UCB/SSL

ESD Control Plan

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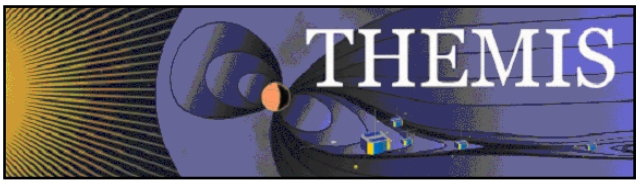

Signature Page

This is a controlled document. Any changes require the approval of the Configuration Control Board.

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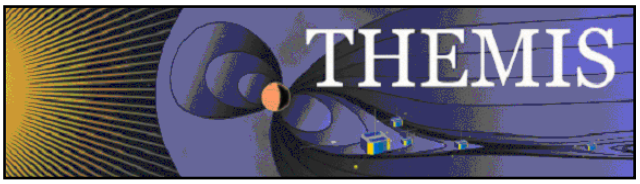

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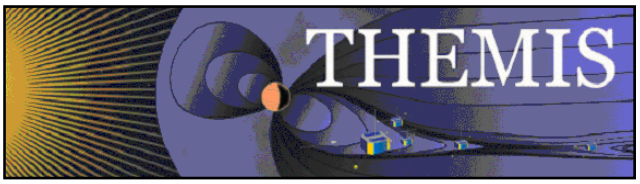

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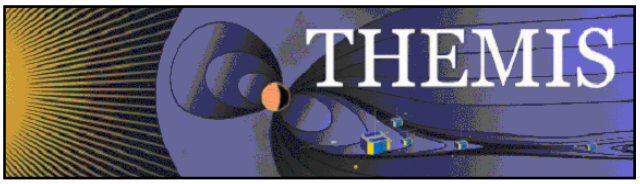
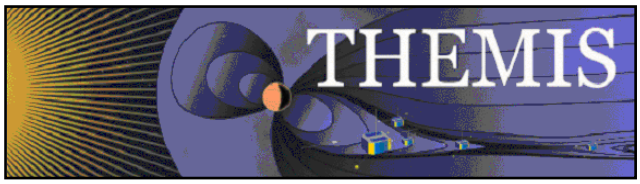




1 Introduction

This document establishes an Electrostatic Discharge Control Plan (ESD Plan) for the University of California, Berkeley, Space Sciences Laboratory. Based on the historical experience of both military and commercial organizations, this plan governs the requirements necessary to design, establish, implement, and maintain an Electrostatic Discharge Control Program for activities that involve manufacture, process, assemble, install, package, label, service, test, inspect or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges. It is intended for the protection of electrical and electronic parts, assemblies and equipment, excluding electrically initiated explosive devices.

The generation of triboelectric and electrostatic charges is a common cause of damage and degradation to unprotected Electrostatic Discharge Sensitive (ESDS) devices. One common form of this damage is a deterioration-to-failure process, which may not be detected by ground testing. The damaged device may result in early degradation in performance or in mission failure. A carefully devised and implemented ESD control program can provide protection from this damage.

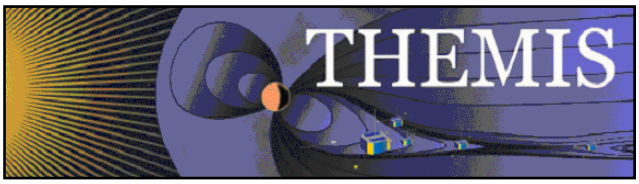
The ESD Plan is intended to complement overall project management of which ESD management will be an integral part. Programmatic and technical decisions will be made with a disciplined ESD effort that includes identification, planning, tracking, and control of ESD. The description of this process has been provided in ANSI/ESD-S20.20-1999, the ESD Association Standard for the Development of an Electrostatic Discharge Control Program

1.1 Electrostatic Discharge

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 can be measured and that can influence other objects at a distance. Electrostatic discharge (ESD) is defined as the transfer of charge between bodies at different electrical potentials caused by direct contact or induced by an electrostatic field.
Key concepts of ESD are: (a) Almost all materials, even conductors, can be triboelectrically charged (see **Appendix A1, Table 1-1**). (b) The level of charge is affected by material type, speed of contact and separation, humidity, and several other factors. (c) Electrostatic fields are associated with charged objects. (d) Electrostatic discharge can damage devices so they fail immediately, or ESD may result in latent damage that may escape immediate attention, but cause the device to fail prematurely once in service. (e) Electrostatic discharge can occur throughout the manufacturing, test, shipping, handling, or operational processes. (f) Component damage can occur as the result of a discharge to the device, from the device, or from charge transfers resulting from electrostatic fields. (g) Sensitivity to ESD varies significantly for devices.

2 Purpose

The purpose of this document is to provide procedural guidelines for UC Berkeley, Space Sciences Laboratory (UCB/SSL) personnel, visitors, suppliers, contractors, and subcontractors to assure that adequate ESD control measures are applied and maintained during the design, assembly, testing, and handling of spaceflight hardware at the UCB/SSL.
The procedures and guidelines establish ESD Controls for ESDS devices that may be received, distributed, assembled, disassembled, handled, tested, repaired, or stored. These measures are required during all phases of receiving, inspecting, assembling, disassembling, cleaning, testing, repairing, packaging, handling, storing, and shipping of all devices that are designated as ESD sensitive. To the extent possible any Project (the Project) and the Project's Quality Assurance team (QA) will utilize lessons learned from other NASA, GSFC, JPL, and UCB programs in carrying out this Plan.



3 Scope

This plan governs activities that manufacture, process, assemble, install, package, label, service, test, inspect or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 volts Human Body Model. This document does not apply to electrically initiated explosive devices, flammable liquids and powders. The methods, procedures and requirements contained herein support the standards and requirements of ANSI/ESD-S20.20-1999. The ESD control plan provides guidelines for ESD protective area design, selection and use of protective materials and equipment, documentation, and quality control.

4 Applicability

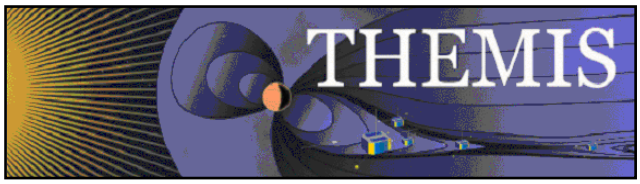
The Mission Assurance Manager (MAM) may apply the ESD control plan to any ESD sensitive device included in any process as deemed applicable. This document applies to all members of the Project, contractors and sub-contractors, involved in handling, testing, installing, inspecting, repairing or calibrating parts, assemblies, or equipment sensitive to ESD, unless they have a program that meets or exceeds these requirements. Further, it applies to all members of the Project, contractors and sub-contractors, who are responsible for GSE, GBO, and equipment that are sensitive to ESD. This document applies, also, to all levels of fabrication, production, integration, and testing of the Project's hardware.

Where the procedures given here differ from those given in reference documents, this procedure takes precedence over given reference documents (see applicable documents and reference documents). Special requirements may exist that will not be covered by or will not be in conformance with requirements of this document. The Project's engineering documentation will contain the detail for these requirements, details of the proposed techniques and inspection, and will provide appropriate test data.

