



# Standard Operating Procedure

Title: Electrostatic Sensitive Devices (ESD)

Document No.: SOP 15-05

Reference: Lord Corporation Quality Manual Section 15

Sponsoring Unit: Quality Department

Applicable Documents:

- (1) MIL-HDBK-263, Handbook for Protection of Electrical & Electronic Parts
- (2) MIL-STD-1686, ESD Control Program for Protection of Electronic Parts
- (3) MIL-HDBK-773, Handbook on Electrostatic Discharge Protective Packaging
- (4) MIL-PRF-87893, Workstation, Electrostatic Discharge (ESD) Control
- (5) EOS/ESD-S5.1, EOS/ESD Association Standard for ESD Sensitivity Testing, Human Body Model (HBM) - Component Level<sup>1</sup>
- (6) ESD-S5.2, ESD Association Standard for ESD Sensitivity Testing, Machine Model (MM) - Component Level<sup>1</sup>
- (7) ESD-S5.3, ESD Association Standard for ESD Sensitivity Testing, Charged Device Model (CDM) - Component Level<sup>1</sup>
- (8) VZAP-95, Electrostatic Discharge Susceptibility Data 1995, Reliability Analysis Center, P.O. Box 4700, Rome, NY 13442-4700
- (9) ANSI/ESD S 20.20-1999, Standard for the Development of an Electrostatic Discharge Control Program<sup>1</sup>

Attachments: [Appendix A](#) – ESD Protected Area (EPA)

## PURPOSE

The purpose of this document is to establish requirements for an Electrostatic Sensitive Device (ESD) control program to minimize the effects of ESD on parts, assemblies, and equipment.

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<sup>1</sup> Copies are available from the ESD Association, Inc, 7902 Turin Road, Suite 4, Rome, NY 13440-2069, website: <http://www.esda.org>

This procedure defines the performance requirements for an ESD control program for electrical and electronic parts, assemblies and equipment susceptible to damage from ESD. This procedure covers identification, testing, classification, assembly and equipment design criteria, protected areas, handling procedures, training, marking of hardware, protective covering and packaging, and provides for quality assurance requirements, audits and reviews.

## **POLICY**

It is the policy of the Lord Corporation that all ESD sensitive products be protected from electrostatic discharge during any activity that designs, tests, inspects, services, manufactures, processes, assembles, installs, packages, labels or otherwise handles electrical or electronic parts, assemblies and equipment susceptible to damage by static electricity.

## **APPLICATION**

This procedure applies to all Lord facilities and Lord Suppliers that handle ESD sensitive Lord products as part of a production process. Non-production laboratories are not required to implement all the measures of this procedure, but will benefit from using them as guidelines.

## **DEFINITION OF TERMS**

1. Assembly: A number of parts or subassemblies or any combination thereof joined together to perform a specific function and capable of disassembly.
2. Electrostatic Discharge (ESD): A transfer of electrostatic charge between objects at different potentials caused by direct contact or induced by an electrostatic field.
3. Equipment: An assembly or any combination of parts, subassemblies and assemblies mounted together, normally capable of independent operation in a variety of situations.
4. ESD Protected Area: An area which is constructed and equipped with the necessary ESD protective materials, equipment and procedures to limit ESD voltages below the sensitivity level of ESD Sensitive items handled therein.
5. ESD Protective Material: Material with one or more of the following properties: limits the generation of electrostatic charge; dissipates electrostatic charge; or provides shielding from electric fields.
6. ESD Protective Packaging: Packaging with ESD protective materials to prevent ESD damage to ESD sensitive items.

7. Part: One piece, or two or more pieces joined together, which are not normally subjected to disassembly without destruction of designed use. Parts, components and devices are synonymous terms.

