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STANDARD**

National Aeronautics and Space Administration
Washington, DC 20546

NASA-STD 8739.6

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**IMPLEMENTATION REQUIREMENTS
FOR NASA WORKMANSHIP STANDARDS**

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FOREWORD

This NASA-STD is published by the National Aeronautics and Space Administration (NASA) to provide uniform engineering and technical requirements for procedures that have been endorsed for NASA programs and projects, including requirements for selection, application, and design criteria of an item.

This NASA-STD is approved for use by NASA Headquarters and NASA Centers, including component facilities, and is intended to be applied on NASA contracts.

This document contains clarifications, additions, and exceptions to requirements specified in NASA workmanship standards and industry consensus standards referenced in NPD 8730.5, NASA Quality Assurance Program Policy. These exceptions and additions are considered to be NASA requirements and take precedence over the requirements that they modify. These changes reflect essential requirements previously contained in NASA standards that have been cancelled and superseded by industry standards.

This document contains NASA workmanship training center requirements.

For the purpose of this document, the term “supplier” includes in-house NASA production operations, NASA prime contractors, and NASA subcontractors who are manufacturing or otherwise processing mission hardware.

Questions concerning the application of this publication to specific procurements should be referred to the applicable NASA program/project or Center.

Requests for information, corrections, or additions to this NASA-STD should be submitted via “Feedback” in the NASA Technical Standards System at <http://standards.nasa.gov>. This NASA-STD was developed by NASA Headquarters Office of Safety and Mission Assurance and the NASA Workmanship Standards Program.


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Approval Date

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IMPLEMENTATION REQUIREMENTS FOR NASA WORKMANSHIP STANDARDS

CHAPTER 1. SCOPE

1.1 SCOPE

This publication sets forth quality requirements for the manufacture of electronic assemblies and for electrostatic discharge (ESD) control which augment requirements found in one or more of the documents listed in Table 1.

Table 1: Workmanship Requirements Documents

Title	Number
Workmanship Standard for Polymeric Application on Electronic Assemblies	NASA-STD 8739.1
Workmanship Standard for Crimping, Interconnecting Cables, Harnesses, and Wiring	NASA-STD 8739.4
Workmanship Standard for Fiber Optic Terminations, Cable Assemblies, and Installation	NASA-STD 8739.5
Standard for the Development of an ESD Control Program for the Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)	ANSI/ESD S20.20
Space Applications Electronic Hardware Addendum to J-STD-001E Requirements for Soldered Electrical and Electronic Assemblies	IPC J-STD-001ES

1.1.1 Where there are conflicts between the requirements found in this document and NPD 8730.5, the requirements of NPD 8730.5 take precedence.

1.1.2 Where there are conflicts between the requirements found in this document and the documents in Table 1, the requirements of this document take precedence.

1.2 APPLICABILITY

1.2.1 This standard applies to NASA Centers, including component facilities, and to the Jet Propulsion Laboratory, other contractors, grant recipients, or parties to agreements to the extent specified or referenced in their contracts, grants, or agreements.

1.2.2 This standard applies to critical work, as defined by NPD 8730.5. Critical work is any task that if performed incorrectly or in violation of prescribed requirements poses a credible risk of loss of human life; serious injury; loss of a Class A, B, or C payload (see NPR 8705.4); loss of a Category 1 or Category 2 mission (see NPR 7120.5); or loss of a mission resource valued at greater than \$2M (e.g., NASA space flight hardware, Government test or launch facility).

1.2.3 The workmanship requirements of this document do not apply to suppliers of commercial-off-the-shelf (COTS) items. Projects which use COTS hardware for applications described in

1.2.2 above are responsible for identifying and managing risk associated with hardware that was built without material controls, production methods, and/or quality inspections defined by the workmanship standards.

1.3 SPECIAL REQUIREMENTS

1.3.1 Local workmanship requirements not contained in this publication or the standards referenced in Table 1 shall be formally documented (Requirement).

1.3.2 Local requirements which conflict with requirements stated herein or in the standards in Table 1 shall be formally approved per paragraph 1.4.1 below and traceable to approved requests for relief (Requirement).

1.4 RELIEF FROM REQUIREMENTS

1.4.1 The NASA program or project office is responsible for assuring that requests for relief from requirements in this publication are documented and adjudicated in accordance with NASA-STD-8709.20, Management of Safety and Mission Assurance Technical Authority (SMA TA) Requirements.

CHAPTER 2. APPLICABLE DOCUMENTS

2.1 SPECIFICATIONS

Copies of the following documents required in connection with a specific procurement may be obtained from the procuring NASA Center or as directed by the contracting officer.

FEDERAL REGULATIONS:

Occupational Safety and Health Administration, 29 C.F.R.

Federal Acquisition Regulations (FAR), Quality Assurance, 48 C.F.R. pt. 46

NASA DIRECTIVES (NPD)

NPD 8730.2 NASA Parts Policy

NPD 8730.5 NASA Quality Assurance Program Policy

NASA PROCEDURAL REQUIREMENTS (NPR) DOCUMENTS

NPR 1800.1 NASA Occupational Health Program Procedures

NPR 7120.5 NASA Space Flight Program and Project Management Requirements

NPR 8705.4 Risk Classification for NASA Payloads

NASA STANDARDS:

NASA-STD-8709.20 Management of Safety and Mission Assurance Technical Authority (SMA TA) Requirements.

NASA-STD-8739.1 Workmanship Standard for Polymeric Applications on Electronic Assemblies.

NASA-STD-8739.2 Workmanship Standard for Surface Mount Technology.

NASA-STD-8739.3 Soldered Electrical Connections.

NASA-STD-8739.4 Crimping, Interconnecting Cables, Harnesses, and Wiring.

NASA-STD-8739.5 Fiber Optic Terminations, Cable Assemblies, and Installation.