Without written approval by the procuring MAM and the project manager (PM), engineering documents will not take precedence over conflicting portions of this document. The accordance with the requirements of this document and the related additions in engineering documents is required, to provide continuous protection for ESD sensitive (ESDS) parts, assemblies, and equipment.
1. The applicable control program functions will also be applied at all levels of production and integration of the Project's hardware to provide continuous protection for ESDS parts, assemblies and equipment.
2. Assemblies, components and equipment shall be designed to provide ESD protection for the sensitivity level of the most sensitive ESDS parts chosen for the design.
The ESD control plan may be applied to any ESD sensitive device included in any process as deemed applicable by the MAM.
ESDS devices within this context are listed in **Appendix A-2, Table 3-1**.

4.1 Definitions

This subsection provides key definitions that will be used in this Plan. The terms used in the body of this document are in accordance with the definitions found in EOS/ESD Association Glossary of Terms, ESD ADV1.0-2003
Other important definitions used are listed in **Appendix A-3, Table 3-2** and **Appendix A-8**, Acronyms.



5 Documents and Standards

This section lists the applicable documents that are in conformance with the requirements and contents of this Plan.

5.1 Parent Document

THM-SYS-014-ESD - THEMIS ESD Control Plan

5.2 Applicable Documents

The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the referenced documents shall be of the issue or revision in effect on the date of use of this specification.
ANSI ESD S20.20-1999 - Standard for the Development of an ESD Control Program
ESD TR 20.20 - ESD Handbook
ESD ADV1.0-1994 - Glossary of Terms

5.3 Reference Documents

NASA-STD-8739.7 - (For new procurements after February 27, 2002 use ANSI/ESD S20.20-1999)
GSFC Document No. P-303-840 A - *Electrostatic Control Program* describes the ESD control program that has been established by GSFC for its spaceflight projects. The GSFC program incorporates the ESD requirements of NHB
ANSI/ESD S541-2003 - Packaging Materials for ESD Sensitive Items
ESD STM97.1-1999: Floor Materials and Footwear - Resistance in Combination with a Person.
Further important reference documents used are listed in **Appendix A-4**.

6 Responsibilities

6.1 Personnel

All personnel who handle ESD sensitive parts and assemblies shall be trained and certified by QA. Training and certification shall be updated on an annual base or will be updated on an as needed basis, determined by the MAM. Each and every person shall handle and protect flight parts and assemblies according to this procedure. All of the Project's Technicians are responsible for the testing and maintenance of their ESD Protected Work Station.

6.2 ESD Training

The Project will receive ESD control training via the ESD Association's (www.ipc.org) multimedia training DVD. The Project's QA team will distribute ESD control training (DVD-54C-ESD Control with Training Certification). Instruction will be provided on the ESD control methods and tools reflected in this plan. The MAM, or designee will coordinate any future ESD training. Key Project personnel, as well as all personnel who directly manage individuals who handle ESD sensitive parts and assemblies shall take the ESD training. Management and QA will ensure that ESD training is provided and that a system is established for appropriate handling and storage of ESDS components and assemblies. Visitors, such as, scientists, NASA representatives, contractors, sub-contractors, and other non-UC Berkley personnel who have access to any area within SSL where ESDS components or assemblies may be present, shall have ESD training or shall be escorted by an ESD trained person.
A QA team member, assigned by the MAM will train, test, and certify Project personnel and will maintain and archive all relevant documentation (**Appendix B-1, Table 6-2**).

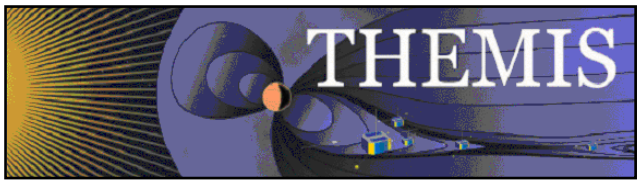
6.3 Parts Procurement

All suppliers shall ensure that ESD sensitive items are properly identified, packaged, handled, and transported in accordance with the ESD Control plan and the related documents. When procuring electrostatic sensitive parts, the Project's personnel shall ensure that parts are in an appropriate ESD protective package, bag, wrapper, or container marked with an ESD symbol shown in **Appendix A-5, Figure 6-2**. Further, the Project shall use the packing slip document (shipper) as shown in **Appendix B-2**, available on the Projects FTP site.

The Project's QA team will ensure that, if special handling, storage, packaging, preservation, or delivery is required that these requirements will be implemented and indicated to the receiving party. These special requirements will be denoted on the P.O. and all related shipping documents to assure communications to the suppliers. Reference to existing procedures that cover special requirements, or new procedures to cover any special requirements shall be implemented by the MAM. Further, the MAM will ensure that all personnel handling the ESDS items have access to procedures covering special requirements.

6.4 Surveying

QA will conduct surveys of all ESD workstations on a schedule (**Appendix B-3**). Survey intervals of less than one month will be accomplished by the responsible user, e.g., technician, engineer, contractor. These might include Humidification (RH), Wrist Strap Resistance, Foot Grounding Device Integrity, Electrostatic Monitor Operation, and Soldering Iron Tip to Ground. QA will verify that surveys are performed by the responsible user by checking the user's records of verification, and by conducting surveys of these items while surveying the monthly, semi-annual, and annually checked items. For ESD survey forms see attached **Appendix B-4.**



6.5 Discrepancy Correction

The QA representative responsible for the area, and the area user, may address discrepancies in a team environment to establish on the spot corrections for discrepancies to assure product reliability. Discrepancies impacting ESDS items or which affect the quality of a product shall be documented and dispositioned using a Nonconformance Report. Decisions for changes will be made immediately and will take effect immediately. These decisions shall be documented in the Nonconformance Report. In case an immediate decision cannot be reached all work impacted by the decision shall be stopped.

7 Requirements

7.1 General

ESDS items shall be handled only in an ESD-protected area. Outside ESD-protected areas, ESDS items shall be enclosed in ESD-protective packaging. Paperwork accompanying an ESDS item (e.g., QA records, routings, instructions) shall be contained in static dissipative bags or envelopes. Paperwork shall not come in physical contact with any ESDS items.
Shunts, such as bars, clips, or conductive covering, shall be used to protect an ESDS item, which is not being tested or worked on. All containers, tools, test equipment, and fixtures used in ESD-protected areas shall be grounded before and during use. A common ground shall be established between an ESDS item and any test equipment before connecting or disconnecting test cables.

7.2 Receipt, Internal Handling, Packaging and Shipping

1. All ESDS items received shall be examined for proper ESDS precautionary marking and for ESD protective packaging.
a) Inadequate precautionary markings shall be corrected prior to further processing.
b) When an ESDS part is received that has not been protected during shipment or internal transfer, it shall be rejected as defective and processed as non-conforming material.
2. When a kit is assembled that includes an ESDS item, the entire kit shall be packaged and marked as an ESDS item. Accompanying documentation shall identify the kit as ESDS.
3. ESDS items packaged for shipping shall be packaged and marked as required by this publication (see ***ANSI/ESD S541-2003*** , ESD symbols **Appendix A-5, Figure 6-2,** ESD shielding bags **Attachment-1**).
Packaging recommended by QA shall be considered acceptable unless special packaging is required.
For internal delivery, shipping, and shipping to higher levels of integration:
If special packaging is required the supplying party will provide the shipping container, packing material, and the marking of the container for the ESDS part or assembly.

