ESD Control in the NASA STD-8739.6

Presented By: Alvin J Boutte
NASA Workmanship Standards Program Manager
Outline

• S20.20
• NASA S20.20 history
• Overview of NASA STD-8739.6 update
• Features of ESD Controls Section 7
• Conclusion
The ANSI/ESD S20.20

For the Development of an Electrostatic Discharge Control Program for:

Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

Electrostatics Discharge Association
500 Farm Road, Big 3
Reno, NV 89503

An American National Standard
Approved July 31, 2014
The ANSI/ESD S20.20

ANSI/ESD S20.20-2014

CAUTION NOTICE

Electrostatic Discharge Association (ESDA) standards and publications are designed to serve the public interest by eliminating misunderstandings between manufacturers and purchasers, facilitating the interchangeability and improvement of products and assisting the purchaser in selecting and obtaining the proper product for his particular needs. The existence of such standards and publications shall not in any respect preclude any member or non-member of the Association from manufacturing or selling products not conforming to such standards and publications. Nor shall the fact that a standard or publication is published by the Association preclude its voluntary use by non-members of the Association, whether the document is to be used either domestically or internationally. Recommended standards and publications are adopted by the ESDA in accordance with the ANSI Patent policy.

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Note: Since 2010 the majority of ESD findings were related to confusion around or mis-interpretation of ANSI/ESD S20.20.

**NASA and the ANSI/ESD S20.20 Timeline**

- **2002**: NASA-STD-8739.7 replaced with ANSI/ESD S20.20-1999
- **2010**: NASA develops and releases NASA HANDBOOK-8739.21
- **2012**: NASA begins development of ESD Standard S20.21
- **2014**: S20.21 standard changed to TR-19.1 due to ESDA feedback
- **2017**: NASA development of ANSI/ESD TR-19.1 falls apart
- **2019**: Supplemental ESD Section added to NASA STD-8739.6

Note: Most findings pre-2010 involve training or not using ANSI/ESD S20.20.
FOREWORD

This NASA-HANDBOOK is published by the National Aeronautics and Space Administration (NASA) to provide standardized guidance for implementing ANSI/ESD S20.20 requirements. This document:

a. Describes basic considerations necessary to ensure ESD protection in work areas to be used with ESD-sensitive items.

b. Reinforces rigorous operator training best practice.

c. May be used by suppliers performing work for NASA to satisfy ANSI/ESD S20.20 ESD implementation plan requirements.

NOTE: For the purpose of this document, the term “supplier” is defined as civil servants and contractors who are building and delivering ESD-sensitive hardware for NASA Projects.
Note: Since 2010 the majority of ESD findings were related to confusion around or mis-interpretation of ANSI/ESD S20.20.
QAAR ESD Findings History

**QAAR Audit Findings 2011-2018**
- S20.20: 52%
- Local Document: 48%

**Breakdown of S20.20 Findings**
- No ESD PM/Doc.: 35%
- Local Control Plan Issues: 17%
- Mat./Req. Verification: 24%
- Training: 10%
- Signage: 14%
Current Use of ANSI/ESD S20.20 at NASA
Future Use of ANSI/ESD S20.20 at NASA
5. **TRAINING REQUIREMENTS**

This section supersedes the Section 5 requirements of NASA Standards 8739.1, 8739.4, and 8739.5.

5.1 **General Training Requirements**

5.1.1 This section:

a. Establishes the training requirements for all employees, including:

7. **ELECTROSTATIC DISCHARGE CONTROL STANDARD IMPLEMENTATION**

7.1 **Applicable ESD Documents**

<table>
<thead>
<tr>
<th>Requirements for Soldered Electrical and Electronic Assemblies</th>
<th>IPC® J-STD-001G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space and Military Applications Electronic Hardware Addendum to IPC® J-STD-001G Requirements for Soldered Electrical and Electronic Assemblies</td>
<td>IPC® J-STD-001GS</td>
</tr>
<tr>
<td>Requirements and Acceptance for Cable and Wire Harness Assemblies</td>
<td>IPC® IPC/WHMA-A-620C</td>
</tr>
<tr>
<td>Space Applications Electronic Hardware Addendum to IPC/WHMA-A-620C, Requirements and Acceptance for Cable and Wire Harness Assemblies</td>
<td>IPC® IPC/WHMA-A-620C-S</td>
</tr>
</tbody>
</table>
Appendix A requirements moved to Section 5

APPENDIX A. REQUIREMENTS FOR WORKMANSHIP STANDARDS TRAINING PROGRAMS

A.1 General

A.1.1 This section:

a. Establishes the training requirements for workmanship operators, inspectors, and instructors.

b. Establishes the certification requirements to teach on behalf of a NASA Center’s SMA or

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# Updated Voluntary Consensus Standards

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</tbody>
</table>
Approved Solvents and Cleaners

6.9.2 Acceptable Solvents. The following solvents are acceptable when used for cleaning connectors, hardware, and other materials and parts in cables and harnesses. Other solvents require approval of the procuring activity prior to use.


b. Isopropyl alcohol, TT-I-735.

