GODDARD TECHNICAL STANDARD **Goddard Space Flight Center** **Greenbelt, MD 20771**	**GSFC-STD-8001A** **Approved: 8/24/2026** **Revalidation Date: 8/24/2031** **Superseding GSFC-STD-8001**

Standard Quality Assurance Requirements for Printed Circuit Boards

MEASUREMENT SYSTEM IDENTIFICATION: N/A

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DOCUMENT HISTORY LOG

Status	Document Revision	Approval Date	Description
Baseline	-	11-21-2019	Initial Release
	-	03-09-2026	Administratively extended for two years from revalidation date.
Revision	A	08-24-2026	General update, including the addition of applicable standards and updates to applicability and processes.

FOREWORD

This standard is published by the Goddard Space Flight Center (GSFC) to provide uniform engineering and technical requirements for processes, procedures, practices, and methods that have been endorsed as standard for NASA GSFC programs and projects, including requirements for design, procurement, and quality verifications of printed circuit boards (PCB).

This standard establishes requirements that apply to PCBs of all types used for GSFC missions and for engineering model work that directly affects the design or quality of PCBs used in GSFC missions. The requirements address design criteria, procurement instructions, quality requirements, quality data deliverables, and review and approval processes.

Requests for information, corrections, or additions to this standard should be submitted via "Contact Us" on the GSFC Technical Standards website at http://standards.gsfc.nasa.gov.

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1. SCOPE

1.1 Purpose

The purpose of this standard is to provide requirements and recommendations that ensure that high-reliability PCBs are designed, produced, procured, and used in GSFC project mission hardware.

1.2 Applicability

The requirements herein apply across the full lifecycle of PCB design, manufacturing, and application. The performance and assurance requirements herein are addressed to organizations who establish PCB requirements, design PCBs, perform PCB design review, procure systems with integrated PCBs, procure PCBs, test or evaluate PCB production lots, assess or certify PCB testing facilities, assure PCBs, or manage risk associated with PCBs that do not meet the requirements herein.

The requirements herein define a standard engineering and quality assurance baseline for all mission risk classes that are applicable to GSFC flight and flight spare hardware. Compliance with this standard can be established for inherited PCB designs, spares, or build-to-print designs by conducting an inheritance risk assessment in accordance with Goddard Procedural Requirement (GPR) 8730.5.

Requirements herein that are unique to a certain mission risk class (e.g., Class A, Class B, Class C, Class D) shall be applied in accordance with the mission risk class defined by the project's mission assurance baseline. Requirements herein that are not associated with a particular mission risk class are applicable to all mission risk classes for missions required to follow NASA Procedural Requirement (NPR) 7120.5.

1.2.1 Engineering Test Unit

Engineering test units are built and tested to establish confidence that the design will function in the expected environments, especially when the test unit is used to validate manufacturing processes or is subjected to full environmental testing prior to build of the flight model or there is a possibility that the engineering model may become a flight spare. The requirements herein shall be applied to engineering model hardware in cases where

1. the engineering model is being used to validate manufacturing processes,
2. the engineering model is going through full environmental testing prior to build of the flight model, or
3. there is a possibility that the engineering model may become a flight spare.

1.2.2 Technology Demonstration Prototype

Projects should not impose the requirements stipulated herein on technology demonstration prototypes to enable such units to be produced at a low cost and without expectations for extensive failure analysis.

1.2.3 Ground Support Hardware

For ground support hardware that must survive environmental testing and the loss of which would realize a programmatic risk, it is acceptable to forego imposing a PCB specification and PCB structural integrity coupon testing if one or more spares are available, or replacement hardware can be readily produced.

2. APPLICABLE DOCUMENTS

2.1 General

The documents listed in this section contain provisions that constitute requirements of this standard as cited in the text of Sections 4 through 7. The latest issuances of cited documents shall be used. The applicable documents are accessible via the NASA Technical Standards System at http://standards.nasa.gov, directly from the Standards Developing Organizations, or from other document distributors.

2.2 Government Documents

NPR 7120.5	NASA Space Flight Program and Project Management Requirements
GPR 8705.4	Risk Classification Guidelines and Risk-Based SMA Practices for GSFC Payloads and Systems
GPR 8730.5	Safety and Mission Assurance Acceptance of Inherited and Build-to-Print Products
NASA-STD-8739.6	Implementation Requirements for NASA Workmanship Standards
MIL-STD-100	Standard Practice for Engineering Drawings
MIL-PRF-55110	Performance Specification: Printed Wiring Board, Rigid General Specification For
MIL-PRF-31032	Performance Specification: Printed Circuit Board/Printed Wiring Board, General Specification For

2.3 Non-Government Documents

Where applicable, the space applications addendum(s) of documents shall apply.