NASA HANDBOOKS:

NASA-HDBK-8739.21 Workmanship Manual for Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)

INDUSTRY SPECIFICATIONS:

ANSI/ESD S20.20	Standard for the Development of an ESD Control Program for the Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices).
IPC J-STD-001	Requirements for Soldered Electrical and Electronic Assemblies
IPC J-STD-001ES	Space Applications Electronic Hardware Addendum to J-STD-001E
SAE AS9100	Quality Management Systems: Requirements for Aviation, Space & Defense Organizations

2.2 OTHER DOCUMENTS

Industrial Ventilation Manual of Recommended Practices, American Conference of Governmental Industrial Hygienists

CHAPTER 3. DEFINITIONS AND ACRONYMS

3.1 ACRONYMS

ANSI	American National Standards Institute
AO-HRR	American Optical Hardy-Rand-Rittler
CD	Compact Disc
CFR	Code of Federal Regulations
CIS	Certified IPC® Application Specialist
CIT	Certified IPC® Trainer
COTS	Commercial Off The Shelf
DCMA	Defense Contract Management Agency
E-NMTTC	Eastern NASA Manufacturing Technology Transfer Center
ESD	Electrostatic Discharge
FAR	Federal Acquisition Regulations
GSFC	Goddard Space Flight Center
HBM	Human Body Model
HQ OSMA	NASA Headquarters, Office of Safety and Mission Assurance
IPC®	Registered trademark for IPC-Association Connecting Electronic Industries
JPL	Jet Propulsion Laboratory
JSC	NASA Johnson Space Center
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
MIT	Certified IPC® Master Trainer
MSFC	NASA Marshall Space Flight Center
OSHA	Occupational Safety and Health Administration
SAE	Society of Automotive Engineers
SATERN	System for Administration, Training, and Educational Resources for NASA

SMA	Safety and Mission Assurance
STD	Standard
TA	Technical Authority
TAA	Technical Assistance Agreement
W-NMTTC	Western NASA Manufacturing Technology Transfer Center

3.2 TERMS AND DEFINITIONS

The below listed definitions are in addition to those listed in NASA-STD 8709.22, Safety and Mission Assurance Acronyms, Abbreviations, and Definitions.

NASA Level A Instructor Instructor certified to teach one or more of NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, or NASA-STD-8739.5 courses to operators, inspectors, and Level B instructors (See A.2.1.g). The local ESD Control Plan may choose to define and use a NASA Level A Instructor classification in its training section.

Level B Instructor Instructor certified to teach one or more of NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, or NASA-STD-8739.5 courses to operators and inspectors. (See A.2.1.d). The local ESD Control Plan may choose to define and use a Level B Instructor classification in its training section.

Mission Hardware Hardware used in Category 1 and Category 2 projects and/or Class A, B, or C payloads.

NASA Level A Training Center
The Eastern NASA Manufacturing Technology Transfer Center at NASA Goddard Space Flight Center and the Western NASA Manufacturing Technology Transfer Center at Jet Propulsion Laboratory.

NASA Workmanship Standards Technical Committee
NASA civil service employees who are the primary points of contact for the NASA Workmanship Standards Program for each NASA Center. See <http://nepp.nasa.gov/workmanship> for the current roster.

CHAPTER 4. GENERAL

4.1 IMPLEMENTATION.

NASA quality assurance and/or engineering personnel are responsible for providing program/project support by advising, assisting, and managing suppliers, NASA personnel, and delegated agencies in the proper and effective implementation of the provisions of this publication.

4.2 CHANGES IN REQUIREMENTS.

When changes are made to the requirements herein, NASA quality assurance and/or engineering personnel are responsible for providing program/project support by assuring that the new requirements are flowed to program/project mission assurance plans, prime contracts, and subcontracts, and for providing this information to delegated agents serving as inspectors in supplier manufacturing facilities.

CHAPTER 5. TRAINING REQUIREMENTS

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

5.1 PERSONNEL TRAINING/CERTIFICATION

Personnel performing manufacturing processes and inspections prescribed in workmanship standards listed in Table 1 shall be trained and certified in accordance with Appendix A (Requirement).

5.2 PROGRAM IMPLEMENTATION

Workmanship training and certification programs shall be implemented in accordance with Appendix A of this standard (Requirement).

CHAPTER 6. FACILITY OPERATING CONDITIONS

This section establishes requirements for work environment conditions for workmanship processes applied to NASA mission hardware. This section supersedes the requirements of NASA-STD-8739.1, Section 6.3.1.2; NASA-STD-8739.4, Section 6.2.1; and the last sentence of NASA-STD-8739.5, Section 6.2.1. This section establishes requirements which augment or modify the requirements of IPC J-STD-001ES and ANSI/ESD S20.20.

6.1 TEMPERATURE AND RELATIVE HUMIDITY (RH)

6.1.1 Temperature and relative humidity (RH) shall be monitored in the processing area and maintained within the following limits (Requirement):

- a. For temperature: 18° - 30° C (65° - 85° F).
- b. Maximum relative humidity: 70 percent RH
- c. For ESD-sensitive hardware, minimum humidity: 30 percent RH.
- d. For ESD-sensitive hardware, HBM Class 0, minimum humidity: 40 percent RH.

6.1.2 For instances where maintaining an RH level shown in c. or d. above is not practical, special methods, procedures, equipment, and assurance requirements designed to overcome the risks of relative humidity levels below 30% RH shall be used and documented in the applicable ESD Control Program Plan.

6.2 OCCUPATIONAL HEALTH REQUIREMENTS

Related occupational health requirements for protection and assessment of individuals exposed to lead (Pb) containing solders can be found in NPR 1800.1 and OSHA regulations (29 CFR 1910.1025). See also NPD 8730.2, Appendix A, paragraph d, NOTE.

CHAPTER 7. ELECTROSTATIC DISCHARGE CONTROL STANDARD IMPLEMENTATION

7.1 APPLICABLE ESD STANDARD

ANSI/ESD S20.20 contains baseline ESD control requirements for mission hardware.