## PROCEDURE

1. ESD Control Plan: Each Lord work area that handles ESD Sensitive parts shall implement and document the ESD control program for its area in accordance with the requirements of this SOP insofar as they differ from those steps specified in this procedure.
2. Subcontractor Control: All Lord subcontractors, suppliers and vendors that handle ESD Sensitive parts shall have established and implemented ESD control programs in accordance with, or equivalent to, this SOP. Requirements for ESD control programs and applicable ESD packaging requirements shall be passed down as Lord Purchase Order requirements (via Lord engineering drawings and/or specifications and quality clauses referenced on the purchase order).
3. Classification of ESD Sensitive Parts: Lord Product Engineering shall identify all ESD Sensitive parts on Lord drawing for the parts.
4. Protected Areas: Handling of ESD Sensitive parts, assemblies and equipment without ESD protective covering or packaging shall be performed in ESD protected areas (EPA) in accordance with ESD protective handling procedures as outlined in Appendix A. If there are practical considerations which preclude handling in the protected areas, alternative handling precautions and procedures shall be prepared and utilized in the unprotected areas. Electrostatic voltages and charges generated in areas where ESD Sensitive parts, assemblies and equipment are handled without protective covering or packaging shall be minimized to the lowest practical level.
5. Handling Procedures: Each affected area shall establish, document and implement ESD protective handling procedures insofar as those procedures differ from those laid out here. Special handling procedures shall be in the form of Work Instructions that include, as applicable, ESD damage prevention procedures to be used in all areas where ESD Sensitive items are processed.
6. Protective Covering: When not being worked on, or when outside protected areas, ESD Sensitive parts and assemblies shall be enclosed in ESD protective covering or packaging. Protective packaging of ESD Sensitive items shall be in accordance with MIL-STD-2073 codes GX, JK, JW, KB or KE for ESD Sensitive Items.
7. Lord Plants and Lord Suppliers shall provide ESD training to all personnel who perform or supervise any of the work associated with ESD Sensitive items.

## 7.1 Personnel Training

In addition to employees, any applicable sub-contractors, consultants and temporary personnel shall receive awareness or appropriate training to their activities.

Visitors should be made aware of the handling procedures.

Training records shall be maintained.

## 7.2 Course content

Items which shall be included in a training course

- Theory of the causes of charging
- Some basic theory of electrostatic discharge
- Special handling procedures
- Identification of ESDS in equipment
- Limits of the protection
- High voltage precautions
- Awareness of the procedures

## 8. Marking of Hardware: Marking shall be as specified below:

**Assemblies:** ESD Sensitive assemblies shall be marked with the EIA RS-471 symbol or the symbol for ESD susceptibility adopted by the ESD Association. The two are very similar. The symbol shall be located in a position readily visible to personnel when the assembly is incorporated in its next higher assembly.

**Equipment:** Equipment containing ESD Sensitive parts and assemblies shall be marked with the EIA RS-471 symbol or the symbol for ESD susceptibility adopted by the ESD Association, as shown below.



The symbol shall be located on the exterior surface of the equipment and readily visible to personnel prior to gaining access to ESD Sensitive parts and assemblies with the equipment. The following ESD caution statement should be placed adjacent to the RS-471 symbol:

**CAUTION!**  
**CONTAINS PARTS AND ASSEMBLIES**  
**SUSCEPTIBLE TO DAMAGE BY**  
**ELECTROSTATIC DISCHARGE (ESD).**

Lord engineering drawings and/or specifications shall define the location and size of required ESD markings.

9. Packaging: ESD protective packaging shall be in accordance with contract or purchase order requirements for ESD Sensitive items. If ESD protective packaging is not specified in the contract or purchase order, requirements for packaging shall be in accordance with MIL-STD-2073 codes GX, JK, JW, KB or KE for ESD Sensitive items. When ESD protective packaging is used, it should be marked with the ESD Association's standard symbol denoting protective packaging, as shown below:



10. Quality Assurance Reviews and Audits: Lord Quality shall address ESD control in the planning and preparation performed for quality assurance reviews and audits to ensure that these consistently address ESD control. Scheduled design, program reviews and audits shall include ESD control program requirements.
11. Failure Analysis: Failure analysis, when performed, shall consider ESD related failure modes and effects as part of the failure analysis.
12. Design Considerations to minimize the effect of ESD: Damage can be minimized by using design practice in devices and assemblies to make them less susceptible.

