



George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

MSFC-P09.1-C07
BASELINE
OCTOBER 7, 1997

CENTERWIDE WORK INSTRUCTION

CR01

REQUIREMENTS FOR ELECTROSTATIC DISCHARGE CONTROL

CHECK THE MASTER LIST at
<http://masterlist.msfc.nasa.gov/>
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 1 of 9

DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		10/07/97	

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 2 of 9

REQUIREMENTS FOR ELECTROSTATIC DISCHARGE CONTROL

1. SCOPE

1.1 Scope. This instruction provides a consistent application of requirements for an electrostatic discharge (ESD) control program for electrical and electronic assemblies, and equipment, and their constituent parts susceptible to damage from ESD. This instruction does not address ESD requirements for electrically initiated explosive devices.

1.2 Purpose. The purpose of this instruction is to establish the requirements for an ESD control program to minimize the effects of ESD on parts, assemblies, and equipment and to meet the requirements of MSFC-P09.1, *Process Control*.

1.3 Applicability. This instruction applies to all MSFC organizational elements involved in the design, procurement, fabrication, inspection, test, handling, storage, and operation of flight and flight associated hardware containing ESD sensitive items for MSFC projects. Specifically, these requirements apply to the following personnel as a minimum: electrical designers, engineers who troubleshoot electrical hardware, manufacturing personnel, quality assurance (QA) personnel, shipping/receiving personnel, kitting personnel, and electrical test personnel.

2. APPLICABLE DOCUMENTS

MSFC-P09.1	<i>Process Control</i>
MSFC-P17.1	<i>Internal Audits</i>
MSFC-P18.1-C01	<i>Personnel Certification Program</i>
MSFC-P18.1-C03	<i>Personnel Certification for Electrical Processes</i>
NHB 5300.4(1G)	<i>NASA Assurance Terms and Definitions</i>
MIL-STD-129	<i>Standard Practice for Military Marking</i>

3. DEFINITIONS

Refer to NHB 5300.4(1G), *NASA Assurance Terms and Definitions*.

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 3 of 9

4. INSTRUCTIONS

4.1 ESD controls, as a minimum, shall be implemented to include the following ESD control program requirements:

a. Protected areas and work stations shall be established and verified as adequate by Quality Assurance personnel prior to their use.

b. Use of protective personnel clothing and proper personnel grounding at all necessary points where ESDS items will be handled.

c. Establish a certification program to ensure that all personnel handling electrostatic discharge sensitive (ESDS) items have received the necessary training and have been certified.

d. Perform internal audits to ensure the integrity of the ESD protected areas and equipment.

e. Inspection of documentation for ESD markings, precautions, and handling procedures as applicable.

4.2 Handling. Handling and moving of ESDS items will be accomplished using appropriate ground straps, grounding chains, and/or protective packaging. Detailed ESD procedures will be developed to minimize occurrence of discharge when handling of ESDS items where ESD protection is not practicable.

4.2.1 Packaging. Electrostatic protective packaging requires the prevention of charge generation and protection from strong electrostatic fields. Materials used in protective bags and pouches shall be constructed from a single folded piece of material and the resistivity of internal and external surfaces shall not exceed 10^9 ohms/square. Non-metallic conductive and static dissipative magazines, chutes and dip-tubes shall be used for shipping integrated circuits. Tote boxes and covers shall be made of conductive or static dissipative material.

4.2.2 Receiving. All ESDS items received shall be examined for proper ESD precautionary marking and for ESD protective packaging. Inadequate precautionary markings shall be corrected prior to further processing. When an item is received that has not been protected during shipment or internal transfer, it shall be rejected as defective and processed as nonconforming material.

4.2.3 Kitting and Shipping. When a kit is assembled that includes an ESDS item, the entire kit shall be packaged and

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 4 of 9

marked as ESDS. The accompanying documentation shall identify the kit as ESDS. ESDS items packaged for shipping shall be packaged and marked as required by the contract or this instruction.

4.2.4 Component Testing (Black Box). Wrist straps shall be used when cabling boxes unless the box design precludes ESD damage due to discharge into connector pins. Environmental controls during testing shall be in accordance with the test procedure.