7.2 ESD REQUIREMENTS ADDENDUM TO ANSI/ESD S20.20

7.2.1 See paragraph 6.1.2 of this standard for relative humidity requirements.

7.2.2 ANSI/ESD S20.20 requires the development and implementation of an ESD Control Program which provides detailed requirements and acceptance levels applicable to local production facilities. A recommended ESD Control Program plan template is provided in NASA-HDBK-8739.21.

7.2.3 ESD wrist straps and heel strap systems shall be verified to be functional each time they are put on prior to entry into an Electrostatic Protected Area (EPA) or prior to coming within one meter of an ESD sensitive item (Requirement).

CHAPTER 8. POLYMERIC APPLICATIONS STANDARD IMPLEMENTATION

8.1 APPLICABLE POLYMERIC APPLICATIONS STANDARD

NASA-STD-8739.1 contains baseline staking, bonding, conformal coating, and encapsulation requirements for mission hardware. This section defines requirements which are applicable to, and in addition to, those found in the baseline document.

8.2 EXCLUSION OF IPC J-STD-001ES CHAPTER 10 FOR POLYMERIC APPLICATIONS

Chapter 10 of IPC J-STD-001ES shall not be used without waiver approval (Requirement).

CHAPTER 9. SOLDERING STANDARD IMPLEMENTATION

9.1 APPLICABLE SOLDERING STANDARD

9.1.1 J-STD-001ES contains baseline soldering requirements for mission hardware. This section defines requirements which are applicable to and/or in addition to those found in the baseline document.

Note: J-STD-001, Class 3 is not an authorized substitute for the most recent revision of IPC J-STD-001ES.

9.2 USE OF CANCELLED NASA WORKMANSHIP SOLDERING STANDARDS

9.2.1 NASA-STD-8739.2 and NASA-STD-8739.3 are cancelled documents as of October 2011. Use of these standards without waiver is allowed for programs and projects that have assurance baseline documents which were published prior to their cancellation. Programs and projects shall obtain waiver approval prior to using cancelled standards in their baseline requirements (Requirement).

9.2.2 Programs and projects that have invoked NASA-STD-8739.2 and NASA-STD-8739.3 in their baseline requirements prior to October 2011 may use IPC J-STD-001ES for soldering new mission hardware without waiver approval. Inspectors trained to J-STD-001ES may inspect hardware built to cancelled NASA soldering standards in accordance with the accept/reject criteria of the cancelled standard, however, when an artifact is identified that is considered a defect in accordance with IPC J-STD-001ES criteria, authorized technical experts and contract authorities shall disposition the defect (e.g., use or repair) based on mission risk. Programs and projects that are building, replacing, modifying, or repairing equipment defined by drawings which invoke the cancelled NASA soldering standards may work to the requirements and training certifications of IPC J-STD-001ES without waiver.

9.3 IPC J-STD-001ES TRAINING PROGRAMS

Three training program approaches, as described below, are available and recognized as valid for students seeking operator and inspector training to IPC J-STD-001ES. Suppliers are responsible for determining how they meet the training requirement for operators and inspectors, whether through IPC[®] course offerings or through a locally developed training program. See Appendix A, sections A.2 through A.6 for NASA workmanship certification requirements.

9.3.1 IPC[®] Modular IPC J-STD-001ES Training: The IPC[®] offers a six-module IPC J-STD-001ES course which is recognized as valid for meeting the NASA workmanship training requirement for IPC J-STD-001ES. The IPC[®] may be contacted to obtain information concerning certified suppliers of this training and for registration instructions. Certification to IPC J-STD-001ES under IPC training policy is constrained to the specific modules or combination of modules completed. This constraint is noted on the IPC certificate. As a minimum, Module 1, Module 6, and one other Module (either 2, 3, 4, or 5) shall be taken to meet the minimum IPC J-STD-001ES training requirement (Requirement). Students who take the modular course are instructed in all quality class levels including the space class.

9.3.2 IPC[®] Non-Modular IPC J-STD-001ES Training: The IPC[®] offers a non-modular course in which students are instructed only in the space quality class. This non-modular IPC J-STD-001ES class is considered valid for meeting the workmanship training requirement for IPC J-STD-001ES. This non-modular course does not provide training for IPC J-STD-001 quality Class 1, 2, and parts of Class 3 and therefore may not be acceptable for contracts which require IPC J-STD-001 Class 1, IPC J-STD-001 Class 2, or IPC J-STD-001 Class 3 IPC[®] CIS certification (these contracts would not be those applicable to NASA mission hardware).

9.3.3 Custom IPC J-STD-001ES Training: The supplier has the option to create a training program for IPC J-STD-001ES which meets the requirements of Appendix A, with the condition that only IPC[®] certified trainers (IPC[®] CIT or IPC[®] MIT) act as the instructor.

9.3.3.1 Custom training program curriculum and materials which are developed solely by the supplier and used by Level B instructors, IPC[®] CITs, and IPC[®] MITs at supplier facilities shall be made available to NASA programs and projects for review and approval upon request (Requirement).

9.3.3.2 Custom computer-based courses shall not be used for IPC[®] J-STD-001ES initial training (Requirement).

9.3.3.3 For custom IPC[®] J-STD-001ES retraining courses, computer-based training is allowed, but shall be combined with practical exercises and exams which are administered and evaluated by an IPC[®] CIT or IPC[®] MIT (Requirement).

CHAPTER 10. CABLE HARNESS ASSEMBLY STANDARD IMPLEMENTATION

10.1 APPLICABLE CABLE HARNESS STANDARD

NASA-STD-8739.4 contains baseline requirements for electrical cable and cable harness assembly for mission hardware.

10.2 USE OF IPC J-STD-001ES FOR SOLDERING

Where NASA-STD-8739.4 invokes NASA-STD-8739.3 for soldering processes and inspections, IPC J-STD-001ES may be used without waiver approval.