12.1 Design of Assemblies

Electronic assemblies should be designed to minimize damage due to ESD.

Consideration should be given to the use of the least sensitive devices possible, which fit all the necessary parameters of the design.

To prevent charge and voltage build up, consideration shall be given to the use of resistive and/or diode protection on edge connectors and other means of connecting inputs to and outputs from the assembly.

Consideration shall be given to the electrical connections of all unused Electrostatic Discharge Sensitive Devices (ESDS) inputs directly or indirectly to a suitable point, usually an appropriate power supply or ground as close as possible to the ESDS. Other inputs and outputs shall use this protection where appropriate.

Tracks leading to or from ESD sensitive devices shall be kept as far as possible away from the edges of printed wiring board except when they lead directly to a connector.

## 12.2 Packaging Design

Consideration should be given at the design stage to ESD packaging.

## 12.3 Design for Service.

All systems that contain ESD sensitive devices and are liable to be serviced in a stand alone configuration shall be designed such that they can be maintained in accordance with this standard. Where size permits an ESD bonding point shall be provided.

## 13. Disposition of ESD Compromised Material

In the event that materials that should have been protected against ESD damage were not protected, the following rules shall be followed.

13.1. Potentially compromised units shall be processed in accordance with SOP 13-01 and appropriate corrective measures taken. All potentially ESD compromised units that are intended for applications where failure of the unit could result in loss of human life, human injury or significant financial loss shall be dispositioned as "scrap."

## FORMS

<u>Form Name/Number</u>	<u>Record Location</u>	<u>Archive Location</u>
None Required	N/A	N/A

## RESPONSIBILITIES

- Lord Quality Department shall be responsible for:
  1. Establishing, implementing and documenting the ESD Control Procedure.
  2. Ensuring that subcontractors and suppliers have established ESD Control procedures in accordance with the Lord ESD Control Procedure.
  3. Designating areas requiring ESD protective controls.
  4. Quality assurance reviews and audits.
  5. Failure analysis.
- Lord Product Engineering shall be responsible for:
  1. Classifying parts as ESD Sensitive.
  2. Communicating ESD Sensitive part classification on the Lord engineering drawing and/or specification.
  3. Specifying required ESD marking on Lord engineering drawings and/or specifications.
  4. Specifying required ESD packaging on Lord engineering drawings and/or specifications.
- Lord Manufacturing and Lord Suppliers shall be responsible for:
  1. Establishing, implementing and documenting ESD control plans, including:
    - handling procedures to be used in ESD protected work areas.
    - ESD protective covering that shall be used on ESD Sensitive items when they are outside protected work areas.
    - ESD packaging procedures.
  2. Assuring that all affected personnel are sufficiently trained in the requirements and execution of the ESD control plan.

Revision A: Retraining not required. Reason for changes: Improve clarity.

- Added Appendix A.
- Added reference document #9.
- Added Lord suppliers and development labs to “Application” section.
- Added definitions of ESD Protected Area and ESD Protective Material.
- Changed all references to “Lord engineering drawings” to “Lord engineering drawings and/or specifications”.
- Procedure Paragraph 4 – added reference to Appendix A.
- Paragraph 7 – added responsibilities for training. Added 7.1 and 7.2.

- Paragraphs 8 and 9 – added ESD association symbols.
- Added paragraphs 11, 12, 13.

Revision B: Retraining not required. Reason for changes: Delete requirements for classifying parts according Human Body Model, Machine Model and Charged Device Models. This classifying scheme is not appropriate for ESD sensitive parts designed for Lord.

- Added website address for referenced specifications in footnote on page 1.
- In Application, “Non-production” was “Development.”
- Deleted “Charged Device Model” and “Human Body Model” from Definition of Terms.
- Deleted reference to HBM and CDM models in step 3 of Procedure.
- Deleted Table I, Classes of ESD Sensitive Parts, and Table II, ESD Test Methods for Classification of ESD Sensitive parts.
- “Lord Plants” was “Lord Manufacturing” in Procedure Step 7.
- Deleted reference to ASTM F1166 in Procedure Step 8.

