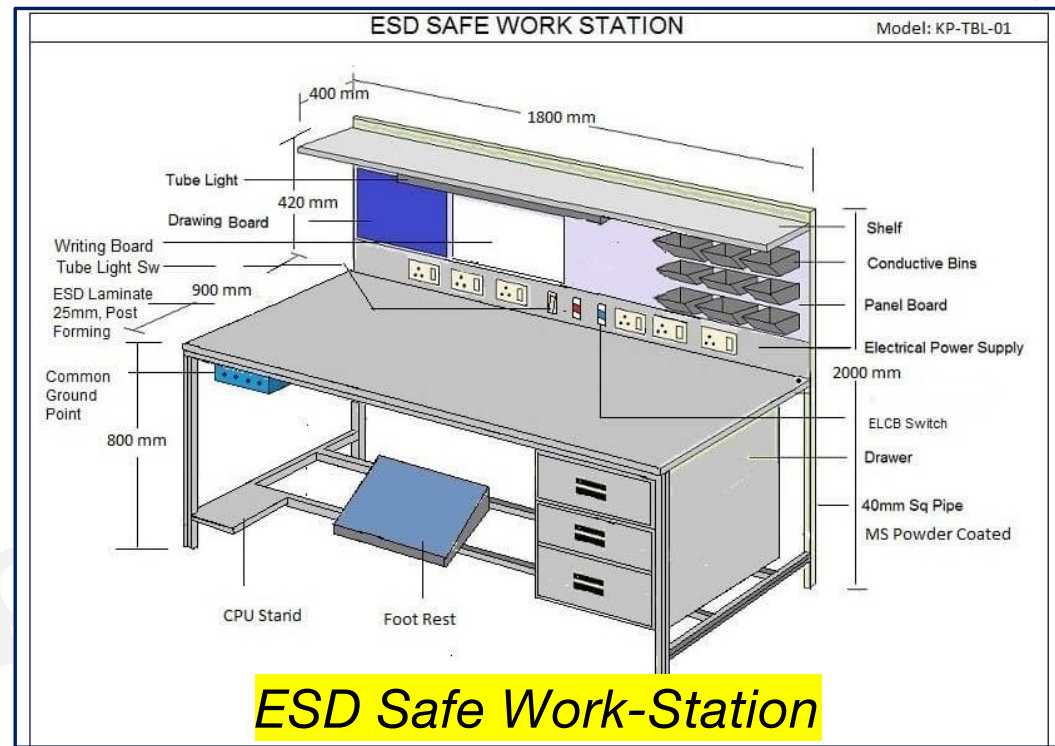
ESD Turnstile Gate

- It is recommended to install an ESD turnstile station at the shop floor entrance.
- The purpose of the turnstile gate is to verify the shoe grounding and working of the wrist straps before entering the shop floor.
- It is a poke yoke process, where everyone need to pass the test before entering the shop floor.
- In case the turnstile is not in place, manual ESD testers needs to be installed.

Equipment Grounding



At attached drag chain to be used to contact the ESD floor all the time



Each work-station needs to be verified for ESD effectiveness as per defined frequency

ESD Storage Bins



ESD Safe Conductive Storage Bins

- All the bins on the shop floor must be ESD safe.
- All the storage bins need to be verified periodically for their conductive or dissipative properties. The verification needs to be recorded on each bin in the form of a label.
- It is recommended to keep the material in supplier original package if possible. This avoid any potential ESD exposure to the components.

ESD Operational Process

- It is recommended to have an ESD champion in the organisation. The champion will be responsible for implementation and execution of the overall ESD program in the organisation.
- All the operators once hired, must be trained on ESD process. It is also recommended that a refresher training to be conducted every six months for everyone working on the shop floor.
- ESD Compliance must be a part of the daily process audit process. All the abnormalities needs to be reported as part of the monthly MIS and tracked for effective closure.
- All the visitors must follow the ESD process defined in the organisation. The host needs to make sure that the Aprons, ESD shoes or shoe covers etc are made available to the visitors accordingly.
- It is also recommended to have an ESD done by 3rd party consultants every two years.

Generic Guidelines

- It is recommended to keep the ESD safe area neat and clean.
- To correctly maintain and clean your ESD smocks, we should wash the garment in warm or cool water, tumble dry with low heat (up to 60°C) or hang dry. We recommend to only use non-ionic softeners and detergents when laundering; do not use bleach to clean your clothes as this can erode the carbon threading.
- For ESD shoes Keep the outsole very clean and free of all dirt, debris and other contaminants. Scrub the outsole using a mild soap and water solution.
- The floor cleaning needs to be done using soft non-ionic detergents and without using any steel wool etc. The hard cleaning might damage the ESD properties of the ESD floor.



Do you have more questions on topic ?

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Thank You

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