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Massachusetts Institute of Technology
Kavli Institute for Astrophysics and Space
Research (MKI)

Workmanship Requirements for Electronic
Equipment

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Preface

This document was taken from LSE Specification QAP-G-401.

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Revision B issued a General Update on 07/10/06.

Revision C issued a new format and general editorial update on 07/16/14.

1.0 Introduction

1.1 Scope

This specification establishes workmanship standards for electronic equipment fabricated for Sponsored Research Projects by the MIT Kavli Institute for Astrophysics and Space Research (MKI).

1.2 Purpose

These standards will govern workmanship in electronic assemblies. These same standards will be applied by the MKI Mission Assurance group to determine the acceptance or rejection of electronic equipment during an inspection. The standards of workmanship contained herein are designated as the minimum acceptable.

2.0 Applicable Documents

2.1 NASA and Industry Standards

The following documents, of the issue in effect at contract start, form a part of this specification:

- NASA-STD-8739.1, Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Assemblies
- NASA-STD-8739.4, Crimping, Interconnecting Cables, Harnesses, and Wiring
- NASA-STD-8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation
- NASA-STD-8739.6, Implementation Requirements for NASA Workmanship Standards
- IPC-J-STD-001ES, Joint Industry Standard, Space Applications Electronic Hardware Addendum (except Chapter 10 of this standard and Chapter 10 of IPC-J-STD-001E)
- IPC A-600, Acceptability of Printed Boards (Class 3 requirements)
- IPC-A-610, Acceptability of Electronic Assemblies
- IPC-2221, Generic Standard On Printed Board Design (Class 3)
- IPC-2222, Sectional Standard on Rigid PWB Design (Class 3)
- IPC-2223, Sectional Design Standard for Flexible Printed Boards
- IPC-2225, Sectional Design Standard for Organic Multichip Modules (MCM-L) and MCM-L Assemblies
- IPC-6011, Generic Performance Specification for Printed Boards (Class 3)
- IPC-6012B, Qualification and Performance Specification for Rigid Printed Boards (Flight Applications supplemented with: IPC-6012B "Performance Specification Sheet for Space and Military Avionics") (Class 3)
- IPC-6013, Qualification and Performance Specification for Flexible Printed Boards (Class 3 requirements)
- IPC-6015, Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures
- IPC-6018, Microwave End Product Board Inspection and Test (Class 3 requirements)
- GSFC-STD-6001, Ceramic Column Grid Array Design and Manufacturing Rules for Flight Hardware
- ANSI/ESD S20.20, Protection of Electrical and Electronic Parts, Assemblies and Equipment

2.2 MKI

The applicable project Performance Assurance Plan.

3.0 Requirements

3.1 Conflicting Requirements

In the event of discrepancies between this specification and a detail specification or drawing, the detail specification or drawing shall prevail.

Note: Departures from contractual requirements shall be documented in the form of a deviation request. Such departures in MKI drawings and specifications must be approved prior to the final approval and release of the drawing or specification.

4.0 Limitations

4.1 Acceptance or Rejection

Acceptance or rejection of parts, modules, subassemblies, assemblies, or materials will be based on the data contained in this specification. These requirements are to be construed as minimum limits. Since all possible situations cannot be covered in this document, any processes, materials, or workmanship suspected of being substandard will be reported to the MKI Project Engineer and to the Quality Assurance Group at once.

5.0 Misapplication of Materials

Materials which are not used as specified in the applicable drawings, specifications, or related documents, will be cause for rejection.

6.0 Inspection Criteria

6.1 Soldering

The soldering of connections shall be inspected for compliance with requirements of IPC-J-STD-001ES as appropriate.

6.1.1 Microscopic Inspection

All soldered connections on flight hardware shall be 100 percent visually inspected aided by a magnification between 3x and 10x. Higher powers of magnification may be used as required. Binocular microscopes are recommended.

6.1.2 Acceptable Soldering

Acceptable soldering shall be in accordance with IPC-J-STD-001ES as applicable.

6.2 Part Installation and Inspection

Part mounting and installation shall be in accordance with paragraph 4.9 of IPC-J-STD-001ES. Inspection shall be in accordance with drawing requirements.

6.3 Fabrication of Printed Wiring Boards

Printed wiring boards will be inspected for compliance with requirements of IPC-A-600.

6.4 Assembly and Subassembly Wiring

Assembly and subassembly wiring shall be inspected for compliance with the NASA-STD_8739.4.

6.4.1 Materials

Materials used in printed wiring boards shall comply with the requirements of IPC-6011.

6.4.2 Acceptance Criteria for Assembly and Subassembly Wiring

Acceptance criteria shall be per NASA-STD-8739.4.

6.4.3 Unacceptable Assembly and Subassembly Wiring

Reject criteria shall be per NASA-STD-8739.4.

6.5 Temperature Control Surfaces

6.5.1 Inspection

Temperature control surfaces shall be inspected for compliance with the requirements of this document and such other documents as may be specified.

NOTE: Special precautions are required during handling of temperature control surfaces to prevent degradation of the surface due to fingerprints, solvents, tool marks, corrosive gases, etc.

6.5.2 Materials

Materials will comply with the applicable detail and process specification.

6.5.3 Acceptance Criteria for Temperature Control Surfaces

- a. Surface will be free from nicks, scratches, bubbles, and blisters.
- b. Coatings will be uniform on color and texture.
- c. Surface is free from stamps, stickers, or other identification marks.
- d. Evidence of special tests if required.