7.3 Facility and in the Field

When servicing equipment containing ESDS items:
1. Personnel grounding shall be made using a wrist strap before each maintenance action. Maintenance actions include adjustments, restoring covers, and tightening fasteners.
2. Protective packaging of a replacement ESDS item shall be grounded to the equipment to dissipate any static charge before the package is opened.
3. As an ESDS item is installed, contact with parts, electrical terminals, and circuitry shall be minimized.
4. Failed ESDS items shall be placed in protective packaging after removal from the equipment.
5. Probing ESDS items with test leads shall be conducted, while taking maximum precautions, e.g., ensuring proper grounding and using ionized air, when available.

7.4 Testing

While testing flight assemblies, any and all procedural guidelines of this document shall be strictly followed. The related test documentation will also contain the verification procedures used to monitor the ESD precautions used.

7.5 Handling

Actions will be taken to move or handle product while preventing damage or deterioration. This includes:
1. Proper ESD identification on ESDS items.
2. Inclusion of ESD requirements on purchasing documentation.
3. Handling of ESDS items only at ESD workstations and verified protected areas.
4. Description of field operations and precautionary procedures, when applicable, to prevent ESD damage.
5. All ESDS items and assembly components shall be carried from one room to another, using ESD tote boxes.
6. During transportation: parts, components, trays/frames, sub-assemblies shall be packaged free form movement (for example, sharp points, i.e., pins shall not puncture an ESD bag to prevent damage).

7.6 Storage

Storage will be such that it will keep the product free from damage or deterioration until ready to deliver to an internal or external user or the next higher level of integration. All pre-assembly ESDS parts will be stored in an air-conditioned, controlled access area of UCB/SSL, currently at room 220-Silver. All ESDS parts will be stored in ESD tote boxes or similar acceptable ESDS packaging materials, in locked metal cabinets. Humidity will be monitored on a daily basis.

8 Protected Work Environment

8.1 Identification and Access - ESD Areas.

The ESD-protected area, where ESDS items are to be processed, will be clearly identified by prominently placed signs, such as shown in **Appendix A-6**. Access to such areas will be limited to trained and equipped personnel. A partition or similar means will be set up to assist in prohibiting unauthorized and untrained personnel from entering the ESD-protected area. All other personnel will be escorted and be equipped with standard protective clothing, as required.

8.2 Prohibited Materials and Activities

The area shall be maintained in a clean and orderly condition. Smoking, eating and drinking in ESD protected areas will not be permitted. Materials unessential to the fabrication area are also prohibited at the ESD workstation. Plastic document covers shall not be used unless made specifically for use in static sensitive areas. Pressure sensitive adhesive tapes shall be avoided as unrolling or removal generated electrostatic charges. Pressure sensitive adhesive ESD tape, clearly marked by the ESD symbol printed on the tape shall be used and should be available on all ESD workstations. Pens should preferably be metal-cased; otherwise they must be kept well away from sensitive parts. The use of an air ionizers will reduce the risk from these items. Plastic tools such as nylon brushes and tweezers shall be avoided. Polystyrene, Styrofoam, and polythene shall also be avoided.

8.3 ESD-Protective Work Surfaces.

QA is responsible for the initial setup of ESD protected workstations (ESD workstation, workstation). All work surfaces in an ESD-protected area will be static dissipative and electrically connected to the common point ground. Homogeneous materials will have surface resistivity in the range of 10^{5} to 10^{9} Ohms/square meter.

The protective work surface shall be sufficiently large to encourage the resting of common hand tools on the protective surface rather than on an adjacent non-protected surface. The protective work surface shall not release particle contaminants and shall resist attack by common solvents or cleaners. On a daily basis, the workstation shall

be cleaned by the user with Anti-Static work surface cleaner, such as, ACL's Staticide "Mat&Taple Top Cleaner P/N6001."

8.4 ESD-Protective Floor Coverings

Conductive floors and/or grounded conductive floor mats are mandatory in areas where personnel are not wearing wrist straps. Under these conditions, the use of leg straps, heel straps or conductive shoes is mandatory. Conductive floors or mats need to be kept free of dust, dirt and other contaminants. After each cleaning, conductive floor resistivity shall be verified (the acceptable level of resistance ANSI/ESD states: $<1x10^9$ Ohms). The Project, however, requires all personnel to wear wrist straps, while performing ESD sensitive work. For any exceptions, i.e., situation in which an operator would use conductive floors and/or grounded conductive floor mats in conjunction with leg straps, heel straps or conductive shoes, intervals for testing and cleaning of ESD floor materials shall be specified. It shall only be allowed with written approval from QA.

8.5 Personnel Grounding Devices.

Personnel grounding devices will be supplied to all personnel working with or handling ESDS items to prevent the accumulation of dangerous electrostatic charge levels. All personnel coming within 1 meter of any ESDS items shall wear a grounding device. When personnel are seated at ESD protected workstations, they shall be connected to the common point ground via a wrist strap.
The types of approved grounding devices are as follows:
1. Wrist Straps.
The wrist strap is composed of four major elements:
- *Cuff*. The design of the wrist strap cuff shall ensure conductive contact with the wearer's skin.
Metallic cuffs are preferred over plastics. Bead type chains are prohibited.
- *Lead*. For operator safety, the wrist strap release force of the cuff and the lead shall occur with at least 8.9 Newtons (2 pounds) but not more than 22.2 Newtons (5 pounds) of force.
- *Safety Resistor*. All wrist straps shall contain an integral current-limiting safety resistor
- *Ground Termination*. The wrist strap ground termination shall ensure a positive and durable connection between the lead and the soft ground. All wrist straps within a protective area must utilize a common type of termination. Continuity from the wrist strap (as normally worn) to the connecting plug should be checked and logged before each period of work.
2. Foot Grounding Devices.
Heel straps as an alternative for personnel standing, shall be regarded as an exception. It shall only be allowed with written approval from the MAM.
Leg, toe or heel straps or conductive shoes worn in conjunction with a conductive floor and/or conductive floor mats, are acceptable alternatives to a wrist strap in those situations where the operator needs to be mobile and the use of a wrist strap is impractical or unsafe. The integrity of foot grounding devices shall be verified in the same manner as wrist straps.

8.6 Equipment and Facilities Grounding

The preferred practice is to use the third wire AC line ground for grounding all items at the ESD-protected workstation. When a separate grounding line is present or used in addition to the equipment ground, it should be bonded to the equipment ground at each ESD-protected work station to minimize the difference in potential.

To establish grounding of stools and chairs, they should be constructed of conductive material and the cover material fabricated from static dissipative materials. Where chairs and stools are required to be grounded and approved conductive flooring is utilized, positive electrical contact between the floor and metallic structure of the chair or stool is required.

Where cart or wagons are required to be grounded and approved conductive floors are utilized, positive electrical contact must be made between the floor and conductive structure of the cart, wagon or tram. If the floor is non-conductive, the vehicle will be grounded before ESDS items are loaded or removed from the vehicle. Carts or wagons are not required by the Project.

8.7 Humidification & Air Ionizers

The relative humidity will be maintained in ESD-protected work areas at 30% to 70%. At levels below 30%, work shall be stopped (per NASA requirement), QA shall be notified, and additional precautions will be employed (e.g., air ionizers, humidifiers). If other precautionary methods are not available, work will be halted until the required humidity level is obtained. Hygrometers and temperature meters used are described in **Appendix A-7**.
Air ionizes are recommended where grounding is impractical. But the use of any type of air ionizes is prohibited in the presence of high-voltage or RF sensitive equipment to avoid breakdown in presence of ionized air (please note that such restrictions shall be indicated by the supplying party).