CHAPTER 11. FIBER OPTIC CABLE ASSEMBLY STANDARD IMPLEMENTATION

11.1 APPLICABLE FIBER OPTIC CABLE STANDARD

NASA-STD-8739.5 contains baseline requirements for fiber optic cable assembly for mission hardware. This standard does not contain any changes to the baseline requirements.

APPENDIX A REQUIREMENTS FOR WORKMANSHIP STANDARDS TRAINING PROGRAMS

A.1 General

A.1.1 This section:

- a. Establishes the training and certification requirements for workmanship operators, inspectors, and instructors.
- b. Establishes training requirements for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, NASA-STD-8739.5, IPC J-STD-001ES and ANSI/ESD S20.20.
- c. Establishes requirements for ensuring that successful completion of the courses by workmanship operators, inspectors, and instructors results in a common knowledge baseline among those personnel, and that common and predictable student processing practices are applied.

A.1.2 NASA Level A training centers have been designated at NASA Goddard Space Flight Center (GSFC) and the Jet Propulsion Laboratory (JPL) for the purposes of providing master training sites for the dissemination of training for all levels of NASA workmanship students, including Level B instructors. Terms and requirements included in this document for NASA Level A training centers do not apply to courses designed for GSFC or JPL internal use. See <http://nepp.nasa.gov/workmanship> for NASA Level A training center contact information.

A.1.3 NASA Center Safety and Mission Assurance (SMA) organizations may sponsor and manage local Level B instructors for the purpose of providing greater access to training by operators and inspectors with lower associated travel costs.

A.2 Workmanship Certified Personnel

A.2.1 The following personnel shall be certified in workmanship standards (Requirement):

- a. Operator: Builds and inspects printed wiring assemblies, cables, and cable harnesses (electrical). For soldering per J-STD-001ES, the terminology for an IPC-trained operator is Certified IPC® Application Specialist (CIS).
- b. Inspector: Inspects printed wiring assemblies, cables, and cable harnesses (electrical) for defects in accordance with workmanship standard requirements. For interconnections which are soldered per J-STD-001ES, the terminology for an IPC-trained inspector is CIS-inspector.
- c. ESD operator and ESD program monitor: Handles ESD sensitive hardware or performs special duties relative to ESD controlled area certification. The local ESD control implementation plan may define alternative names for these roles.
- d. Level B instructor: Trains operators and inspectors to NASA workmanship standards; NASA-STD 8739.1, NASA-STD 8739.2, NASA-STD 8739.3, NASA-STD 8739.4, and/or

NASA-STD 8739.5. Suppliers and NASA Centers may choose to use a Level B instructor designation for ESD training (see Table A-1 Note).

e. ESD Instructor: Instructs ESD operators, ESD program monitors, and local instructors to the local ESD control implementation plan traceable to ANSI/ESD S20.20 and as defined in the plant-local ESD Control Program. The local ESD Control Program defines the minimum qualifications required for ESD instructors and any hierarchies that apply to instructors and students they teach.

f. Certified IPC[®] Trainer (CIT): Trains CIS operators and inspectors inside or outside of their own company.

g. NASA Level A Instructor (on behalf of a NASA Level A training center): Trains operators, inspectors, and Level B instructors inside and outside of their own company to NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5. Suppliers and NASA Centers are permitted to use a NASA Level A instructor designation for ESD training (see Table A-1 Note).

h. Certified Master IPC[®] Trainer (MIT): Trains CISs and CITs inside or outside of their own company.

A.2.2 Level B instructors sponsored by, or working on behalf of, a NASA Center SMA organization may train operators and inspectors inside and outside of their own company as well as U.S. government civil service personnel (NASA and Non-NASA).

A.2.3 Level B instructors employed in a Level B Supplier Training Program:

a. May train operators and inspectors who are employed by the instructor's company or operators and inspectors who work for companies contracted to their company (e.g., subcontract to NASA).

b. May not train students from organizations to which the instructors' organization delivers mission hardware and/or that have contractual oversight authority.

A.2.4 Training of personnel to NASA workmanship standards and IPC[®] standards is specific to the student type (e.g., operator, inspector, instructor, CIS-operator, CIS-inspector only). Individuals who desire dual certification as an operator and an inspector for the NASA workmanship standards shall make special arrangements with their instructor to take a training program(s) that result in dual certification (Requirement).

A.2.5 CIS training using the IPC J-STD-001ES non-modular course results in dual operator/inspector training except if inspector-only training is requested.

A.2.6 Personnel who are trained to the instructor level (NASA Standard, or IPC standards) meet the training prerequisite for operator and inspector certification. Certifying authorities are responsible for ensuring that personnel who perform more than one role (e.g. instructor and inspector) are competent to perform all work assignments.

A.2.7 Certified workmanship personnel shall not inspect their own work (Requirement).

A.2.8 Where training is performed using primarily computer-based material without the presence of an instructor (e.g., on-line, SATERN, CD-based), the requirements described herein relative to the certification and responsibilities of trainers do not apply. See paragraphs 9.3.5 and A.8.23 through A.8.25 for limitations on the use of computer-based training.

A.3 Responsibility for Personnel Certification

A.3.1 Suppliers who are required to comply with one or more of the workmanship standards in Table 1 are responsible for ensuring that all operators and inspectors in their company who manufacture NASA mission hardware are capable of performing their tasks in a way that results in compliant product. Suppliers who employ Level B instructors are responsible for ensuring that the Level B instructors have a sufficient mastery of the course content they teach, have the appropriate teaching skills to properly instruct students, and have sufficient ability to assess their students' mastery of the subject matter. Evidence that operators, inspectors, and instructors are able to meet workmanship requirements is required in the form of a supplier certification (except NASA Level A instructors, see paragraph A.3.8, and Level B instructors who work on behalf of Center SMA organizations, see paragraph A.3.6).

A.3.2 Certification criteria in addition to that specified in this document may be applied at the supplier's discretion. Personnel who no longer meet one or more of the minimum criteria for certification shall have their certification revoked (Requirement). Recertification shall be performed every two years and is typically timed to coincide with completion of retraining (Requirement).