ASTM-E-595	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
ECSS-Q-ST-70-10C	Qualification of Printed Circuit Boards
ECSS-Q-ST-70-11C	Procurement of Printed Circuit Boards
IPC J-STD-003	Solderability Tests for Printed Boards
IPC-1601	Printed Board Handling and Storage Guidelines
IPC-2221	Generic Standard on Printed Board Design
IPC-2222	Sectional Design Standard for Rigid Organic Printed Boards
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-2226	Sectional Design Standard for High Density Interconnect (HDI) Printed Boards
IPC-2228	Sectional Design Standard for High Frequency (RF/Microwave) Printed Boards
IPC-4552	Specification for Electroless Nickel/Immersion Gold (ENIG) Plating for Printed Boards
IPC-4556	Specification for Electroless Nickel/Electroless Palladium/ Immersion Gold (ENEPIG) Plating for Printed Circuit Boards
IPC-4781	Qualification and Performance Specification of Permanent, Semi-Permanent and Temporary Legend and/or Marking Inks
IPC-6011	Generic Performance Specification for Printed Boards
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards (and Space Addendum)
IPC-6013	Qualification and Performance Specification for Flexible Printed Boards
IPC-6015	Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures
IPC-6017	Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices
IPC-6018	Qualification and Performance Specification for High Frequency (Microwave) Printed Boards (and Space Addendum)
IPC-9252	Guidelines and Requirements for Electrical Testing of Unpopulated Printed Boards
IPC-A-600	Acceptability of Printed Boards
IPC-QL-653	Certification of Facilities that Inspect/Test Printed Boards, Components, and Materials
IPC-T-50	Terms and Definitions
IPC-TM-650, Method 2.1.1	Microsectioning, Manual and Semi or Automatic Method
IPC-TM-650, Method 2.4.15	Surface Finish, Metal Foil
IPC-TM-650, Method 2.6.8	Thermal Stress, Plated-Through Holes
IPC-TM-650, Method 2.6.26	DC Current Induced Thermal Cycling Test

2.4 Order of Precedence

1. When this standard is applied as a requirement on a GSFC program or GSFC project or is imposed by contract or purchase order on a GSFC supplier, the technical requirements of this standard take precedence, in the case of conflict, over the technical requirements cited in the applicable documents in Section 2 herein.
2. When requirements in GSFC project-specific requirement documents imposed by contract or purchase order on a GSFC supplier conflict with requirements herein, the requirements of the project-specific document take precedence when approved by the Chief Safety and Mission Assurance Officer (CSO) or the Code 300 Safety and Mission Assurance (SMA) Technical Authority.
3. When requirements in PCB drawing notes conflict with requirements herein, the PCB drawing notes take precedence over the technical requirements of this standard.
4. In the event of a conflict between revisions of the documents listed in this section, the language in the latest revision of a standard shall take precedence.

5. The guidance in GPR 8705.4 may supersede specific recommendations or requirements in this document.

3. ACRONYMS AND DEFINITIONS

3.1 Acronyms

CAD	Computer-Aided Design
CAGE	Commercial and Government Entity
CIS	Certified IPC Specialist
CRAE	Commodity Risk Assessment Engineer
CSO	Chief Safety and Mission Assurance Officer
DC	Direct Current
DID	Data Item Deliverable
ENEPIG	Electroless Nickel Electroless Palladium Immersion Gold
ENIG	Electroless Nickel Immersion Gold
GPR	Goddard Procedural Requirement
GSFC	Goddard Space Flight Center
HDI	High Density Interconnect
IPC	Global Electronics Association
MCM-L	Multi-Chip Module-Laminated
MEB	Materials Engineering Branch
MIL	Military
MPCB	Microelectronics, Packaging and Circuit Board
MPE	Materials and Processes Engineer
MRB	Material Review Board
NPR	NASA Procedural Requirement
PCB	Printed Circuit Board
PRF	Performance
PWA	Printed Wiring Assembly
PWB	Printed Wiring Board
SMA	Safety and Mission Assurance

3.2 Definitions

Coupon	A portion of quality conformance test circuitry that is used for a specific test, or group of related tests to determine the acceptability of a product.
Heritage Hardware	Hardware whose design has been previously qualified and used in space applications and was accepted for use by a NASA program or project.
Independent Coupon Testing	PCB coupon testing that is performed independently of the original product supplier.

Inherited Hardware	A piece of hardware or hardware design that has some amount of prior history may be built to different design standards and may not require NASA insight into the design or construction.
PCB Lot	One or more boards that are traceable to quality testing and inspection performed on representative samples and coupons.
Supplier	An organization or company that provides a product or service to the user under a contract.
System Developer	An organization or company that provides a subsystem or subsystem-related services to the supplier under contract.
User	An organization or company that receives products or services from a supplier under a contract.
Vendor	An organization or company that offers PCB or PCB-related services.

See IPC-T-50 for technical definitions of PCB-related terms.

4. TRAINING AND CERTIFICATION

4.1 Independent Coupon Testing Lab Qualification

GSFC Supply Chain Quality Management and the Code 371 Microelectronics, Packaging and Circuit Board (MPCB) Commodity Risk Assessment Engineer (CRAE), in collaboration with Code 541 Metallography lab, assess the ability of an independent lab to perform PWB coupon structural integrity tests for GSFC projects. The projects can request a list of qualified coupon testing lab from the Code 371 MPCB CRAE.

4.2 Certification Authority

PCB designers and inspectors should be capable of performing their job duties in a manner that ensures compliance to the requirements herein. The capability to perform job duties is directly related to training and certification.