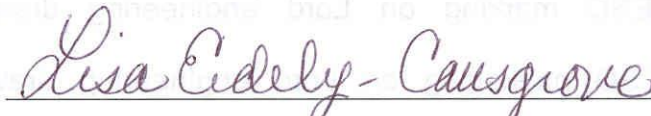
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## **Appendix A - ESD Protected Area (EPA)**

### **1.0 General**

All permanent EPA shall have defined boundaries. No item or activity shall cause significant damage to devices sensitive to ESD (ESDS.)

Notices should show when an EPA is entered and exited. An EPA can be many forms, including the following:

- A bench
- A store
- An area of work
- A field work area
- A work station and equipment, e.g. pick and place machine, wave solder machine

### **2.0 ESD protective items**

Specific ESD protective items when used in a specific ESD area shall have characteristics as described below.

#### **2.1 Working surfaces and storage racks**

All working surfaces and storage racks on which unprotected ESDS may be placed shall be capable of being connected to EPA ground. Resistance to EPA ground point  $R_g$  is between  $7.7 \times 10^5 \Omega$  and  $1 \times 10^9 \Omega$ . It is allowed to use surfaces which are "hard ground" i.e. less than  $1 \times 10^4 \Omega$  to EPA ground.

#### **2.2 Floors**

All floors shall have a surface to EPA ground resistance of  $R_g = 1 \times 10^{10} \Omega$

#### **2.3 Seating**

The resistance from all areas of seating which may have human body contact when in normal use, to either floor contact point or a groundable point shall be  $R_g = 1 \times 10^{10} \Omega$

#### **2.4 Garments**

Coats or overalls shall completely cover all clothing in the area of the arms and torso. They should be electrical continuity between all parts of the garment. The outward facing of the garment shall have the characteristics  $R_p = 1 \times 10^{12} \Omega$

The garments complying with the ESD requirement should be clearly marked.

## **2.5 Wrist straps**

The wrist strap shall consist of a band that fits snugly on the wrist, in contact with the skin and is connected to a cord of conductive wire which is connected to the EPA. The wrist strap should have a quick release mechanism. The cord should have an insulated current limiting resistor incorporated in it. The end to end resistance shall be between  $7.5 \times 10^5 \Omega$  and  $5 \times 10^6 \Omega$ .

## **2.6 Ionizers**

Air ionizers may be used to ground components and assemblies where direct grounding is impractical. Ionization may be used as an additional method of charge neutralization, but shall not be used in an attempt to eliminate other methods of ESD protection.