A.3.3 The supplier shall assign an expiration date for Workmanship certification that is not longer than twenty-four months after the certification date. (Requirement).

A.3.4 The supplier shall apply local policies for reinstating the certification of operators who fail to meet the minimum requirements for competency and work period interruption (Requirement). Local policies may employ retraining and other methods (e.g., mentoring) to ensure that inactive or ineffective personnel can demonstrate the required competency and knowledge of the requirements.

A.3.5 Local policies for managing personnel certification shall be documented and maintained under configuration change control (Requirement) and shall include as a minimum:

- a. Procedures for certification and recertification.
- b. Procedures for recording certification, recertification, and the method of identifying/recalling certified personnel.

A.3.6 The certifying authority for Level B instructors who teach on behalf of a NASA Center's SMA organization shall be the Center's representative on the NASA Workmanship Standards Technical Committee (Requirement). The Center's representative on the NASA Workmanship Standards Technical Committee may delegate this responsibility. See <http://nepp.nasa.gov/workmanship> for the current roster.

A.3.7 Suppliers who are required to comply with IPC J-STD-001ES are responsible for ensuring that all CITs and MITs used by their organization to train CISs carry valid IPC[®] certifications. Additional certification criteria may be imposed by the supplier at the supplier's discretion.

A.3.8 The NASA Workmanship Standards Program Manager is responsible for certifying NASA Level A Instructors who teach operator, inspector, and Level B instructor courses for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5. Responsibility for the certification of Western NASA Manufacturing Technology Transfer Center (W-NMTTC) NASA Level A instructors may be delegated by the NASA Workmanship Standards Program Manager to JPL's representative on the NASA Workmanship Standards Technical Committee. The JPL representative on the NASA Workmanship Standards Technical Committee may delegate this responsibility.

A.3.9 Portability of Workmanship Training

A.3.9.1 NASA workmanship standards training, except ESD training, obtained from a NASA Level A or Level B trainer is transferable and valid for work performed at all NASA supplier facilities.

A.3.9.2 When using IPC training courses for J-STD-001ES training, it is the supplier's decision whether to use the modular or the non-modular course. Either is considered acceptable for meeting NASA quality assurance requirements that specify J-STD-001ES, with the following exception: Since the non-modular course is not considered equivalent to the modular course (the former is a subset of the latter) it does not satisfy contracts invoking IPC J-STD-001E Class 1, Class 2, or Class 3.

A.3.9.3 IPC J-STD-001ES training, using either the IPC modular course or the non-modular course, shall be treated as portable between suppliers (Requirement).

A.3.9.4 Supplier custom-developed IPC J-STD-001ES training shall not be treated as portable between suppliers (Requirement).

A.3.9.5 Early retraining after change of employment may be required if the prior training did not include the full requirements set (i.e. partial training, See A.8.10).

A.3.10 Portability of NASA Workmanship Certification.

A.3.10.1 NASA workmanship certification is not portable between suppliers for operators, inspectors, non-IPC[®] instructors, and ESD program monitors. NASA workmanship certifications for these personnel shall be revoked when employment is terminated (Requirement).

A.3.10.2 A change of employer requires the new employer to recertify the newly hired individual.

A.3.10.3 Employers who are the workmanship certifying authority for operators, inspectors, and Level B instructors may send new employees to retraining.

A.3.11 NASA Workmanship Certification is not required for IPC J-STD-001ES certified instructors (i.e. CIT and MIT). IPC[®] CIT and MIT certifications are fully portable between suppliers. Certification to the Modular IPC J-STD-001ES training for operators and CISs shall not be used as the sole justification for NASA workmanship certification (Requirement). See paragraph A.5 for NASA workmanship certification requirements for operators and inspectors.

A.4 Certification Records

A.4.1 Certification records shall be retained by the certifying authority for a minimum of five years (Requirement).

A.4.2 Evidence of certification status shall be maintained in the work area (Requirement).

A.5 Minimum Certification Requirements for Operators, Inspectors, and Personnel Associated with Local ESD Control Programs

A.5.1 Personnel under a local ESD Control Program shall meet the certification requirements defined in the plan (Requirement). The training requirements in local plans shall meet the requirements of ANSI/ESD S20.20, paragraph 7.2, *Training Plan* (Requirement).

A.5.2 Workmanship operators and inspectors shall meet the following certification requirements as a minimum (Requirement):

- a. Retraining every two years from:
 - A NASA Level A or Level B instructor for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5.
 - A CIT or MIT for IPC J-STD-001ES.
- b. Achievement of vision requirements per paragraph A.7.
- c. Continuous competency.
- d. No more than a six month absence from performing duties associated with the applicable workmanship standard.

A.6 Minimum Certification Requirements for Instructors

A.6.1 The local ESD Control Program defines the minimum qualifications required for ESD instructors and any hierarchies that might apply to instructors and the students they are permitted to teach. The training requirements in those plans shall meet the requirements of ANSI/ESD S20.20, paragraph 7.2, *Training Plan* (Requirement).

A.6.2 The minimum certification requirements for Level B instructors shall be as follows (Requirement):

- a. Training every two years at the instructor level from a NASA Level A instructor for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, or NASA-STD-8739.5.
- b. Achievement of vision requirements per paragraph A.7.

c. Continuous competency.

d. No more than a six month absence from teaching a NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, or NASA-STD-8739.5 course.

A.6.3 Additional certification requirements for Level B instructors who work on behalf of a NASA Center's SMA organization shall be as follows (Requirement):

a. Review and comment/concur with all updates to NASA-STD-8739.1, NASA-STD-8739.4, and NASA-STD-8739.5.

b. As an alternative to retraining every two years as stated in A.6.2.a above, an audit by a Level B instructor who is a civil service representative of the Center's SMA organization may be used to establish that the Level B instructor is providing consistent training and policy interpretation to their students. Retraining and audits shall be accomplished a minimum of every two years (Requirement). Audits shall be performed in accordance with a formally documented process (Requirement).