4.3 Protective Areas. Protective areas shall be clearly identified by prominently placed signs. Access to such areas shall be limited to certified personnel. All other personnel shall be escorted and equipped with protective clothing, as required.

4.3.1 Work Surfaces. All work surfaces in an ESD protected area shall be static dissipative and electrically connected to a common ground. Homogeneous materials shall have surface resistivity in the range of 10^5 to 10^9 ohms/square.

4.3.2 Flooring. Conductive floors and 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 shall be kept free of dust, dirt, and other contaminants. After each cleaning, conductive floor resistivity shall be verified and the results shall be recorded. Conductive floors shall not be waxed or buffed unless the flooring manufacturer's recommendations are followed and the materials used do not inhibit flooring conductivity. Carpet in ESD protected areas is prohibited unless precautionary measures are documented and approved in writing.

4.3.3 Air Ionizers. If the use of air ionizers is necessary, then their design shall incorporate a continuous balance status indicator (alarm). Otherwise, the air ionizer must be placed on category I calibration (recall) with the interval established by the calibration laboratory.

4.4 Personnel Grounding Devices. Grounding devices shall be supplied to all personnel working with or handling ESDS items to prevent the accumulation of ESD. A grounding device shall be worn by all personnel coming within 3 feet of any ESDS item.

4.4.1 Wrist Straps. Wrist straps shall ensure conductive contact with the wearer's skin. The safety resistor shall

Marshall Space Flight Center Centerwide Work Instruction		
CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 5 of 9

measure 1 mega-ohm (+/- 20%). Wrist straps that alarm when the connection to ground is compromised are preferred.

4.4.2 Other. Foot grounding devices, such as leg, toe, heel straps, or conductive shoes worn in conjunction with a conductive floor and/or conductive mats, are acceptable alternatives to wrist straps in those situations where the operator needs to be mobile and the use of a wrist strap is impractical or unsafe.

4.5 Equipment and Facility Grounding. The preferred practice for equipment and facilities ground is to use the third wire alternating current (AC) line ground for grounding all items at the ESD-protected work station. 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. The resistance of the conductor from the common point ground to the equipment AC ground should not be greater than 1.0 ohm. The impedance from the work station common point ground to the neutral bond at the main service box should not be greater than 2.0 ohms.

4.5.1 Chairs and stools should be constructed of conductive material and the cover material fabricated from static dissipative materials. Where carts, wagons, or trams 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 vehicle. If the floor is non-conductive, the vehicle will be grounded before ESDS items are loaded or removed from the vehicle.

4.6 Humidity. The relative humidity shall be maintained in ESD-protected work areas at 30 percent to 70 percent. At levels below 30 percent, additional precautions shall be employed (e.g., air ionizers, humidifiers). If other precautionary methods are not available, work shall be halted until the required humidity level is obtained.

4.7 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.

4.7.1 Equipment containing ESDS items shall be identified internally with either the sensitive electronic device symbol

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 6 of 9

from MIL-STD-129 or the Electronic Industries Association RS-471 symbol. The following caution statement shall be placed adjacent to the ESDS symbol if room is available: CAUTION - CONTAINS PARTS AND ASSEMBLIES SUSCEPTIBLE TO DAMAGE BY ESD.

4.7.2 Equipment having external sensitivity shall have ESDS symbols affixed to their exterior.

4.7.3 The ESDS 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 NASA procuring organization when the prescribed marking is not possible.

4.8 Monitoring.

4.8.1 Annual Measurements. The following measurements/verifications will be recorded annually by the organization responsible for the protected area/workstation:

- a. resistivity of anti-static mats and floors (except floor resistivity shall be measured after each cleaning).
- b. resistance of all personnel protective devices connected to audible alarms.
- c. resistance of all power tools.
- d. all grounding points.

4.8.2 Daily Measurements. The resistance of all personnel protective devices that do not use an audible alarm will be verified and recorded daily by the responsible organization.

4.8.3 Audits. Initial verification audits will be performed by the Quality Assurance Office upon request using MSFC Form 4294 as a guide. Verification of current status will be accomplished by the following:

- a. During MSFC internal audits, organizations with protected areas/workstations may be audited in accordance with MSFC-P17.1 for compliance with this instruction.
- b. Spot audits will be performed by Quality Assurance personnel on a random basis using the audit report form of Appendix A to further assure compliance with this instruction.