PCB designers and inspectors shall be certified by their supervisor or the individual who is responsible for their job assignment as capable of performing to the requirements herein and of continuously meeting the certification criteria in 4.3, 4.4, or 4.5 herein. Evidence of certification that includes the signature of the certification authority and date of certification shall be available for review upon request, preferably in a centralized certification management system.

4.3 Personnel Certification - Printed Circuit Board Designers

Personnel who perform PCB layout for boards under this standard shall be certified. The minimum certification criteria for PCB designers are:

4.3.1 IPC Certified Interconnect Designer - Basic certification or equivalent training/experience

4.3.2 No lapse in designer duties for greater than two years

4.4 Personnel Certification - Printed Circuit Board Inspectors, External Visual

Personnel who perform external visual inspection on PCBs under this standard shall be certified. The minimum certification criteria for PCB inspectors are:

4.4.1 Visual acuity per NASA-STD-8739.6 or IPC-QL-653

4.4.2 IPC-A-600 Certified IPC Specialist (CIS) certification or IPC-6012 CIS certification with Space Addendum

4.5 Personnel Certification - Printed Circuit Board Inspectors, Microsection

Personnel who perform microsection analysis of PCB test coupons that represent PCBs under this standard shall be certified. The minimum certification criteria for PCB inspectors are:

4.5.1 Visual acuity per NASA-STD-8739.6 or IPC-QL-653

4.5.2 IPC-A-600 Certified IPC Specialist (CIS) certification or IPC-6012 CIS certification with Space Addendum

4.5.3 No lapse in inspector duties for greater than two years

5. DESIGN

5.1 Design Standard

5.1.1 PCBs shall be designed in accordance with IPC-2221 (Class 3), Generic Standard on Printed Board Design, and one or more of the following relevant design standards:

1. IPC-2222 Sectional Design Standard for Rigid Organic Printed Boards
2. IPC-2223 Sectional Design Standard for Flexible Printed Boards
3. IPC-2225 Sectional Design Standard for Organic Multichip Modules (MCM-L) and MCM-L Assemblies
4. IPC-2226 Sectional Design Standard for High Density Interconnect (HDI) Printed Boards
5. IPC-2228 Sectional Design Standard for High Frequency (RF/Microwave) Printed Boards

5.1.2 PCB test coupons shall be designed per IPC-2221 into all PCB production panels (See Section 6.2.5).

5.2 Non-standard Features

Any PCB features that are not defined by the IPC-2220 and IPC-6010 series standards are considered non-standard and shall be evaluated for possible impacts to hardware performance,

reliability, or manufacturing success per Section 5.5. The evaluation shall be provided to the project CSO and the GSFC MPCB CRAE to be approved for use prior to final board design.

5.3 Drawings

5.3.1 The PCB drawings shall be used to provide instructions to the PCB vendor related to design intent as well as to flow down applicable quality assurance requirements from this standard.

The project / project CSO retains the option to review the drawings before providing them to the PCB vendor and to use Code 541 Metallography Lab specialists / the GSFC MPCB CRAE as consultants in this process.

5.3.2 The design organization shall create a drawing note baseline that addresses all critical requirements.

5.3.3 Direction shall be provided in the procurement documentation for each applicable requirement in the standards listed in Sections 5.1 and 6.3.2 that are defined as "as agreed between the user and the supplier (ABUS)" or for items requiring specification.

5.4 Outgassing Requirements

5.4.1 Nonmetallic materials used in PCB fabrication shall meet acceptance criteria of ≤ 0.1 percent collected volatile condensable materials (CVCM) and ≤ 1.0 percent total mass loss, when tested in accordance with ASTM-E-595.

5.4.2 Outgassing properties shall be established for all new material (e.g., laminates, silk screen ink, solder resist). A new material is a material for which there are not pertinent test reports or reports from prior flight history available. The project materials engineer should decide which tests are applicable. The new material shall be approved by the GSFC Materials Engineering Branch for mission use prior to PCB procurement.

5.5 Design and Process Reviews

5.5.1 For risk classes A and B PCB designs, PCB master drawings shall be approved prior to initiation of design or design procurement by a review team designated by the project. This requirement is optional for risk classes C, D, and Sub-D per GPR 8705.4.

5.5.2 The review team shall include representatives from the engineering and SMA directorates who can represent the interests and perspectives of the technical authorities for PCB design and assurance.

5.5.3 The drawing notes shall be reviewed for compliance with the requirements herein. The complete and approved PCB master drawing shall be included in the lot data acceptance package. Evidence of PCB master drawing approval by the review team shall be provided to the PCB procuring agent.

5.5.4 If the system developer or supplier uses alternate PCB standards for design, manufacturing instructions, or quality test and inspection criteria, these shall be provided to the project office for review for risk assessment. An alternate standard is defined as a document or a collection of criteria that are different than those contained in the documents listed in Sections 2.2 and 2.3 above.

5.5.5 When the system developer or supplier uses existing board lots to manufacture printed wiring assemblies (PWA) or uses previously manufactured assemblies, such hardware shall be accepted via review and approval by the project CSO and the GSFC MPCB CRAE. The review will consist of mission environmental constraints and the board or assembly handling and storage history. The MPCB CRAE will assess the risk (if applicable) associated with the use of the existing board lots or assemblies for the project office to support the program office in making the final determination on acceptance.