A.6.4 Minimum certification requirements for NASA Level A instructors shall be as follows (Requirement):

a. Review, negotiate, and concur with all updates to NASA-STD-8739.1, NASA-STD-8739.4, and NASA-STD-8739.5.

b. Achievement of vision requirements per paragraph A.7.

c. Continuous competency.

d. No more than a six month absence from teaching a NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, or NASA-STD-8739.5 course.

e. Participate in and successfully complete yearly continuing education and NASA Level A training center information-sharing programs developed and provided by the NASA Workmanship Standards Program.

A.6.5 Proficiency based on hands-on experience is expected for all NASA Level A and Level B Instructors.

A.7 Vision Requirements

A.7.1 Vision testing is a prerequisite for initial training, retraining, and workmanship certification. Vision testing is not required for ESD training or ESD certification unless required by the local ESD Control Program.

A.7.2 Vision screening shall be performed within 23 months of the date of the start of training or retraining as a prerequisite for NASA workmanship standards training (Requirement).

A.7.3 Vision requirements may be met with corrected vision (eyeglasses or contact lenses).

A.7.4 Vision tests shall be administered a minimum of once every two years by a qualified examiner using standard instruments and techniques (Requirement).

A.7.5 Documentation indicating that minimum visual requirements have been met shall be made available to training centers or instructors when students register for workmanship training (Requirement).

A.7.6 Vision testing shall verify the following (Requirement):

a. Near Vision. Jaeger 1 at 14 inches (355.0 mm), reduced Snellen 20/20, or equivalent approved testing methods.

b. Color Vision. Ability to distinguish red, green, blue, and yellow colors as prescribed in Dvorine Charts, Ishihara Plates, AO-HRR Tests, or equivalent approved testing methods. A practical test, using color coded wires or electrical parts, is acceptable for color vision testing.

A.8 General Training Program Requirements for NASA Workmanship Standards

A.8.1 NASA workmanship training for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5 is intended for US-domestic manufacturing personnel, particularly those producing high reliability items. This training is not intended for foreign nationals who are not sponsored by the U.S. Government or who are not currently in a contractual relationship with NASA (either directly or via subcontract).

A.8.2 Personnel who have never taken a NASA workmanship standards training course shall first take the initial training course (Requirement). See Table A-1 for the recommended duration and minimum content requirements for the initial course.

A.8.3 Personnel who take and pass the initial training course or the retraining course shall be awarded evidence of successful completion of training (e.g., certificate, wallet-sized card, electronic record) (Requirement).

A.8.4 When training completion records are issued, it shall be clearly stated that the record is not a substitute for certification or evidence of certification (Requirement).

A.8.5 Personnel who are repeating training within twenty-seven months of taking the initial training course may take a shortened retraining class. See Table A-1 for the recommended duration for retraining courses.

A.8.6 Operators, inspectors, and Level B instructors who fail to enroll and complete the retraining course within twenty-seven months of taking the initial training course forfeit the option to take the shortened class for retraining.

A.8.7 The NASA Level A training center or Level B instructor may reinstate the option to students, whose prior training occurred more than 27 months in the past, to take the shortened retraining class. The criteria used to determine which students qualify for this option shall be documented in written procedures (Requirement).

A.8.8 Training credentials are valid for 27 months. In the absence of renewed credentials following retraining, Workmanship certification shall be revoked when the training credentials expire (Requirement).

A.8.9 The curriculum of the initial training course or the retraining course may be expanded to meet local needs. The training completion record shall clearly indicate that the student successfully completed training for the applicable standard (Requirement). Indications on the training record which are applicable to the added material may be added at the instructor's or supplier's discretion.

A.8.10 The curriculum of the initial training course or the retraining course may be reduced in circumstances where the students do not perform work in certain areas. The training record and training completion record shall detail the limits of the training by identifying the training as partial and by either specifying the included material or by specifying the excluded material (Requirement).

A.8.11 The curriculum for operators and inspectors shall be identical (Requirement). Operators and inspectors may be tested differently for hands-on proficiency so as not to penalize inspectors for not possessing hands-on skills which apply only to operators. All students shall participate in ungraded hands-on demonstrations and exercises (Requirement).

A.8.12 All instructor students shall be trained and tested to the level of operator, inspector, and instructor (Requirement).

A.8.13 The evidence of successful completion of training shall contain the following information as a minimum (Requirement):

- a. Student's name.
- b. Course name, with exclusions or inclusions as applicable.
- c. Training level: operator, inspector, instructor (instructor training completion documents are only provided by a NASA Level A training center, by a NASA Level A ESD instructor, or by an IPC MIT).
- d. Completion date.
- e. Instructor's name.
- f. Instructor's organization such as the training center name, sponsoring SMA organization, or the supplier name.

A.8.14 The instructor or the instructor's organization shall maintain training records for all students they have trained for a minimum of five years (Requirement).

A.8.15 Training equipment does not require regular calibration, however, it shall be maintained and checked in a manner that ensures that students are able to obtain normal results using the recommended techniques and are not prevented from successful course completion due to underperforming classroom equipment or supplies (Requirement).

A.8.16 Expired calibration stickers shall not be left on equipment that does not require calibration (Requirement). When expired calibration stickers are used as teaching aids, they shall be identified in advance to auditors performing institutional-level quality audits (Requirement).

A.8.17 A training package including the instructional presentations and all paper tests and quizzes will be made available to all Level B instructors following successful completion of training. Level B instructors may use these training materials with or without modification or augmentation.

A.8.18 Training program curriculum and materials which are developed solely by the supplier and used by Level B instructors, CITs, and MITs at supplier facilities which are not NASA Training Centers shall be made available to NASA programs and projects for review and approval upon request (Requirement).