6.5.4 Unacceptable Temperature Control Surfaces

- a. Nicks, scratches, bubbles, blisters, or fingerprints on surfaces.
- b. Coating applied to incorrect area.
- c. Incomplete removal of polishing compound, primer, abrasive, etc.
- d. Streaks or uneven texture color.
- e. Incomplete or missing test documentation.
- f. Missing sample if required to determine proper bonding of surface to base material.

6.6 Conformal Coating and Staking

6.6.1 Inspection

Conformal Coating and staking shall be inspected for compliance with the requirements of NASA-STD-8739.1

6.6.2 Criteria

Acceptance/Rejection Criteria for coating and skating shall be per NASA-STD-8739.1.

6.7 Cabling Flight Equipment

Cabling shall be tested and inspected for compliance with requirements of NASA-STD8739.4.

6.8 Splices

6.8.1 Materials

Materials used will conform to the requirements of the appropriate detail specification.

6.8.2 Acceptance Criteria for Lead Splicing of Flight Equipment

Broken or damaged conductors, part leads, or printed wiring conductors shall not be spliced.

6.9 Shield Terminations

6.9.1 Inspection

Shield terminations for flight equipment will be inspected for compliance with the requirements of NASA-STD-8739.4

6.9.2 Materials

Materials used in the construction of shield terminations will comply with the requirements of the detail specification.

6.9.3 Acceptance Criteria for Shield Termination

Shield terminations shall be per NASA-STD-8739.4

6.9.4 Unacceptable Termination Conditions

The characteristics detailed in NASA-STD8739.4 shall be cause for rejection.

6.10 Potting of Connectors – Flight Equipment

The potting of connector back shells will be inspected for compliance with the requirements of the detail specification.

6.10.1 Materials

Materials utilized will conform to the requirements of the detail specification.

6.10.2 Acceptance Criteria

Acceptance criteria for potted connector back shells will be as follows:

- a. Potting material is that which is required in the detail drawing or specification.
- b. Evidence that in-process inspection had been completed.
- c. Potting compound free from voids, cracks, and foreign material.
- d. Potting compound fully cured.

6.10.3 Unacceptable Potting of Connector Backs Shells

- a. No evidence that in-process inspection had been completed.
- b. Potting compound material not to specification.
- c. Potting compound material soft, tacky, or otherwise has not completed the curing cycle.
- d. Cracks, voids, cavities, or any other evidence of unsuccessful blending or uneven curing.
- e. Uneven discoloration or streaks in the potting compound material.
- f. Floating connector pins unintentionally locked in place by potting compound.

- g. Unsuccessful bonding of the potting material to any part of the connector or cable.
- h. Dust or other contaminants trapped in the cured compound.
- i. Potting material torn, burned, or crumbling.
- j. Potting compound in any area of the connector or cable outside of the potting boot.

6.11 Identification

Identification of parts, subassemblies, assemblies, components, cable harness, etc., will be inspected for compliance with the marking requirements of the appropriate drawings.

6.11.1 Acceptance of Markings

Acceptance of identification will be based on the following requirements:

- a. Identification complete as specified in the MKI design documentation.
- b. Identification is positioned so that it is visible after installation, unless otherwise specified.
- c. All markings are clean, legible, well defined, and uniform.
- d. Letters are between 1/8 and 3/16 of an inch high (or as specified by the detail drawing).

6.11.2 Impression Stamping

6.11.2.1 Acceptable Impressions

- a. Impressions are uniform and deep enough to be entirely legible.
- b. Stampings leave no sharp edges.
- c. Impression markings will be utilized only where specifically authorized by the appropriate drawing or specification.

6.11.2.2 Unacceptable Impressions

- a. Markings are indistinct.
- b. Stamping has created sharp burrs.
- c. Markings are double stamped.
- d. Markings not uniform.

6.11.3 Identification of Cabling

Cable identification shall conform with NASA-STD-8739.4.

6.11.4 Acceptable Criteria for Cable Identification

- a. All markings will be permanent, well defined, and legible.
- b. Identification will be located so that it is visible after cable installation.
- c. Identification will be complete as specified in the applicable MKI specification.
- d. All cables will be identified.
- e. All connectors and pigtails will be identified.

6.11.5 Unacceptable Cable Identification

- a. Stamping process has damaged cable.
- b. Label has been altered or re-identified.
- c. Stamping or marking process had damaged insulation.

6.12 Crimp Connections

Crimping shall be performed in accordance with the requirements of NASA-STD-8739.4.

6.12.1 **Process Controls**
Tools shall be calibrated in accordance with MIL-C-22520. The calibration period shall not exceed six (6) months. The crimping process shall be per NASA-STD-8739.4.

6.12.2 **Acceptance Criteria**
Crimp acceptance shall be per paragraph NASA-STD-8739.4.

6.12.3 **Rejection Criteria**
Crimp acceptance shall be per NASA-STD-8739.4.

6.13 General Notes on Completed Assemblies

In addition to the requirements detailed in the proceeding sections of the document. Completed assemblies will be inspected to the following requirements.

6.13.1 **Cleanliness**
Completed assemblies shall be free of all drill chips, greases, oils, thread tapping residue, solder flux, loose bits of solder, wire fragments, fingerprints on sensitive surfaces, metal fragments, hairs, or other foreign matter.

6.13.2 **Finish**
Treated surfaces such as paint, coatings, platings or etchings will be complete, uniform, and free from scratches or voids.

6.13.3 **Handling**
Completed assemblies shall show no evidence of deformed castings, bent walls, buckled or concave webs, fractures, twisted supports or brackets, or any other abnormal condition acquired through mishandling or abuse.