5.5.6 A design review of the complete circuit board assembly should precede the PCB assembly process.

5.5.7 The system developer or supplier shall facilitate a review of non-standard PCB designs, or PCB designs that include non-standard features (See Section 5.2), that are not covered by the IPC-2220 and IPC-6010 series. The project CSO or the CSO's representative shall be part of this review. Evaluation should be based on mission risk, heritage of use, and test/qualification data that supports the reliability of the non-standard PCB design for use in applicable hardware. The supplier should assess the ability of the PCB vendors to manufacture non-standard features.

6. PROCESSING

6.1 Assurance and Reviews

1. This standard shall be imposed for all PCBs for missions required to follow NPR 7120.5, with or without exceptions or additions approved by the project CSO.
2. The CSO or the Code 300 SMA Technical Authority shall approve PCB lots prior to board assembly.
3. The Project CSO or their delegate is responsible for reviewing the structural integrity evaluation results and recommending acceptance or rejection of the lot. The project CSO or their delegate should include the MPCB CRAE in this review and use their risk assessments and recommendations in the dispositioning process. Successful completion of the structural integrity analysis, by the PCB vendor (per Section 6.5) and/or by an independent (third-party) structural integrity testing lab (per Section 6.6.7), along with the MPCB CRAE's risk assessment, forms the basis to accept or reject delivery of the PCB lot. The requirement for independent (third-party) labs to perform structural integrity analysis only applies to mission risk class A and B. This requirement is optional for mission class C and sub-C. PCB vendor internal test result may be shared with the MPCB CRAE for preliminary evaluation of unreleased product to expedite the approval process. The review and recommendation shall be included in the PCB Lot Acceptance and Quality Conformance Testing Results. See Section 6.4.2 for non-conforming lots.

4. The GSFC Safety and Mission Assurance Directorate (Code 300) shall be the technical authority for PCB quality assurance and shall be responsible for interpreting the intent for each requirement stated herein and for approval of related waivers. Approved waivers shall be included in the lot data acceptance package.
5. The project CSO or their delegate shall record that the PCBs are inherited designs or build-to-print designs in the project's risk management system.
6. The PCB vendor's capability should be reviewed and assessed for ability to manufacture hardware features present on project designs.

6.2 Printed Circuit Board Procurement

6.2.1 Flow Down of Manufacturing and Quality Requirements

PCB procurements shall impose on the PCB vendor all applicable requirements defined herein and in applicable project quality assurance requirements documents that are related to realization of the PCB design and intended performance, manufacturing materials and processes, requisite tests and inspections, quality assurance, data delivery, data retention, and test coupon delivery. These requirements and specifications may be represented in drawing notes as well as in procurement documentation, such as a purchase order or contract, and shall include:

1. All additions and exceptions to the baseline design requirements in Section 5.1
2. All additions and exceptions to the baseline manufacturing quality requirements in Section 6.3.2
3. All additional design and quality assurance requirements defined in Section 6.3.3
4. All additional design and quality assurance requirements defined by project-specific, approved requirements documents
5. Use of Direct Current (DC) Induced Thermal Cycling Test per Section 6.5.2 when applicable

6.2.2 Qualified Vendors

The system developer or supplier shall have performed a source inspection/qualification research of the vendor's manufacturing capability and reviewed production lot quality history within the prior two years. The PCB vendor qualification and assessment shall be carried out based on criteria identified in IPC-6011. The extent of the qualification and assessment shall be commensurate with the requirements of the quality criteria identified in the applicable IPC-6010 series standards. An additional one-year grace period to receive periodic reviews may be permitted if approved by the project. The system developer or supplier can involve the GSFC MPCB CRAE in the PCB vendor qualification and assessment process.

6.2.3 PCB Test Coupons and Coupon Testing

1. Procurement documentation shall specify that sufficient quantities of coupons shall be built into the production panel to satisfy needs for vendor acceptance coupon testing.
2. Procurement specifications shall direct the PCB supplier to ship the test coupons to GSFC or to a GSFC-approved lab for analysis. The test coupons that are submitted to the GSFC or to a GSFC-approved laboratory for structural integrity evaluation, shall be directly traceable to each board used in flight hardware.

3. Procurement specifications should define optional acceptance tests, when applicable.
4. For mission risk classes A and B per GPR 8705.4, PCB test coupons shall be generated and provided to the GSFC or a GSFC-approved laboratory for structural integrity evaluation. This requirement is optional for mission risk classes C, D, and Sub-D.

6.2.4 Delivery of PCB Lots

Procurement requirements shall specify to the vendor that procurement documentation, PCB lot data, and structural integrity test coupons be delivered prior to the delivery of the finished boards.