A.8.19 Workmanship training programs for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, NASA-STD-8739.5, and supplier-created IPC J-STD-001ES training programs shall (Requirement):

- a. Document the methods and procedures proposed to fulfill the requirements of this standard.
- b. Utilize visual standards consisting of satisfactory work samples or visual aids that clearly illustrate the quality characteristics relevant to the applicable workmanship standard. Examples of unacceptable conditions may also be used for clarification or comparison.
- c. Make applicable standards readily available.
- d. Not duplicate IPC[®] copyrighted material.

A.8.20 Workmanship training program documentation shall include, as a minimum (Requirement):

- a. Procedures for training and retraining, including who will be trained and for what purpose (e.g., operator, inspector).
- b. Procedures for recording training/retraining, and the method of identifying/recalling trained personnel.
- c. Lesson plan(s)/student workbook.
- d. Hours of instruction.

A.8.21 Personnel certification shall be reviewed for impact when a supplier training program fails to meet requirements set forth herein (Requirement). Retraining from an alternate source may be required to meet the certification requirements.

A.8.22 Initial training courses, except for ESD control, shall not be primarily computer-based courses without the use of an instructor (Requirement).

A.8.23 Retraining courses may use computer-based content; however, they shall also include practical/hands-on content that has been evaluated by a certified instructor (Requirement).

A.8.24 Long-distance-learning retraining programs that deliver tests and practical exams to remotely located students and then evaluate the exams using certified instructors in another

location (completed tests and boards shipped to instructor) are allowed. The supplier is accountable for the effectiveness of computer-based or distance-learning arrangements.

A.8.25 Validation of the effectiveness of computer-based or distance-learning arrangements is demonstrated through the supplier's certification of the operator, inspector, or Level B instructor who successfully completed that training (also see A.8.18).

A.9 Training Program Requirements, NASA Training Centers

A.9.1 The NASA Workmanship Standards Program Manager is responsible for ensuring compliance by the Eastern NASA Manufacturing Technology Transfer Center (E-NMTTC) with the requirements herein.

A.9.2 JPL's representative on the NASA Workmanship Standards Technical Committee is responsible for ensuring compliance by the Western NASA Manufacturing Technology Transfer Center (W-NMTTC) with the requirements herein.

A.9.3 The NASA Center's representative on the NASA Workmanship Standards Technical Committee is responsible for ensuring compliance by Level B instructors working on behalf of their Center SMA organizations with the requirements herein.

A.9.4 The responsible parties described in A.9.1 through A.9.3 shall:

- a. Ensure that their NASA Level A and NASA Level B instructors are provided current information disseminated by the NASA Workmanship Standards Program Manager that impacts workmanship policy, training, and curriculum (Requirement).
- b. Certify the NASA Level A and/or Level B instructors who work on behalf of their Center's SMA organization (Requirement).
- c. Deliver a yearly activity report to the NASA Workmanship Standards Program Manager which describes the number of students trained and the number and types of NASA workmanship standards courses taught for the report year. These yearly reports shall include as a minimum (Requirement):
 - The name of each workmanship course given (NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, or NASA-STD-8739.5)
 - The number of students who attended each course.
 - Breakdown for students between NASA civil service and non-NASA.
 - The number of students who have passed and the number of students that have failed the classes in the reporting period.

A.9.5 Procedures used by NASA Level A and Level B trainers who work on behalf of a Center's SMA organization shall specify methods for ensuring that students enrolled in workmanship standards courses are only those individuals who comply with the visual acuity requirements herein (see A.7) (Requirement).

A.9.6 Foreign nationals shall not be enrolled in a NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, or NASA-STD-8739.5 course taught by a NASA Level A instructor or a Level B instructor working on behalf of a NASA Center's SMA organization unless a Technical Assistance Agreement (TAA) is drawn up between that Training Center, the foreign company or governmental organization, and the U.S. State Department (Requirement).

A.9.7 If a foreign national is to receive workmanship training under an approved TAA, NASA Headquarters approval shall be required for training which lasts longer than 14 days or if the enrollee is from a designated country (as determined by the U.S. State Department) (Requirement).

A.9.8 All NASA workmanship training centers offering NASA Workmanship Standards courses to the general public shall provide ready access to (Requirement):

- a. course offerings.
- b. schedules, including start and stop times.
- c. course descriptions.
- d. course prerequisites including:
 - required visual acuity testing prior to course attendance.
 - limitations on enrollment in retraining classes based on date of last training (maximum time elapsed is 27 months, see paragraph A.8.7).
- e. enrollment information including:
 - course fees, payment requirements (timing, methods).
 - rules and amounts applicable to financial penalties for cancelled reservations.
 - registrar point of contact.
- f. rules on course attendance (e.g., lateness, missed time).

A.9.9 Advertising content shall include a description of the target audience and practical experience level of the typical passing student to make clear to interested parties what experience is needed for this training (Requirement). Schedule information should include encouragements to the students to sign up for courses three months in advance of their need.

A.10 IPC® J-STD-001ES Training

The IPC® J-STD-001ES training program is designed and controlled by the IPC®. IPC® J-STD-001ES training materials may be augmented but not modified due to copyright limitations. Acceptable IPC® J-STD-001ES training for NASA workmanship certification is described in Section 9.3 of this document.

A.11 Courses

A.11.1 Course material shall accurately and completely represent the requirements statements in the applicable standards (Requirement).

A.11.2 For courses where each requirement cannot be directly covered due to time constraints, the course content shall combine overviews of less critical areas, more detailed coverage of the critical topics, and instructions related to finding all applicable requirements in the standard (Requirement).

A.11.3 Workmanship courses may omit topic areas that are not used by the local organization. If whole topic areas are absent from the training, it shall be made clear to the students and shall be represented in the training completion certificate, preferably by paragraph number (Requirement).

Note: Using NASA-STD-8739.1 as an example, if bonding is not covered, the training certificate says "except Bonding per Section 11."

A.11.4 Requirements above and beyond those included in the NASA standards may be taught, but shall be identified as auxiliary to the NASA standards baseline (Requirement). Incorrect answers to test questions, and failure of students to demonstrate practical skills which are not directly related to requirements found in the relevant NASA Workmanship Standard, shall not be considered when assessing the student's successful completion of the NASA Workmanship Standards courses for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5 (Requirement).