<table>
<thead>
<tr>
<th>Solvents and Cleaners</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethyl Alcohol</td>
<td>Per Federal Regulation 27 CFR Part 21, Subpart 35, Formula No. 3-A</td>
</tr>
<tr>
<td>Isopropyl Alcohol</td>
<td>TT-I-735A</td>
</tr>
<tr>
<td>Deionized Water</td>
<td>1 megohm-cm, minimum resistivity (See paragraph 6.9.8)</td>
</tr>
<tr>
<td>Detergent cleaners and saponifiers</td>
<td>(See paragraph 6.9.9)</td>
</tr>
</tbody>
</table>
Approved Solvents and Cleaners

NASA STD 8739.6 - 2016

6.7 Solvents and Cleaning

6.7.1 Deionized water and isopropyl alcohol are considered standard solvents and do not require approval prior to use for cleaning printed circuit boards, printed wiring assemblies, or soldered contacts, terminals, or splices. All other solvents require prior approval from the applicable NASA Technical Authority.

NASA STD 8739.6 - 2019

6.7 Solvents and Cleaning

6.7.1 Deionized water, denatured ethyl alcohol, and isopropyl alcohol are considered standard solvents and do not require approval prior to use for cleaning printed circuit boards, printed wiring assemblies, soldered contacts, terminals, cable harness assemblies, or splices. All other cleaning processes require prior approval from the applicable NASA Technical Authority.
Addition of Section 7 ESD Control Requirements

7. ELECTROSTATIC DISCHARGE CONTROL STANDARD IMPLEMENTATION

7.1 Applicable ESD Standard

ANSI/ESD S20.20-2014 contains the baseline requirements for the ESD Control Program.

ANSI/ESD S20.20-2014 requires the development of an ESD Control Program Plan that serves as the principle document for ESD control at each NASA Center.

ESD Product Qualification test data generated in accordance with ESDA product qualification standards have been accepted by NASA Centers as a part of their ESD Product Qualification.

<table>
<thead>
<tr>
<th>#</th>
<th>ESD Control</th>
<th>Verification Values (Alternate Test Methods)</th>
<th>Recommended Verification Intervals</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Work Surface Resistance</td>
<td>$10^6$ to $&lt;10^9 \Omega$ (ANSI/ESD S4.1)</td>
<td>Continuous Daily Monthly Biennial Annual</td>
</tr>
<tr>
<td>2</td>
<td>Work Surface Grounding</td>
<td>$10^6$ to $&lt;10^9 \Omega$ (ANSI/ESD S4.1)</td>
<td>x</td>
</tr>
<tr>
<td>3</td>
<td>Protective Floor Resistance</td>
<td>If Dissipative: $10^6$ to $&lt;10^9 \Omega$ (ANSI/ESD S7.1) If Conductive: $&lt;10^6 \Omega$ (ANSI/ESD S7.1)</td>
<td>x</td>
</tr>
<tr>
<td>4</td>
<td>Protective Floor Grounding</td>
<td>If Dissipative: $10^6$ to $&lt;10^9 \Omega$ (ANSI/ESD S7.1) If Conductive: $&lt;1 \Omega$ (ANSI/ESD S7.1)</td>
<td>x</td>
</tr>
</tbody>
</table>
Clarified Technical Requirements

7.2.4.1 Work Surfaces

Work surfaces in EPAs are those that will be used to physically host the ESDS item and may be used as a ground path for items that can be grounded but do not contain a Groundable Point (Gp). The work surface shall meet the following requirements:

7.2.4.1.1 The resistance of work surface where ESDS items are handled shall be in the dissipative range, from $10^6$ to $<10^9\Omega$. See Table 3, #1 for alternative verification methods.

*Note: This should be measured between two points 10” apart on the Work Surface and 2” from the edge in the commonly used area.*

7.2.4.1.2 The resistance from the center of the work surface to the common point ground shall be $10^6$ to $<10^9\Omega$. See Table 3, #2 for alternative verification methods.

7.2.4.1.3 When conductive surfaces must be used as an ESD work surface, control methods to prevent an ESD event shall be documented by the ESD Control Program Plan.