1. The acceptability of the lot is predicated on the compliance and acceptability of the lot data.
2. All PWB test coupons provided to GSFC or to an independent GSFC-qualified laboratory shall be directly traceable to each corresponding board used in flight hardware.
3. Risk assessments, as discussed in Section 6.8, are performed for coupons that exhibit nonconformance or anomalous conditions. If the risk assessment indicates elevated risk due to the nonconformance or anomalous conditions, then use of the board(s) shall be dispositioned by MRB. Vendors shall be responsible for replacing PCB lots that are not accepted by the GSFC project. Boards should not be rebuilt without a determination of the cause for the nonconformance, including whether the cause traces to a problem in the design, specification, or flow down of requirements.
4. Neither test coupons nor finished boards shall be delivered for lots that fail to pass vendor acceptance testing as defined in Section 6.5.1.
5. When the system developer or supplier will use existing board lots or previously manufactured assemblies, see Section 5.5.5.

6.2.5 Lot Information and Data

Procurement requirements shall specify that the PCB vendor submit the following information and data for each board lot. The following lot information and data shall be included in the lot data acceptance package:

1. Panel map
2. PCB drawings
3. Drill chart
4. PCB stack-up
5. Specification of base material construction
6. Location of holes and features when board is submitted in lieu of test coupons
7. IPC-6010 series PCB vendor acceptance test and periodic data. The PCB vendor shall provide the results, in the form of data, for all verification tests required by the applicable IPC-6010 series standard and Section 6.3.2 herein. The delivered results shall provide resolution that is commensurate with the requirement (e.g., quantitative if the requirement is quantitative, “pass/fail” if the requirement is defined as such).
8. Data shall be supplied for the most recent acceptance and quality conformance testing performed per the frequencies prescribed in the applicable procurement specification for example, requirements listed in IPC-6012. The microsections associated with vendor

acceptance testing shall be made available to the project upon request.
9. Results of external visual inspection (Section 6.7)

6.2.6 Test Coupons for Structural Integrity Testing

1. The minimum set of coupons necessary to complete structural integrity testing is defined by the latest version of IPC-2221. The system developer or supplier shall ensure that the coupons of the correct type and quantities are supplied to the assigned analysis lab (See Section 6.6).
2. Custom coupons may be submitted instead of those required in item 1 above. Custom coupons shall comply with the latest version of the IPC-2221 and contain, at a minimum, two sets of three holes, one set in the X and one in the Y dimensional planes, as well as a set of three holes to evaluate blind, buried, and micro via structures if contained in the represented panel. If ENIG or ENEPIG are used as a final finish, the coupon shall contain a pad with minimum size of 0.060 in x 0.060 in for the plating measurement.
3. A qualification board may be submitted instead of the coupons required in item 1 above, provided the qualification board complies with IPC-2221 and contains, at a minimum, two sets of three holes, one set in the X and one in the Y dimensional planes, as well as a set of three holes to evaluate blind, buried, and micro via structures if contained in the represented panel. The location of the holes and features to be evaluated shall be provided by the vendor. If the PCB vendor provides quantitative results of ENIG or ENEPIG surface finish thickness, those results may be used in lieu of qualification-board third-party testing of surface finish. Procurement documentation shall specify that sufficient quantities of coupons shall be built into the production panel to satisfy needs for vendor acceptance coupon testing per Section 6.5 as well as independent (third-party) coupon testing per Section 6.6.
4. For projects requiring independent coupon testing, procurement specifications shall direct the PCB vendor to ship the test coupons defined in Section 6.2.5 to GSFC or to an independent GSFC-qualified PCB coupon test lab for analysis in accordance with Section 6.6. The GSFC PCB Coupon Submittal Form (GSFC Form 23-16) shall be used for submitting printed wiring board (PWB) test coupons to the GSFC Code 541 Metallography Lab. The test coupons that are submitted to the GSFC or to a GSFC-qualified laboratory for structural integrity evaluation, shall be directly traceable to each board used in flight hardware. A list of qualified independent PCB coupon test labs is maintained and updated by the GSFC MPCB CRAE and GSFC Supply Chain Quality Management.
5. Procurement specifications should define optional acceptance tests, when applicable. For a list of optional acceptance tests, see Section 6.5.2.
6. The representative test coupons for production PCBs shall be retained by the supplier for a time period defined by the project.

6.3 Manufacturing Quality Requirements

6.3.1 Master Drawings and Computer-Aided Design (CAD) Files

If there is a discrepancy between the master drawing and the CAD files, the vendor shall obtain verification from the PCB procuring agent regarding the correct design to be fabricated. The

procuring agent shall obtain concurrence from the designer when providing clarifications about design files to the PCB vendor.

6.3.2 Quality Standard

PCBs shall be manufactured and tested in accordance with the requirements of IPC-6011, Generic Performance Specification for Printed Boards, and the relevant quality standards shown below.

Alternate standards (e.g., military, European Space Agency, vendor performance specifications) may be used in accordance with the project's MAR or contract. Use of any other standard is a departure from this standard (See Section 7).