A.11.5 Course content shall consist of lectures, practical exercises, quizzes, and exams which accomplish the following (Requirement):

- a. Describe and interpret the technical requirements in the standard.
- b. Reference the location of each of the technical requirements.
- c. Demonstrate the method for achieving compliant assembly features (i.e., solder joints, contact crimps, polymer coating layers, etc.).
- d. Demonstrate the student's ability to achieve compliant features and/or recognize disallowed defects.
- e. Assess the student's retention and understanding of the requirements.
- f. Assess Level B instructor candidates' abilities to teach the material.

A.11.6 When the course is intended for use for training or retraining Level B instructors, course material shall include special topics relative to instructor competencies (e.g. time management, assistance to students, certification policies) (Requirement).

A.11.7 Class time shall be provided to the Level B instructor students to allow them to demonstrate adequate instructor skills (Requirement).

A.11.8 Course content shall be available for review and approval by the NASA Workmanship Standards Program Manager and/or the local responsible Workmanship Standards Technical Committee member (See A.9.3) (Requirement).

A.11.9 Course content deemed inappropriate or insufficient by the Workmanship Standards Program Manager and/or the local responsible Workmanship Standards Technical Committee member (See A.9.3) shall not be used (Requirement).

A.11.10 Courses shall be limited to teaching only one NASA-STD document. Overview classes which introduce the content of several or all of the NASA Workmanship Standards are not within the scope of this NASA-STD (Requirement).

A.11.11 NASA Level A training centers shall be capable of providing training courses for NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5 (Requirement). Level B instructors have the option to provide only those courses which are required by their student body.

A.11.12 The recommended course lengths for the NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5 courses (slide package, practical exercises and exams, written exams, and quizzes) are shown in Table A-1.

Table A-1: Recommended Course Lengths

Course	Initial Training Class Duration Operators & Inspectors	Instructors	Re-training Class Duration
Polymeric Operations (Operators), per NASA-STD-8739.1	32 hours	40 hours	16 hours
Polymeric Applications (Inspectors) per NASA-STD-8739.1	8 hours	N/A	8 hours
Surface Mount per NASA-STD-8739.2	32 hours	40 hours	16 hours
Hand Solder per NASA-STD-8739.3	36 hours	56 hours	16 hours
Crimp, Cable & Harness per NASA-STD-8739.4	36 hours	56 hours	16 hours
Fiber Optics per NASA-STD-8739.5	32 hours	56 hours	16 hours

Note: There is no NASA-wide training program for ESD control because all students are trained in accordance with the local implementation plan used in the facility in which they operate (see ANSI/ESD S20.20).

A.12 Student Requirements

A.12.1 The NASA workmanship standards training classes are intended for personnel seeking one or more of the certifications described in paragraph A.2 (except NASA Level A instructor).

This training is not intended or designed to teach basic electronic assembly and manufacturing skills such as basic soldering.

A.12.2 Level B instructor students shall successfully demonstrate the requisite skill needed to demonstrate the practical exercises (Requirement).

A.12.3 Students shall provide evidence to their NASA Level A or Level B instructor or training center's registrar of a visual acuity assessment completed within the preceding 23 months which meets the requirements of paragraph A.7 prior to training or retraining (Requirement).

A.12.4 For NASA-STD-8739.1, NASA-STD-8739.2, NASA-STD-8739.3, NASA-STD-8739.4, and NASA-STD-8739.5 courses, students shall be evaluated on the basis of written and practical tests (Requirement).

A.12.4.1 A passing grade for written exams shall be 80% and above (Requirement).

A.12.4.2 A passing grade for the practical exams shall be 85% and above (Requirement).

A.12.4.3 Written and practical scores shall not be averaged (Requirement).

A.12.4.4 To pass the class, the student shall pass both the written and the practical exams (Requirement).

A.12.4.5 The IPC[®] establishes the testing and scoring requirements for the IPC[®] J-STD-001ES courses. For the local ESD courses, the NASA Center or supplier establishes the testing and scoring requirements.

A.12.5 A student shall not be allowed to pass a class if they are absent for more than 10% of the overall class time, or if the time missed is considered detrimental to the required level of training by the instructor (Requirement).

A.12.5.1 If the student's lateness or absence has been deemed detrimental, the student shall be dismissed from class and will have to re-enroll (Requirement).

A.12.5.2 A dismissed student forfeits all course costs.

A.13 Enrollment

A.13.1 Students shall be able to enroll in workmanship standards courses by mail, email, phone, or fax (Requirement).

A.13.2 See Section A.8.5 and A.8.6 above for timing restrictions associated with registering for retraining courses and A.7.2 for expiration limits on vision test results. Current vision test results are a prerequisite for workmanship training.

A.13.3 Students who have taken their prior class (full class or retraining) at a different facility or from a different instructor than the facility or instructor from which they are seeking retraining shall produce evidence of successful completion of the prior class and the name of the instructor (Requirement). Prior to enrollment the evidence provided shall be analyzed to ensure that the prior training was not a limited training course per A.8.10 and was obtained from a valid source

(Requirement). Level B instructors shall have been trained by a NASA Level A instructor or certified by a NASA Workmanship Standards Technical Committee member (Requirement).

A.14 Applicability of Training

A.14.1 Students who pass classes given by a NASA Level A or Level B instructor meet the training portion of the certification requirements of the applicable NASA Workmanship Standards for the duration of twenty-seven months following course completion and can apply that certification to their work done on behalf of any NASA Center or NASA contract.

A.14.2 Students who take and pass a workmanship standards training course where portions of the requirements are not taught, and those portions are noted on the training completion certificate or card, are not permitted to perform those functions (as an operator or inspector) on NASA mission hardware. This policy applies regardless of the source of training (NASA Training Center or from a supplier's Level B instructor).