*Note: Conductive surfaces, grounded or ungrounded, can enable ESD events to occur.*
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<td>2</td>
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<td>✗</td>
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<td>3</td>
<td>Protective Floor Resistance</td>
<td>If Dissipative: $10^6$ to $&lt;10^9 \Omega$ (ANSI/ESD S7.1)</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>If Conductive: $&lt;1 \Omega$ (ANSI/ESD S7.1)</td>
<td>✗</td>
</tr>
<tr>
<td>5</td>
<td>Wrist Strap Check</td>
<td>Go/No Go functional check</td>
<td>✗</td>
</tr>
<tr>
<td>6</td>
<td>Wrist Strap Resistance range</td>
<td>From $800 \text{k}\Omega$ to $1.2 \text{M}\Omega$ <em>per ANSI/ESD S20.20-2014</em> (ANSI/ESD S1.1)</td>
<td>✗</td>
</tr>
<tr>
<td>7</td>
<td>Wrist Strap Ground Point Resistance</td>
<td>$&lt;1 \Omega$ or $&lt;1.2 \times 10^6 \Omega$ if measured through a CMS</td>
<td>✗</td>
</tr>
<tr>
<td>8</td>
<td>Foot Grounding Device Integrity</td>
<td>$&lt;3.5 \times 10^7 \Omega$ (ANSI/ESD STM97.1)</td>
<td>✗</td>
</tr>
<tr>
<td>9</td>
<td>ESD CMS</td>
<td>Calibration is required</td>
<td>✗</td>
</tr>
<tr>
<td>10</td>
<td>Stool / Chair Grounding</td>
<td>$10^6$ to $&lt;10^9 \Omega$ (ANSI/ESD S12.1)</td>
<td>✗</td>
</tr>
</tbody>
</table>
ESD Control Plan Requirements Tailoring

7.2.1 General ESD Control Program Plan Requirements

7.2.1.1 The baseline ESD Control Program Plan shall be fully traceable to ANSI/ESD S20.20-2014 and the requirements herein.

7.2.1.2 Tailoring is permitted, as the requirements in Section 7 of this document may not be applicable in all situations. Tailoring is accomplished by evaluating the applicability of, or the risk of not implementing, a requirement for a specific application or scenario (e.g., mission class, R&D project, facility limitations, etc.). Upon completion of the evaluation, requirements may be deleted or modified outside the limits of this standard for technical or logistical reasons with ESD Control Program Manager approval. Tailoring decisions shall be documented in the ESD Control Program Plan and include rationale, risk assessments, and technical justifications.
### ESD Control Plan Requirements

**7.2.3 Baseline ESD Control Program Plan Requirements**

**7.2.3.1 The Certification, Recertification, and Compliance Verification Plan requirements of ANSI/ESD S20.20-2014 apply with the following additions and modifications:**

- **7.2.3.1.1** The ESD Control Program Plan shall define the baseline sensitivity level addressed by the EPA requirements (e.g., HBM 1A) as well as any other EPA sensitivity levels considered to be within the scope of the plan (e.g., HBM 1B, HBM 0, CDM C1).

- **7.2.3.1.2** The ESD Control Program Plan shall define the criteria for when ESDS hardware is to be handled within a certified EPA (e.g., mission risk class, R&D status, commercial off-the-shelf ground support equipment, etc.).

- **7.2.3.1.3** All EPA certifications shall be performed by the ESD Control Program Manager, or their representative.
Certified ESD Control Program Manager

7.2.2.1 Personnel Training and Certification

7.2.2.1.1 The ESD Control Program Manager shall have formal training in:

(a) the technical requirements in Chapter 8 of ANSI/ESD S20.20-2014

(b) static charge prevention and mitigation methods for operators and EPAs

(c) processes for certification and verification of ESD control materials and ESD protected areas

Note: ESDA, iNARTE, or other third-party ANSI/ESD S20.20 training courses are recommended to meet this requirement. This may also be accomplished via documented on-the-job training.
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6.2 ESD Control Program Manager or Coordinator
An ESD Control Program Manager or Coordinator shall be assigned by the Organization to verify the compliance of the Program in accordance with the requirements of this document.

7.1 ESD Control Program Plan
The Organization shall prepare an ESD Control Program Plan that addresses each of the requirements of the Program. Those requirements include:

- Training
- Product Qualification
- Compliance Verification
- Grounding / Equipotential Bonding Systems
- Personnel Grounding
- ESD Protected Area (EPA) Requirements
- Packaging Systems
- Marking
Conclusion

• The update to the NASA STD-8739.6 includes:
  – Reorganization of training requirements
  – Adoption of most recent revisions of J-STD001GS and IPC/WHMA-A-620C-S
  – Re-addition of denatured ethyl alcohol as a standard solvent
  – Administrative and technical ESD requirements to supplement ANSI/ESD S20.20 and clarify commonly misunderstood requirements
Questions