8.8 Hand Tools, Equipment and Fixtures.

ESD safe conductive handles and uninsulated metal hand tools such as pliers, cutters, tweezers and wire strippers are required in ESD protected areas. Hand tools shall be kept on the grounded work surface when not in use. Only antistatic solder extractors made of metal, or having a metallized plastic barrel and tip, shall be used in an ESD-protected area Electrical tools used in ESD-protected areas shall have a three-wire grounded power cord or be double insulated. No plastic tools, unless anti-static approved, shall be used.

9 Protective Packaging

9.1 General

Electrostatic protective packaging shall maintain both the prevention of charge generation (e.g., triboelectric contact and separating) end protection from strong electrostatic fields. The surface resistivity of any material shall not exceed 10^{12} Ohm/square meter. *ANSI/ESD S541-2003* (Packaging Materials for ESD Sensitive Items) shall be applied to packaging used to store, transport, and protect ESDS electronic items during all phases of production and distribution.

Protective packaging is considered ESD protective based on the following application methods:
1. Protective Bags and Pouches
a. Materials used in protective bags and pouches shall satisfy the resistivity requirements to avoid triboelectric charge build-up.
b. Bags and pouches used for electrostatic shielding shall be constructed from a single folded piece of material. Two-piece construction is prohibited. Only approved ESD bags shall be used (see **Attachment 1**). If bags or pouches are not transparent to allow identification of contents without removal, a label shall be placed on the outside of the bag or pouch that identifies its contents.

2. Magazines, Chutes and Tubes
a. Non-metallic conductive and static dissipative magazines, chutes and tubes shall be used for shipping integrated circuits.
b. Neither static dissipative impregnated nor topically treated plastics provide electrostatic shielding. Both types shall be enclosed in an outer container, which will provide such protection during shipping.

3. Tote Boxes and Other Holders.
Tote boxes shall be made of conductive or static dissipative material. All tote boxes shall be fitted with covers of the same conductivity as the bottom sections. The fit of this cover shall be such as to assure the conductivity across this interface. ESD-protective covering or protective caps on external terminals, interconnecting cables, and connector assemblies shall not be removed until necessary to permit the installation. The cable connector pins and cable shield (connector outer shell) shall be grounded prior to engaging a de-energized connector and cable with a mating receptacle connected to an ESDS item. For shipping of ESDS products from UCB/SSL, refer to 7.2 Receipt, Internal Handling, and Shipping.

9.2 Identification and Marking

ESDS items, equipment, and assemblies shall be identified in compliance with the following requirements. Identification shall be placed so as to warn personnel before any ESD damaging procedure can be performed. Packing lists, inspection reports, travelers, and other paperwork accompanying the hardware shall contain ESDS labels and cautionary notes (see ESD symbols, **Appendix A-5, Figure 6-2**). Equipment having external sensitivity shall have ESD symbols affixed to their exterior. The ESD cautionary mark on an assembly shall be visible when the assembly is installed in the next higher assembly. Alternative identification shall be used as approved by the procuring level QA and the responsible managers when the prescribed marking is not possible. All documentation (e.g., drawings, work instructions) will contain ESD markings, precautions, and handling procedures as applicable.

10 Further Requirements

10.1 Temperature Chambers and Cooling Agents

Gas flow is a significant generator of electrostatic charges. Precautions must be taken when gas flow is utilized in the area of ESDS items. Cold chambers shall have the conductive baffles and shelves within the chamber grounded. The ESDS items shall be contained within or mounted on conductive material. When pressurized cryogenic cooling agents are used for localized cooling, as in troubleshooting, they shall be electrostatically safe. The stability of ESD-protective materials, which are used in temperature chambers, should be suitable for the test temperature and humidity ranges. Suitability will be determined by QA.

10.2 Cleaning and Cleaning Agents

Cleaning agents and methods used on ESD-protective items (e.g., work surfaces and floor coverings) shall not reduce the effectiveness of these items. They shall not cause leaching or leave insulating residues. In addition to other required properties (e.g. solvency) cleaning agents used on ESDS items shall be chosen for low electrostatic charging propensity. Only natural fiber materials shall be used for cleaning ESDS items. Synthetic materials are prohibited.

10.3 Clothing Requirements

Non-static generating clothing shall be worn in ESD-protected areas or static dissipative smocks shall be worn as an outer garment. Finger cots and gloves, when worn in an ESD-protected area, shall be made of static dissipative materials.

11 Control of ESD preservation measures

In general control of ESD preservation will be done by checking, testing and by following handling procedures.

11.1 Checks

1. Check area for signs limiting access to certified personnel, and that workstation access is limited.
2. Check workstation area to verify that it is clean and clear. Work area shall also be free of papers, wrappers, or any other items that are not ESD controlled. Smoking is not allowed in the UCB Building. Eating and drinking are only allowed in designated areas of the Lab (e.g., lunch rooms, outdoor rest areas).
3. Check protective bags, pouches, or conductive tote boxes (Faraday Cages) that are in use for content identification. Also, check the condition of the containers for holes, cuts in bags and boxes. Check for proper fitting of lids on tote boxes.
4. Check the wrist strap monitor (where used) on the ESD workstation for calibration (current sticker). Verify that clothing that does not generate static is being worn in the ESD area. (Note: constant monitors shall always be used).
5. Before conducting any equipment survey, verify calibration of test equipment in the ESD survey kit by checking labels for the date of calibration and the calibration due date. Any test equipment that is due to be calibrated will be sent to the Calibration Lab prior to using that equipment to conduct tests.

11.2 Verifications of Tests performed by ESD station users

QA shall verify that the continuous wrist strap monitor is functioning properly and perform ESD surveys (see below 11.3, 11.4, and 6.4 Surveying). These tests include:

11.2.1 Humidification

Continuous, constant humidification monitoring is in place. Humidity will be checked by the ESD station user and verified by QA.

11.2.2 Wrist Strap Resistance

The Project will use continuous wrist strap monitors wherever possible. QA shall verify that the continuous wrist strap monitor is functioning properly. Use of wrist straps that are not continuous wrist strap monitors shall only be used in special situations, with prior approval of QA. In this case, verification of records to assure that the wrist strap resistance test is being performed on a daily basis shall be provided by the operator.

11.2.3 Foot Grounding Device Integrity

Verification of records to assure that this test is being performed on a daily basis if a foot-grounding device is being used. Currently, foot-grounding devices are not used by the Project.

11.3 Monthly Checks

The QA team will check the following items informally, on a monthly basis:

- Equipment and Facility Grounding
- Work Surface Grounding
- Work Surface Resistivity
- ESD Signage

11.4 Semi-Annual Surveys

Results of the following tests will be recorded. The following items shall be surveyed on a semi-annual basis (TBD) on:
- Work Surface Static Dissipation
- Continous Monitor Wrist Strap Resistance (Verification)

11.5 No following tests

No following tests will be performed on:
- Conductive Floor Resistivity (Currently, foot-grounding devices are not used by the Project.)
- Stool and chair grounding (Currently, ESD and metal stools are used by the Project.)
- Cart and wagon grounding (Currently, carts and wagons are not used by the Project.)
- Air Ionizer

If work areas are configured so that these tests are required the Project's QA manager or designee will perform the appropriate tests.