1. IPC-6012, Qualification and Performance Specification for Rigid Printed Boards
2. IPC-6012 Space Addendum, Space and Military Avionics Applications Addendum to IPC-6012, Qualification and Performance Specification for Rigid Printed Boards
3. IPC-6013, Qualification and Performance Specification for Flexible Printed Boards
4. IPC-6015, Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures
5. IPC-6017, Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices
6. IPC-6018, Qualification and Performance Specification for High Frequency (Microwave) Printed Boards
7. IPC-6018 Space Addendum, Space and Military Avionics Applications Addendum to IPC-6018, Qualification and Performance Specification for High Frequency (Microwave) Printed Boards

6.3.3 Additional Manufacturing and Test Requirements

The following requirements shall be applied for designing, fabricating, and testing PCBs, in addition to or with precedence over the requirements in the IPC-6010 series specifications and drawings.

1. Etchback
    a. Negative etchback shall not be allowed unless evidence is submitted that has been reviewed and approved by the project CSO in consultation with the MPCB CRAE demonstrating that residue is sufficiently controlled in the de-smearing process and/or interconnect stress testing indicates that the finished boards will not contain trapped residues that limit service life.
2. Plating Folds
    a. Plating folds and inclusions are only acceptable if they are enclosed and they conform to the plating thickness requirements.
3. Annular Ring - Filleting or "Tear Drops"
    a. Employment of filleting or "tear drops" is permissible but does not relieve vendors of the minimum external annular ring or breakout requirements.

4. Solderability
    a. It is recommended to perform an electroless nickel hyper-corrosion test per IPC-4552 specification in conjunction with coupon structural integrity tests to evaluate the corrosive reaction on the nickel plate from the immersion gold bath.
    b. For bare PCBs that have been stored for a period of more than six months after fabrication, a surface and plated-through-hole solderability test shall be performed.
    c. Surface and plated-through-hole solderability shall be evaluated in accordance with the latest version of J-STD-003, Category 2.
5. Wire Bond Pad Surface Finish Roughness
    a. The maximum surface roughness in the pristine area of wire bond pads shall be measured in accordance with IPC-TM-650, Method 2.4.15 with a roughness-width cutoff of 80% of the maximum length of the wire bond pad.
6. Electrical Test Requirements
    a. Requirements for impedance and isolation testing should be indicated in the drawing notes, when applicable.
7. Microsection Process
    a. When thermal stress preconditioning is required, test coupons shall be thermally stressed per IPC TM-650 Method 2.6.8 Test Condition A prior to micro sectioning. For certain PCB designs, for example, double-sided flex cables, the thermal ranges defined in IPC TM-650 Method 2.6.8 Test Condition A may be excessive. Deviations shall be approved by the GSFC project.
    b. Microsection procedure, examination, and evaluation shall be performed per IPC TM-650 Method 2.1.1.
8. ENIG and ENIPIG Evaluation

For samples including ENIG and ENEPIG,

1. X-ray fluorescence test is recommended to be performed in accordance with IPC-4552 to determine the composition of materials of surface finishes and to measure the thickness and composition of the metal layers. Out of range measurements require a risk assessment from the MPCB CRAE.
2. For each serial number, an as-polished sample can be evaluated for nickel hyper-corrosion in accordance with IPC-4552. The corrosion level of each individual location and a product rating for each serial number should be determined.

6.4 GSFC Product Acceptance Requirements

All data that are reviewed to determine lot acceptability are collected in the lot data acceptance package. See Appendix A for Data Item Deliverables (DID) pertaining to mission classes A and B. The vendor acceptance test data will be reviewed to ensure compliance with the requirements imposed by the procurement documents, including those imposed by the PCB drawing notes.

6.4.1 GSFC shall perform lot acceptance by:

1. Reviewing the delivered vendor acceptance test data package. See Sections 6.2.4 for lot data acceptance details for PCB procurement.

2. Performing an external visual inspection of each delivered PCB.
3. Reviewing the DC Current Induced Thermal Cycling Test results, in accordance with Section 6.5.2, when specified by the project, to augment PCB vendor or independent (third-party) structural analysis results.
4. A final signoff by the project CSO.

6.4.2 Handling of Non-conformances

When delivered data, either from testing or structural integrity analysis, reveals a nonconformance, handling this situation should be per Section 6.6.4.

Use of a non-conforming lot shall be recorded by the project or GSFC SMA and noted in the project's configuration management system and any risk included to the record. Final dispositions for PCBs that do not conform to applicable requirements will come from the GSFC project office.

6.5 Supplier Product Acceptance Testing

Quality assurance for PCBs used in applicable hardware consists of ensuring conformance with baseline manufacturing quality standards, additional quality and performance criteria defined herein, in the PCB drawing notes, and in project-specific requirement documents. Quality conformance is evaluated through inspections and tests performed on the boards that will be used in the mission as well as on representative samples of those boards, called coupons.

6.5.1 IPC-6010 Vendor Acceptance Testing

1. The PCB vendor should perform acceptance testing to verify quality conformance of each production panel and represented board.
    - For rigid printed boards, vendor acceptance testing per IPC-6012.
    - For flexible printed boards, vendor acceptance testing per IPC-6013, Table 4-3.
    - For MCM-L (Multi-Chip Module-Laminated) boards, vendor acceptance testing per IPC-6015, Table 4-1.
    - For boards containing embedded passive devices, vendor acceptance testing per IPC-6017, Table 4-1.
    - For high frequency boards, vendor acceptance testing per IPC-6018, Table 4-3.
2. The vendor shall conduct thermal shock tests and destructive physical analysis as specified in the Special Requirements section of the applicable IPC-6010 series specification.