## **2.7 Tools, machinery and dispensers**

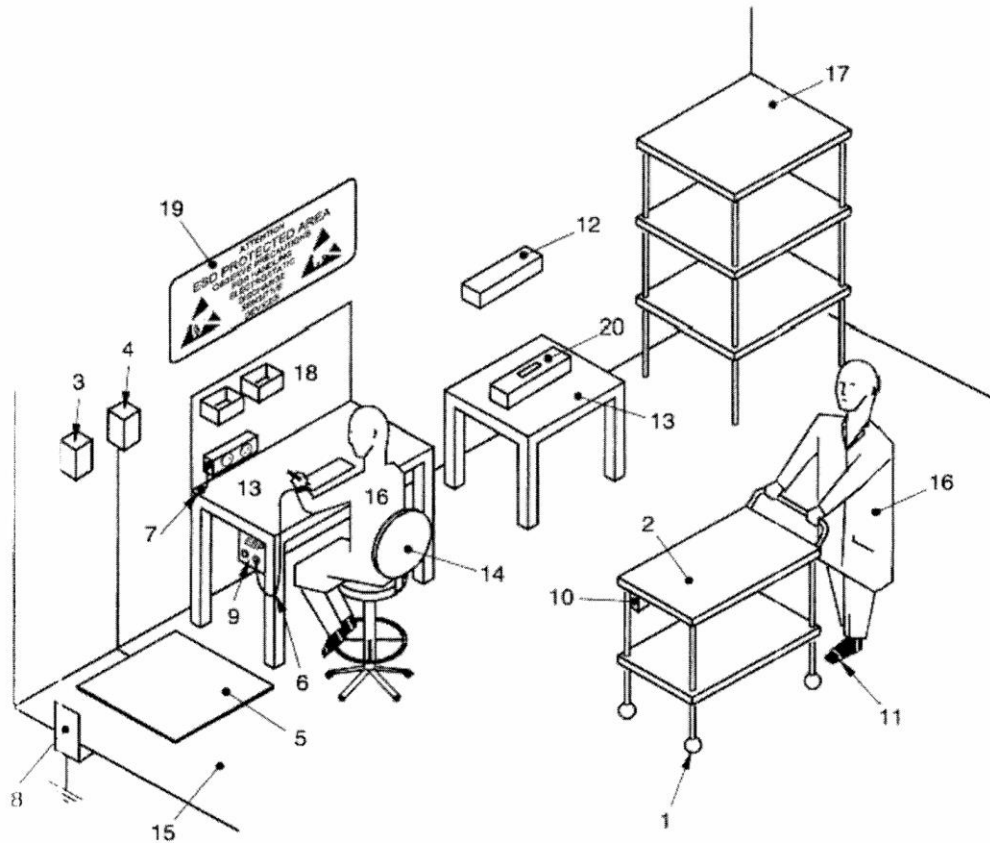
Tools intended for use in an EPA shall be so constructed that they do not generate or hold an electrostatic charge. All tools shall be constructed that any non-insulated part which may touch an ESDS shall be at EPA ground potential.

Tools with insulated handles may not be used.

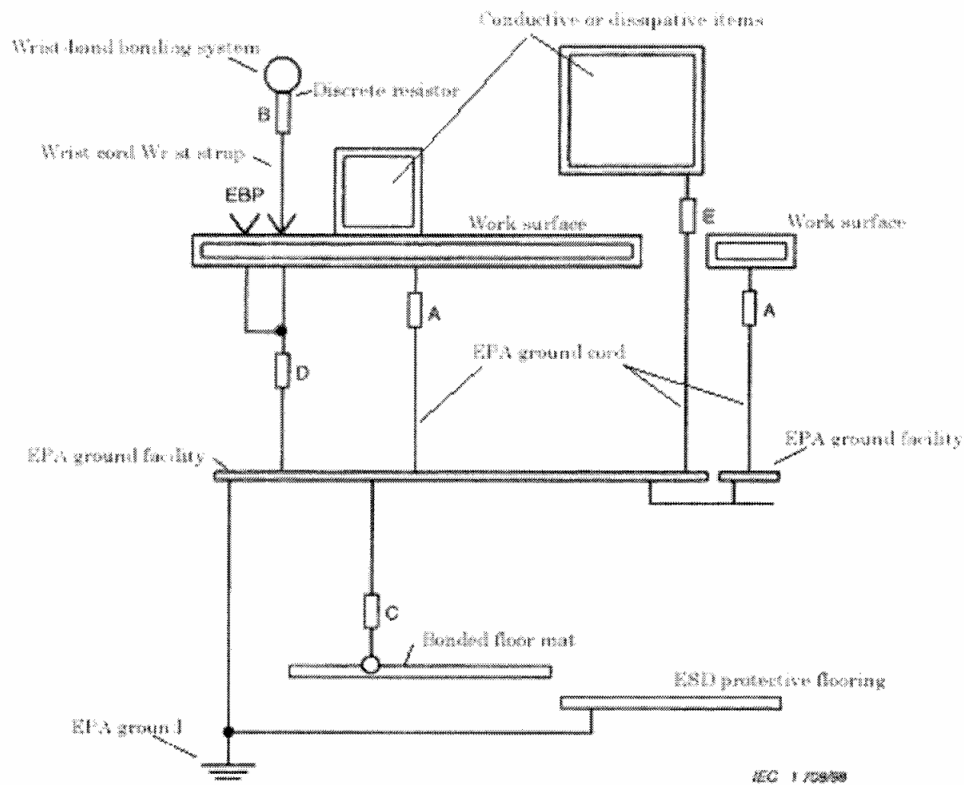
Soldering irons used within the EPA shall be fitted with a grounded tip.