11.6 Documentation

Survey results shall be documented and shared with the ESD area owner. Deficiencies which impact the ESDS item and are not correctable on the day of the survey, or which affect the quality of the product, will be documented on a Non-conformance Report.

11.7 Measurements, Tests and Monitoring

All test and measuring equipment used to perform surveys will be in a current state of calibration. Measurements will be made following guidelines provided in the test equipment manuals. Methods and procedures for monitoring the continued effectiveness of protected areas will be prepared together with the procedures for handling, assembling, integration and testing. Results will documented and be available throughout the Project via QA.

11.8 ESD Control Communications

Communicating ESD control risks on the Project provides personnel an understanding of the overall ESD control status. Project ESD control communications have the following characteristics:

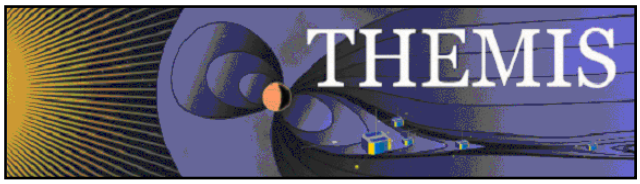
a) Free flow of information between individuals, groups, and management.
b) Inclusion of formal, informal, and impromptu communications.
c) Value of individual contributions.

11.9 ESD Control

ESD control is performed using standard UCB/SSL Project management monitoring techniques. Controlling ESD risks will be integrated and coordinated into the UCB/SSL Project's routine management activities. The following are ESD control mitigation plan decisions:

a) Re-plan
b) Close the ESD control risk
c) Invoke a contingency/workaround plan
d) Continue tracking and executing the current ESD control plan

The MAM will have the final decision on ESD control mitigation planning, as well as closing an ESD control issue. The decision to close an ESD control issue will be formally documented with signatures of the MAM, the person having the assigned action for the issue, and the originator of the issue.



12 Resources for the Management of ESD control

The PM will assure that resources are provided at sufficient levels to insure effective and responsive ESD Control for the Project. Resources are broken into three categories, (1) overhead costs associated with the ESD management process (development, implementation, and maintenance), (2) training and certification of Project personnel, and (3) mitigation plan costs.

APPENDIXA

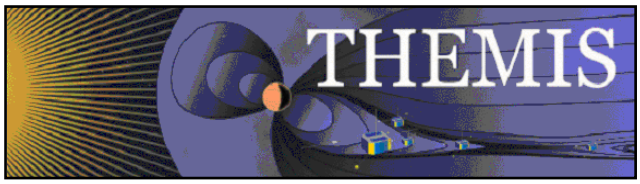
A-1 Table 1-1 Triboelectric Series

Typical Triboelectric Series	
+	Asbestos
	Rabbit fur
	Glass
Positive	Mica
	Human Hands
	Human Hair
Negative	Nylon
	Wool
-	Fur
	Lead
	Silk
	Aluminum
	Paper
	COTTON
	Steel
	Wood
	Amber
	Sealing Wax
	Nickel, copper Brass, silver
	Gold, platinum
	Sulfur
	Acetate rayon
	Polyester
	Celluloid
	Silicon
	Teflon

A-2 Table 3-1 ESDS devices

ESD Sensitivity of Representative Electronic Devices Devices or Parts with Sensitivity Levels of 0-1,999 volts (HBM)
Device or Part Type
Microwave devices (Schottky barrier diodes, point contact diodes and other detector diodes >1 GHz)
Discrete MOSFET devices
Surface acoustic wave (SAW) devices
Junction field effect transistors (JFETs)
Charged coupled devices (CCDs)
Precision voltage regulator diodes (line of load voltage regulation, <0.5%)
Operational amplifiers (OP AMPs)
Thin film resistors
Integrated circuits
AMR and GMR Disk Drive Recording Heads
Laser Diodes
Hybrids
Very high speed integrated circuits (VHSIC)
Silicon controlled rectifiers (SCRs) with Io <0.175 amp at 10°C ambient

ESD Sensitivity of Representative Electronic Devices Devices or Parts with Sensitivity Levels of 2,000 to 3,999 volts (HBM)
Device or Part Type
Discrete MOSFET devices
JFETs
Operational Amplifiers (OP Amps)
Integrated circuits (ICs)
Very high speed integrated circuits (VHSIC)
Precision resistor networks (type RZ)
Hybrids
Low power bipolar transistors, PT £100 milliwatts with Ic <100 milliamps



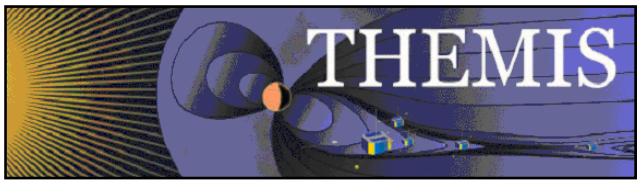
A-3 Table 3-2 ESD Definitions

Certification	The act of verifying and documenting that personnel have completed required training, demonstrated specified proficiency, and have met specified requirements.
Conductive Materials	Materials with a surface resistivity that is less than 10 E5 ohms per square meter or a volume resistivity than 10 E4ohms per square cm.
Designated Uncontrolled Area.	An area at an ESD protected workstation that is clearly identified as the location for safely storing test procedures, travelers, or other documents or materials associated with the items under test/calibration.
ESD Protected Area	Specific areas within the facility that group ESD protected workstations and limit access to trained and certified personnel.
ESD Protected Workstation	A specific location within an ESD protected area that is constructed and equipped with the necessary ESD protective materials, controls, and equipment to limit ESD voltages below the sensitivity level of ESDS items that will be handled at the workstation.
EEE Parts	Electrical, electronic or electromechanical Parts.
ESD Sensitive/Susceptible Items (ESDS)	EEE parts that are sensitive to electrostatic discharges, or assemblies, or equipment that contain parts sensitive to electrostatic discharges. For any EEE parts that personnel are not familiar with, the default procedure should be to handle all electronic parts as ESDS.
ESD Protective Material	Conductive or static dissipative material capable of one or more of the following characteristics: limiting the generation of electrostatic charges; dissipating electrostatic charges over its surface or volume; or providing shielding from electrostatic discharges or fields. These may include bags, pouches, tote boxes, or Faraday Cages (a method of shielding a part by completely surrounding it with a conductive or static dissipative material to protect it from electrostatic influences).
Insulative Materials	Materials with a surface resistivity that is greater than 10 E12 ohms per square meter or 10 E11 ohms per square cm.
Static Dissipative Materials	Materials with a surface resistivity that is greater than 10 E5 Ohms per square meter, but not more than 10 E12 Ohms per square meter.
Triboelectric Charge	A surface generated, positive or negative charge formed when two similar or dissimilar materials are rubbed together or separated from each other.