6.5.2 Optional Acceptance Testing

The project may require a DC Current Induced Thermal Cycling Test as a requirement or as an option for evaluating design reliability and lot quality when boards will not comply with the requirements herein by design.

1. The project may require DC Current Induced Thermal Cycling Test results to perform a risk assessment in cases where test-result non-conformances are observed.
2. When DC Current Induced Thermal Cycling Testing is required, the system developer or supplier shall ensure that testing is in accordance with IPC-TM-650, Method 2.6.26 and

that the test results are delivered to GSFC for review and are included in the lot acceptance data package.

6.6 Structural Integrity Analysis

6.6.1 Internal Testing

Coupon testing conducted by system developers or suppliers that constitutes internal coupon testing.

6.6.2 Independent Testing

Independent coupon testing is performed at the GSFC Code 541 Metallography Lab or other GSFC-qualified/approved laboratories. Suppliers can use Independent Testing alone or in addition to vendors internal testing processes. A list of 3rd GSFC-approved independent PCB coupon test labs is maintained and updated by the GSFC MPCB CRAE and GSFC Supply Chain Quality Management.

6.6.3 Test Report Review

Regardless of whether projects utilize independent coupon testing or rely solely on vendor internal tests, all test reports must be submitted to the GSFC MPCB CRAE for review and feedback.

6.6.4 Handling Non-Conformances

- When non-conformances occur, it is recommended that suppliers submit their own risk assessment to the GSFC MPCB CRAE for evaluation.
- The GSFC MPCB CRAE will provide a comprehensive risk assessment to the project CSO, incorporating the coupon test report, vendor risk assessment, and other relevant information to support the dispositioning process.

6.6.5 General Requirements

1. All submitted lots shall be evaluated for structural integrity by coupon microsection analysis with the exception of lots of single and double-sided boards without plated through holes. This evaluation is in addition to the coupon microsection analysis required by Section 6.5.1.
2. Use of an independent (third-party) structural integrity analysis testing lab that has been evaluated and qualified by GSFC for structural analysis shall be at the discretion of the project.
3. Prime or subcontractors who seek to comply with the requirements herein by using an independent (third-party) structural integrity analysis testing lab shall obtain approval to do so in advance from the project.
4. All personnel evaluating PWB structural integrity coupons shall be trained per Section 4.4 of this standard.

5. The system developer or supplier shall ensure that the coupons of the correct type and quantities (per Section 6.2.6.2), the drawing notes for the lot, and lot traceability data, including those specified in Section 6.2.5 as a minimum, are supplied to the assigned analysis lab.
6. The sample size of coupons for independent coupon analysis is dependent upon the layer count of the represented PCBs.
    a. For single-sided PCBs, coupons are not required.
    b. For double-sided PCBs, a set of coupons shall be provided for evaluation per production lot date code.
    c. For multilayer PCBs (three or more layers), a set of coupons shall be provided for evaluation for each production panel.

6.6.6 The minimum set of coupons

The minimum set of coupons, as defined by the latest version of the IPC-2221, is necessary to complete independent structural integrity testing. The minimum set of coupons shall include:

a. One A and one B, or
b. Two A/B, or
c. Two AB/R
d. In case it is not possible to submit A+B, A/B, or AB/R coupons, the supplier has the option to submit a board on a per panel basis for Destructive Physical Analysis (DPA).
e. If any printed board on the testing panel contains a blind via, buried via, filled through via, and/or microvia, an additional B or A/B coupon duplicating each contained feature shall be provided.
f. An as-received A structure should be included for the electroless nickel hyper-corrosion assessment for boards with ENIG and ENEPIG.
g. If ENIG or ENEPIG is used as a final finish, any one of the following coupons shall be provided: C, M, W, or P. If the PCB vendor provides quantitative results of ENIG or ENEPIG surface finish thickness for the coupons associated with a lot, those results may be used in lieu of independent coupon testing of surface finish.
h. Assurance requirements for PCBs that use organic solderability preservative shall be identified in the procurement documentation.
i. For surface finishes other than ENIG and ENEPIG, requirements for inspection and acceptability shall be identified in the procurement documentation.

6.6.7 Structural Integrity Analysis Lab Process

1. The independent (third-party) structural integrity analysis lab shall review the delivered lot information prior to the start of the structural integrity evaluation.
2. The independent (third-party) structural integrity analysis lab shall prepare and examine as-received microsections perpendicular to the orientation of the thermally stressed microsections. Test coupons containing blind, buried, or microvias shall also be evaluated in the thermally stressed condition.
3. Test coupons shall be inspected for structural integrity in accordance with the criteria in the procurement requirements (See Section 6.2.1). This requirement assumes that the procurement requirements reflect a reviewed and approved design, reflect reviewed and

approved drawing notes, and do not conflict with the quality criteria herein without prior approval by the CSO.