### 3.0 Construction of an EPA

A typical EPA is shown in the following two diagrams:



- |  |   |
|--|---|
| 1. Groundable Wheels                                       | 11. ESD protective footwear               |
| 2. Groundable Surface                                      | 12. Ionizer                               |
| 3. Wrist Strap tester, shall be displayed outside the area | 13. Working Surface                       |
| 4. Footwear tester, shall be displayed outside the area    | 14. Seating with groundable feet and pads |
| 5. Footwear tester foot plate                              | 15. Floor                                 |
| 6. Wrist cord and wrist band (Wrist strap)                 | 16. Garments                              |
| 7. EPA Ground cord   | 17. Shelving with grounded Surfaces       |
| 8. EPA ground  | 18. Groundable racking                    |
| 9. Earth Bonding Point (EBP)                               | 19. EPA sign                              |
| 10. Groundable point of trolley                            | 20. Machine                               |



Values of surface to EPA ground resistance A, C, D, E and ground cord resistance B are defined in Table 1. These may be discrete resistors as shown here, resistance inherent in material or a combination apart from the ground cord where discrete resistor(s) are required.

### Schematic of a typical EPA

#### 3.1 EPA Ground

The EPA ground facility shall be connected to EPA ground and provide a low resistance path to EPA ground ( $<2\Omega$ ).

Typically several access points will be needed to distribute throughout the EPA for connections to ground strap points, working surfaces etc. but only one EPA ground facility is permitted within the EPA.

#### 3.2 EPA ground points

Easily accessible EPA ground points should be established adjacent to each working area or surface. There should be sufficient numbers for operators and visitors and they should be clearly labeled. Such access points are designated with the following symbol:



### **3.3 EPA ground cords**

The ground cords are used to make electrical connections between groundable points and the EPA ground. Where a single resistor is used in the cord, this should be located near the ground point.

### **3.4 Electrostatic Fields**

Electrostatic fields that are generated internal or external to the EPA shall be such that the maximum potential at any unprotected point inside the EPA shall be 100V.

## **4.0 EPA working practices**

- The primary means of grounding personnel is by wrist straps connected to the EBP
- Wrist straps in direct contact with the wearer's skin, and connected to EPA ground point shall be worn at all times when unprotected ESDS are being handled.
- ESD garments shall be worn and properly fastened at all times to ensure that other clothing does not come in contact with unprotected ESDS.
- Personnel with long hair shall have this contained so it does not contact unprotected ESDS.
- All persons including visitors must comply with the above.
- No non essential electrostatic generating materials shall be allowed in an EPA
- Working surfaces and floors are to be kept clean and tidy. Only cleaning materials and processes which do not affect the ESD protective properties can be used.
- Garment changing, consumption of food and drink and smoking shall not be allowed in the EPA.
- Faulty components shall be stored in the same manner as good components to allow correct failure analysis.

## **4.1 Checking Precautions**

### **4.1.1 Daily Checks**

- Visual check on housekeeping
- Each wrist strap tester is in working condition.
- No non essential electrostatic generating materials are present in the EPA.
- When in daily use wrist straps should be checked, worn in contact with the skin before starting work. For occasional use is required, the check shall be carried out before use.
- Records of these checks should be maintained.

### **4.1.2 Monthly Checks**

- Earth bonding of EBP, working surfaces, racks, mats, floors and chairs to be checked.
- If Ionization system fitted, verify it is functionality.

### **4.1.3 Six-monthly Checks**

These can be conducted on a sample basis where practical.

- Check there are no electrostatic fields greater than specified.
- Check signs and labels are correct in the specified places.
- Electrically test the protective garments.
- Check tools comply with the requirements.
- Check records have been maintained.
- Check non-compliances and corrective actions.