A-4 ESD Reference Documents

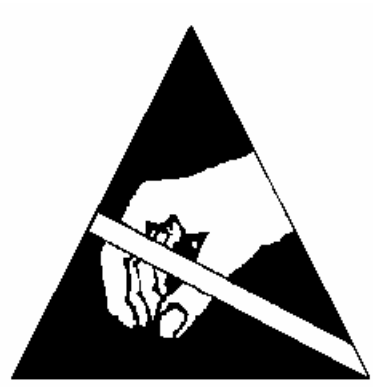
U.S. Military/Department of Defense/ NASA/GSFC/JPL
MIL-STD-1686C - Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
This military standard establishes requirements for ESD Control Programs. It applies to U.S. military agencies, contractors, subcontractors, suppliers and vendors. It requires the establishment, implementation and documentation of ESD control programs for static sensitive devices, but does NOT mandate or preclude the use of any specific ESD control materials, products, or procedures. It is being updated and converted to a commercial standard by the ESD Association. Although DOD has accepted the new ANSI/ESD S20.20 document as a successor, it has not yet taken action to cancel STD-1686
MIL-HBDK-263B - Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
This document provides guidance, but NOT mandatory requirements, for the establishment and implementation of an electrostatic discharge control program in accordance with the requirements of MIL-STD-1686.
MIL-HDBK-454 - Standard General Requirements for Electronic Equipment
MIL-HDBK-773 - Electrostatic Discharge Protective Packaging
MIL-PRF 87893 - Workstation, Electrostatic Discharge (ESD) Control
This document defines the requirements for ESD protective workstations.
MIL-B-81705 - Barrier Materials, Flexible, Electrostatic Protective, Heat Sealable
This documents defines requirements for ESD protective flexible packaging materials.
MIL-STD-129 - Marking for Shipment and Storage
Covers procedures for marketing and labeling ESD sensitive items.
MIL-STD-883E (Method 3015.7) - Electrostatic Discharge Sensitivity Classification NASA
NASA-STD-8739.7 (For new procurements after February 27, 2002 use ANSI/ESD S20.20-1999)
GSFC Document No. P-303-840 A Electrostatic Control Program describes the ESD control program that has been established by GSFC for its spaceflight projects. The GSFC program incorporates the ESD requirements of NHB 5300.4 (3L).
NHB 5300.4 (3L) - Requirements for Electrostatic Discharge Control specifies the NASA requirements for ESD avoidance and control. It describes basic considerations and requirements for ESD control programs including responsibilities of NASA Installations for invoking ESD control programs.
JPL D-1348 Rev the JPL standard for ESD Control
International/European
EN100015: Protection of Electrostatic Sensitive Devices
Adopted in 1992 and 1993, this European Norm covers ESD handling practices for electronic devices.
JESD
EIA-625 (Now JESD-625A) – Requirements for Handling Electrostatic-Discharge-Sensitive Devices
ESD Association
Standards Documents
ESD S1.1-1998: Evaluation, Acceptance, and Functional Testing of Wrist Straps
A successor to EOS/ESD S1.0, this document establishes test methods for evaluating the electrical and mechanical characteristics of wrist straps. It includes improved test methods and performance limits for evaluation, acceptance, and functional testing of wrist straps.
ESD STM2.1-1997: Resistance Test Method for Electrostatic Discharge Protective Garments
This Standard Test Method provides test methods for measuring the electrical resistance of garments used to control electrostatic discharge. It covers procedures for measuring sleeve-to-sleeve and point-to-point resistance.
ESD STM3.1-2000: Ionization
Test methods and procedures for evaluating and selecting air ionization equipment and systems are covered in this standard. The document establishes measurement techniques to determine ion balance and charge neutralization time for ionizers.
ESD SP3.3-2000: Periodic Verification of Air Ionizers.
This Standard Practice provides test methods and procedures for periodic verification of the performance of air ionization equipment and systems (ionizers).

ESD S4.1- 1997(Revised): Worksurfaces - Resistance Measurements
This Standard establishes test methods for measuring the electrical resistance of worksurface materials used at workstations for protection of ESD susceptible items. It includes methods for evaluating and selecting materials, and testing new worksurface installations and previously installed worksurfaces.
ESD STM4.2-1998: Worksurfaces - Charge Dissipation Characteristics
This Standard Test Method provides a test method to measure the electrostatic charge dissipation characteristics of worksurfaces used for ESD control. The procedure is designed for use in a laboratory environment for qualification, evaluation or acceptance of worksurfaces.
ESD STM5.1-1998 Revised: Electrostatic Discharge Sensitivity Testing -- Human Body Model
This Standard Test Method updates and revises an existing Standard. It establishes a procedure for testing, evaluating and classifying the ESD sensitivity of components to the defined Human Body Model (HBM).
ESD STM5.2-1999 (Revised): Electrostatic Discharge Sensitivity Testing -- Machine Model
This Standard establishes a test procedure for evaluating the ESD sensitivity of components to a defined Machine Model (MM). It also provides a system of classifying the sensitivity of these components. The component damage caused by the Machine Model is often similar to that caused by the Human Body Model, but it occurs at a significantly lower voltage.
ESD STM5.3-1999: Electrostatic Discharge Sensitivity Testing - Charged Device Model -- Non-Socketed Mode
This Standard Test Method establishes a test method for evaluating the ESD sensitivity of active and passive components to a defined Charged Device Model (CDM).
ESD S6.1-1999: Grounding -- Recommended Practice
This Standard recommends the parameters, procedures, and types of materials needed to establish an ESD grounding system for the protection of electronic hardware from ESD damage. This system is used for personnel grounding devices, worksurfaces, chairs, carts, floors, and other related equipment.
ANSI ESD S7.1-1994: Floor Materials -- Resistive Characterization of Materials
Measurement of the electrical resistance of various floor materials such as floor coverings, mats, and floor finishes is covered in this document. It provides test methods for qualifying floor materials before installation or application and for evaluating and monitoring materials after installation or application.
ANSI ESD S8.1-1993: ESD Awareness Symbols
Three types of ESD awareness symbols are established by this document. The first one is to be used on a device or assembly to indicate that it is susceptible to electrostatic charge. The second is to be used on items and materials intended to provide electrostatic protection. The third symbol indicates the common point ground.
ESD S9.1-1995: Resistive Characterization of Footwear
This Standard defines a test method for measuring the electrical resistance of shoes used for ESD control in the electronics environment.
ESD SP10.1-2000: Automated Handling Equipment
This Standard Practice provides procedures for evaluating the electrostatic environment associated with automated handling equipment.
ANSI ESD S11.11-1993: Surface Resistance Measurement of Static Dissipative Planar Materials
This Standard defines a direct current test method for measuring electrical resistance. The Standard is designed specifically for static dissipative planar materials used in packaging of ESD sensitive devices and components.
ESD STM11.12-2000: Volume Resistance Measurement of Static Dissipative Planar Materials
This Standard Test Method provides test methods for measuring the volume resistance of static dissipative planar materials used in the packaging of ESD sensitive devices and components.
ANSI ESD S11.31-1994: Evaluating the Performance of Electrostatic Discharge Shielding Bags
This Standard provides a method for testing and determining the shielding capabilities of electrostatic shielding bags.
ESD STM12.1-1997: Seating-Resistive Characterization
This Standard provides test methods for measuring the electrical resistance of seating used to control ESD. The test methods can be used for qualification testing as well as for evaluating and monitoring seating after installation. It covers all types of seating, including chairs and stools.
ESD STM13.1-2000: Electrical Soldering/Desoldering Hand Tools
This Standard Test Method provides electric soldering/desoldering hand tool test methods for measuring the electrical leakage and tip to ground reference point resistance and provides parameters for EOS safe soldering operation.
ANSI ESD S20.20-1999 - Standard for the Development of an ESD Control Program
This Standard provides administrative, technical requirements and guidance for establishing, implementing and maintaining an ESD Control Program.
ANSI/ESD S541-2003 - Packaging Materials for ESD Sensitive Items