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 7 of 9

5. NOTES

5.1 For the purpose of this instruction, parts assemblies and equipment susceptible to ESD voltages of 16,000 volts or higher are considered non-ESD sensitive.

5.2 Surface resistivity changes exponentially with humidity changes. Therefore, relative humidity levels maintained between 40 percent and 60 percent are recommended.

5.3 The Quality Assurance Office will assist in performing annual resistivity measurements when requested.

5.4 This instruction replaces MSFC-RQMT-1493.

6. SAFETY PRECAUTIONS AND WARNINGS NOTES

Work surfaces should be soft grounded to eliminate the safety hazard of touching high voltage circuit with one hand and a hard ground with the other. A work surface which is connected to a hard ground requires that the electrical power line be protected with a ground fault circuit interrupter.

7. APPENDICES, DATA, REPORTS, AND FORMS

MSFC Form 4294 ESD PROTECTED AREA/WORKSTATION AUDIT

8. QUALITY RECORDS

Refer to MSFC-P18.1-C03 for quality records pertaining to training and certification for ESD controls. The completed MSFC Form 4294 shall be maintained by the Quality Assurance Office for 10 years from the audit date or as long as the protected area/workstation is in existence. The measurement and verification records required by paragraphs 4.9.1 and 4.9.2 will be maintained by the organization responsible for the protected area/workstation for 3 years.

9. TOOLS, EQUIPMENT, AND MATERIALS

9.1 Insulated metal hand tools such as pliers, cutters, tweezers, and wire strippers are prohibited. Only anti-static solder extractors made of metal, or having a metallized plastic barrel and tip, shall be used. Electrical tools shall have a three-wire grounded power cord or be double insulated. The area making contact with the work piece shall be grounded with a measured resistance not to exceed 2.0 ohms.

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 8 of 9

9.2 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 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 suited for the test temperature and humidity ranges.

9.3 Cleaning agents and methods used on ESDS protective items shall not reduce the effectiveness of these items. They shall not cause leaching or leave insulation residues. Cleaning agents shall be chosen for low electrostatic charging propensity. Only natural fiber materials shall be used for cleaning ESDS items.

9.4 When necessary, electrostatic survey meters shall be used to detect the presence of electrostatic charges and be of the type which will read charges on a surface without requiring contact. Such meters shall be capable of measuring the voltage on a sample 8 inches in diameter with a minimum resolution of 100 volts and a range of at least 1 kilovolt.

9.5 The use of electrostatic monitors designed to actuate an alarm when an electrostatic field reaches a preset level, is recommended in an ESD protected area.

9.6 A wrist strap tester shall be available in all areas where ESDS items are handled.

9.7 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 protective area, shall be made of static dissipative or conductive materials.

9.8 Conformal Coating Application. When spraying ESDS printed wiring assemblies with conformal coating, an anti-static spray nozzle shall be used.

Marshall Space Flight Center Centerwide Work Instruction CR01		
Requirements for Electrostatic Discharge Control	MSFC-P09.1-C07	Revision: BASELINE
	Date: October 7, 1997	Page 9 of 9

10. PERSONNEL TRAINING AND CERTIFICATION

Certification of personnel shall be based on successful completion of an approved training program. This training is for those who play a major role in ESD damage prevention, i.e., electrical designers, engineers who troubleshoot electrical hardware, manufacturing personnel, QA personnel, shipping/receiving personnel, kitting personnel, and electrical test personnel. MSFC personnel shall be certified in accordance with MSFC-P18.1-C01, *Personnel Certification Program*, and MSFC-P18.1-C03, *Personnel Certification for Electrical Processes*. The training shall include the following: ESD control program, principles/control methods of static electricity, identification of ESDS items, protective materials and equipment, protected areas and work stations, monitoring of the work place, handling ESDS items, packaging, marking and shipping of ESDS items. After personnel successfully complete training, the decal shown in figure 1 will be affixed to their badge as evidence of certification.



Figure 1

11. FLOW DIAGRAM

None.