ESD STM97.1-1999: Floor Materials and Footwear - Resistance in Combination with a Person.
This Standard Test Method provides for measuring the electrical resistance of floor materials, footwear and personnel together, as a system.
ESD STM97.2-1999 Floor Materials and Footwear Voltage Measurement in Combination with a Person
This Standard Test Method provides for measuring the electrostatic voltage on a person in combination with floor materials and footwear, as a system.
Advisory Documents
Advisory Documents and Technical Reports are not Standards, but provide general information for the industry or additional information to aid in better understanding of Association Standards.
ESD ADV1.0-1994: Glossary of Terms
Definitions and explanations of various terms used in Association Standards and documents are covered in this Advisory. It also includes other terms commonly used in the ESD industry.
ESD ADV3.2-1995: Selection and Acceptance of Air Ionizers
This Advisory document provides end users with guidelines for creating a performance specification for selecting air ionization systems. It reviews four types of air ionizers and discusses applications, test method references, and general design, performance and safety requirements.
ESD ADV11.2-1995: Triboelectric Charge Accumulation Testing
The complex phenomenon of triboelectric charging is discussed in this Advisory. It covers the theory and effects of tribocharging. It reviews procedures and problems associated with various test methods that are often used to evaluate triboelectrification characteristics. The test methods reviewed indicate gross levels of charge and polarity, but are not necessarily repeatable in real world situations.
ESD ADV53.1-1995: ESD Protective Workstations
This Advisory document defines the minimum requirements for a basic ESD protective workstation used in ESD sensitive areas. It provides a test method for evaluating and monitoring workstations. It defines workstations as having the following components: support structure, static dissipative worksurface, a means of grounding personnel, and any attached shelving or drawers.
ESD TR 20.20 - ESD Handbook
New handbook provides detailed guidance for implementing an ESD control program in accordance with ANSI/ESD S20.20.

A-5 Figure 6-2 ESD Symbols



A-6 ESD Protected Area Sign

ESD PROTECTED WORK AREA

ESD HANDLING IS REQUIRED

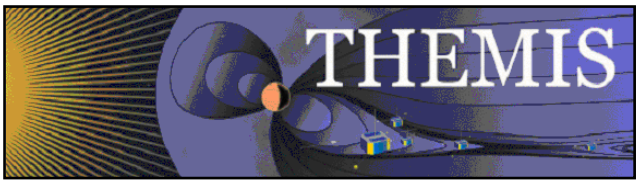
A-7 Hygometers/Thermometers

Unit simultaneously displays ambient temperature, humidity, and time of day. Ideal for use in incubators, storerooms, drying chambers, hoods, cleanrooms, and environmental cabinets. Memory recalls highest and lowest temperature and humidity readings. Clock displays A.M./P.M. or 24-hour military time to the exact minute with 0.01% accuracy.
A certificate is provided to indicate instrument traceability to standards provided by the National Institute of Standards and Technology.

Dimensions:	10.8W x 5.7H x 1.3D cm
	($4^1/_4$ x $2^1/_4$ x $^1/_2$")
Temperature,	
Range:	0 to 50°C and 32 to 122°F
Resolution:	0.1°
Accuracy:	±1°C
Humidity,	
Range:	20 to 90%
Resolution:	1% Relative Humidity
Accuracy:	±2% (mid-range) to ±4% (ends of range)

P/N: 62344-734
DES:Thermometer w/clock and Humidity Monitor
MFG: VWR International
COST: list -$37.23 each
VENDOR:VWR

P/N: 14-648-52
DES:Radio-Signal Hygrometer/Thermometer (Main unit and remote sensor module)
MFG: Fisher Scientific
COST: list -$63.15 each
VENDOR:Fisher Scientific



A-8 Acronyms

GSFC	Goddard Space Flight Center
PROJECT	The project, which is currently implemented at UCB/SSL is THEMIS
THEMIS	Time History of Events and Macroscale Interactions during Substorms
NASA	National Aeronautics and Space Administration
NPG	NASA Procedures and Guidelines
PM	Project Manager
MAM	Mission Assurance Manager
EXPLORER	Solar Terrestrial Probes
TBD	To Be Determined
UCB/SSL	University of California, Berkeley, Space Sciences Laboratory
GSE	Ground Station Equipment
GBO	Ground Bases Observation
ETU	Engineering Test Unit, i.e., Prototype

APPENDIX B

B-1 ESD Training and Certification

Table 6-2

No.	TRAINING & TEST	NAME	TRAINED	DATE	CERTIFIED	DATE	Test on file at UCB/SSL/QA	COMMENT
1	IPC-DVD-54C V.2	Bruce Dalen	**Y**	4/23/2004	**Y**	4/27/2004	**Y-RM140**	
2	IPC-DVD-54C V.2	Chris Scholz						
3	IPC-DVD-54C V.2	Craig Domeny	**Y**	4/20/2004	**Y**	4/23/2004	**Y-RM140**	
4	IPC-DVD-54C V.2	Daniele Meilhan	**Y**	5/7/2004	**Y**	5/10/2004	**Y-RM140**	
5	IPC-DVD-54C V.2	David Stone	**Y**	5/20/2004	**Y**	5/27/2004	**Y-RM140**	
6	IPC-DVD-54C V.2	Dorothy Gordon	**Y**	5/27/2004				

Figure 6-3

IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

ESD CERTIFICATION TEST *(DVD-54C)*

This test consists of twenty-four multiple-choice questions. All questions are from the video: *ESD Control (DVD-54C).*
Each question has only one *most* correct answer. Circle the letter corresponding to your selection for each test item. ….
The passing grade for this test is 70% (17 or more correct answers).

Figure 6-4

IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

TRAINING CERTIFICATION

THIS IS TO CERTIFY THAT

_____

HAS SUCCESSFULLY COMPLETED THE COURSE OF STUDY ON
ESD CONTROL DVD-54C

B-2 - Shipping document

UCB Space Sciences Laboratory	PROJECT: THEMIS	Shipping Number: 042804-2

FROM:
University of California, Berkely, Space Sciences Laboratory
UCB Contact: Jorg Fischer
7 Gauss Way, Berkeley, CA 94720, MailStop: RM140-Silver
Shipper Phone: (510) 642-3942
Shipper email: jorg@ssl.berkeley.edu

TO:
Patti Hart
QSS Group/Goddard Space Flight Center
Parts Analysis Lab Bldg. 22, Room C031 Code 562
Greenbelt, MD 20771
Vendor Contact: Patti Hart
Vendor Phone: 301-441-3311
Vendor email: phart@pop500.gsfc.nasa.gov

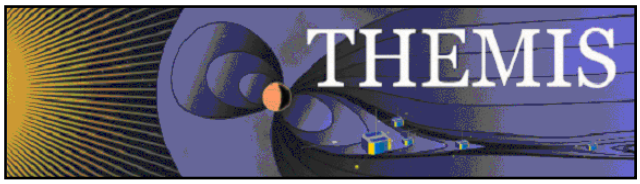
NOTE:
ESD SENSITIVE PARTS
HANDLE WITH CARE

Perform: Testing

311-INST-001A, Level 3

Items Shipped:

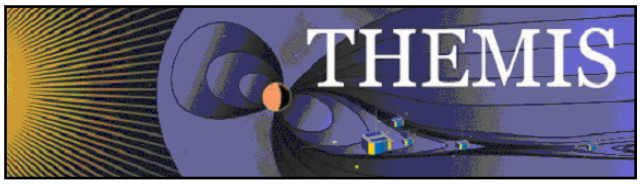
Item	QTY	P/N	Description	Comments	D/C
1	150	2N6519	PNP HV		DC348



B-3 – ESD Workstation Audit

ESD Workstation Checklist			
Project: THEMIS	Area / Building / Room:	Performed By:	
		Date:	

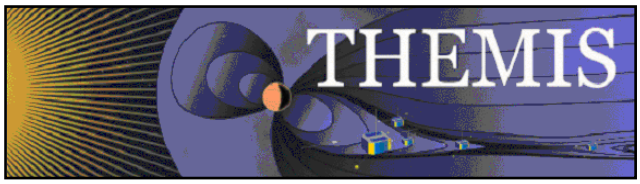
Item	Question	Check	Comment/objective evidence
1	Record the name of ESD workstation operator		
2	Is the workstation operator certified to ANSI/ESD-20.20-1999 or equivalent?		
3	Are wrist straps on an automatic, continuous monitor system or checked daily and recorded?		
4	Record the continuous monitor system Mfg., Model, P/N, and calibration.		
5	Verify limited access to ESD-protected areas.		
6	Is there posted evidence of current ESD calibration for ESD control areas (e.g., hygrometer calibration)?		
7	Is there an ESD floormat installed?		



B-4 - ESD Survey Form

ESD Survey Form			
Project: THEMIS	Area:		Performed By:
			Date:

Item	Question	Check	Comment/objective evidence
1	Is there an ESD control plan in place, including methods for performing audits and inspections of the control plan?		
2	Is ESD sensitivity identified on drawings and production planning?		
3	Is the ESD sensitive label on containers and packaging of ESD sensitive items?		
4	Are ESD audits performed on a scheduled basis and are audit records maintained?		
5	Are all persons certified to ANSI/ESD-20.20-1999 or equivalent?		
6	Are wrist straps on an automatic continuous monitor system or checked daily and recorded?		
7	Are there maintenance guidelines for ESD control areas?		
8	Is there posted evidence of current ESD calibration for ESD control areas?		
9	Verify limited access to ESD-protected areas.		
10	Procedures are in place for the proper handling of ESD sensitive parts, assemblies, and equipment.		
11	Is ESD sensitivity identified on shipping documents?		



ATTACHMENTS

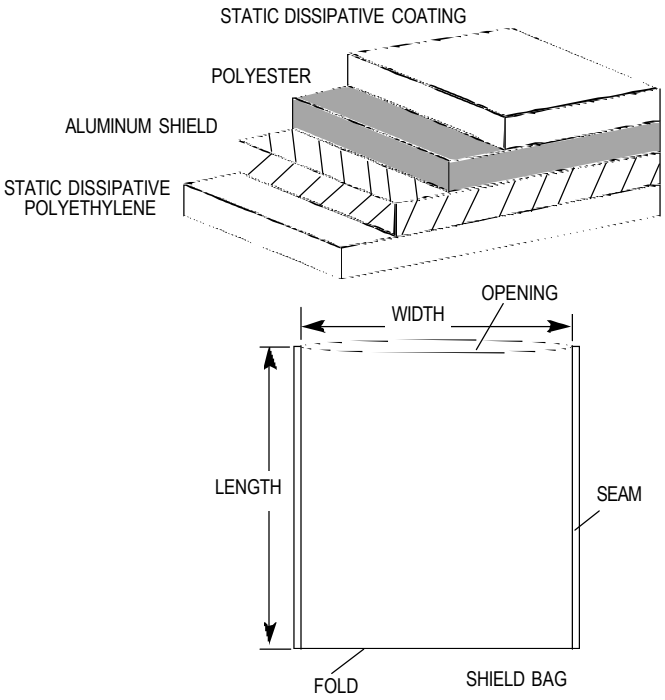
Attachment-1 ESD Bags

Attachment 1, ESD BAGS

SCC1000 Static Shield Bag

SCC Product Bulletin
120296-scc1000

Data Sheet



Description

This transparent, metalized static shield bag provides a static safe environment for sensitive electronic devices. Four layer construction. Polyester dielectric and metal layer provide Faraday effect shielding of ESD and fields. Tribocharging is minimized by the specially processed polyethylene. Flat and zipper closure styles. Coded for QC traceability.

Product Specifications

ELECTRICAL

Surface Resistivity	10^9 10^{10} ohms/square ASTM D257	
Static Shielding	< 30 volts EIA 541	
Static Decay	<0.05 seconds FTMS101 MTH 4046	
Charge Generation		
teflon	0.09 n/C sq.in.	Modified incline plane
quartz	0.01 n/C sq.in.	

MECHANICAL

Tensile Strength	>25 lbs ASTM D882
Seam Strength	Pass MIL-B-81705C
Light Transmission	40% Tobias
Thickness	3.1 mils
Heat Sealing Conditions:	
Temperature	250°F - 375°F
Time	0.5 - 3.5 seconds
Pressure	30 - 70 PSI

CHEMICAL

Outgassing	Pass ASTM E595
Non-corrosive	Pass FTMS 101 MTH 3005

Ordering Information

Standard Sizes - In Stock-Same Day Shipment.
Width is measured from inside seam to inside seam.

SCC 1000			SCC 1000 Zip-Top	
W x L	*W x L*	*W x L*	*W x L*	*W x L*
2 x 3	6.5 x 10	12 x 12	2 x 3	8 x 12
2 x 4	6.5 x 16	12 x 14	3 x 3	9 x 12
2 x 6	7 x 8	12 x 16	3 x 5	10 x 12
3 x 5	7 x 10	12 x 18	4 x 4	10 x 14
4 x 4	7 x 11	12 x 24	4 x 6	10 x 24
4 x 6	7 x 15	12 x 25	4 x 8	10 x 30
4 x 8	7 x 16	12 x 30	4 x 24	11 x 15
4 x 24	8 x 8	14 x 18	4 x 30	12 x 12
4 x 26	8 x 10	14 x 20	5 x 8	12 x 16
4 x 30	8 x 12	14 x 30	5 x 10	12 x 18
5 x 6	8 x 16	15 x 18	6 x 8	14 x 18
5 x 7	8 x 18	16 x 18	6 x 10	15 x 18
5 x 8	8 x 24	16 x 20	6 x 24	16 x 24
5 x 10	8 x 30	16 x 24	6 x 30	18 x 18
6 x 8	9 x 12	18 x 18	7 x 15	18 x 24
6 x 9	10 x 12	18 x 20	8 x 8	
6 x 10	10 x 14	18 x 24	8 x 10	
6 x 12	10 x 16	18 x 30		
6 x 14	10 x 18	20 x 20		
6 x 16	10 x 24	20 x 24		
6 x 18	10 x 26	22 x 24		
6 x 24	10 x 30	24 x 24		
6 x 26	11 x 15	24 x 30		
6 x 30	11 x 15	30 x 24		

Static Control Components, Inc.
ESD Products Division
US and Canada 800.356.2728 Fax 800.356.2729
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Internet: www.scc-inc.com email: esd@scc-inc.com