4. Microsections shall be prepared per IPC-TM-650, Method 2.1.1, or a process that is documented and evaluated during the independent (third-party) structural integrity analysis testing lab assessment process.
    a. Material with a cure temperature that does not exceed 93C shall be used to pot samples.
    b. Traceability to the PCB serial number shall be maintained on the coupon or sample throughout the microsection preparation and inspection processes.
    c. The following quality characteristics of the finished microsection shall apply:
        - Potting material or solder completely filling plated through holes
        - No gaps between the potting material and the sample
        - Microsections free of excessive scratches and smear
5. Microsections shall be examined and evaluated per IPC-TM-650, Method 2.1.1.

6.6.8 Structural Integrity Evaluation Reporting and Retention

1. The results of the structural integrity examination and evaluation shall be included in the PCB Lot Acceptance and Quality Conformance Testing Results (per DID B).
2. The independent (third-party) structural integrity analysis report shall not characterize the overall results of the structural analysis as a pass or fail. This is to prevent the mischaracterization of a non-conformance to qualitative requirements as a functional failure of a populated assembly.
3. The project shall assure the microsectioned coupons and remnants are archived for reference, traceability, or any future test purposes until mission disposal unless otherwise specified by the project.

6.6.9 Structural Integrity Testing Lab Process Data

The GSFC metallography laboratory and all independent (third-party) structural integrity analysis labs shall provide summary data from the structural integrity analyses to the GSFC MPCB CRAE upon request. As an example, the requested summary data may include the following:

1. Unique identifier representing the coupon submission, received date, and structural integrity analysis report
2. GSFC project and subsystem associated with the coupon submission
3. PCB Vendor (Name and Commercial and Government Entity [CAGE] code or address)
4. Lot identifier
5. Applicable specification or standard (IPC or other fabrication standard if applicable)
6. Applicable performance classification
7. Board information
    - Number of layers
    - IPC-6010 series defined board type (if IPC standards are applicable)
    - Base material
    - Surface plating material

- Board interconnect types used (blind via, buried via, via-in-pad, wire bonding, etc.)

8. Defects or non-conformances found (if any)

6.7 Visual Inspection

6.7.1 PCBs delivered (to GSFC or to a designated GSFC assembly facility) shall be optically inspected to verify they comply with applicable procurement specification (See Section 6.2.1 and 6.3.3). The inspection shall be performed by a certified PCB inspector, in accordance with Section 4.3, and the results shall be documented in the project's configuration management system. In the event that PCBs fail to meet the external visual-inspection quality criteria defined in the procurement requirements:

i) the PCB shall be segregated from conforming product at inspection and identified as non-conforming,
ii) a non-conformance shall be raised in accordance with the project's nonconforming product procedure or GPR5340.4, and
iii) the supplier shall be notified of the nonconformance, and a corrective action shall be requested for shipment of nonconforming product. PCB Handling, Storage and Retention Requirements.

a. IPC-1601 or a supplier-established and GSFC-approved handling and storage procedure shall be used by all participants in the PCB supply chain for identifying procedures and practices of PCB handling and storage.
b. PCBs that are not handled and stored per the appropriate requirement shall be segregated from conforming product, identified as non-conforming and a non-conformance shall be raised in accordance with the project's nonconforming product procedure or GPR5340.4A risk assessment may be performed for PCBs that fail to meet the handling and storage requirement. Final directions for the use of PCBs that fail to meet PCB handling and storage requirements will come from the project CSO.

6.8 Lab Report Submission

All coupon reports, generated at either the vendors' internal lab or an independent (third-party) laboratory, shall be submitted to both the supplier and the GSFC MPCB CRAE. The submittal to the GSFC MPCB CRAE allows for an independent assessment of the coupon report and helps the MPCB CRAE maintain a database of test results for statistical and quality assessments.

7. DEPARTURES FROM THIS STANDARD

Risk mitigations shall be defined and documented for requirements herein that cannot be met due to the lack of availability of procurement specifications, test samples, test data, or other required evidence of quality assurance. Risk mitigations shall be approved by the project CSO or the CSO's representative.

7.1 Departures

All departures from this standard shall be approved via the project waiver process. The project

CSO shall consult the GSFC MPCB CRAE in all waiver processes.

7.2 Post-Production Testing

Post-production testing alone, whether on finished boards or representative test coupons, shall not be recognized as a substitute for meeting the design, procurement, manufacturing, and quality assurance requirements herein.

7.3 Non-conforming Product

Documentation of proposed repair or other methods used for risk mitigation for procurement of lots known to not be in conformance with the requirements herein shall be provided to the project CSO and the GSFC MPCB CRAE for approval.

APPENDIX A: EXAMPLE DATA ITEM DELIVERABLES (DID)

The following DIDs are recommended for use in project MARs in accordance with the requirements of this standard.

Note that the following DIDs apply to a Class A or B mission.

DID A Alternate Printed Circuit Board (PCB) Standard Declaration

Title: Alternate Printed Circuit Board (PCB) Standard Declaration	DID No.: A
MAR Paragraph: x.x.x	
Use: Alternate PCB standards for design, manufacturing instructions, or quality test and inspection criteria are reviewed for risk exposure to the project and suitability for flight, flight spare and custom mission critical support hardware.	
Reference Documents: - GSFC-STD-8001 Standard Quality Assurance Requirements for Printed Circuit Boards - IPC-2221 Generic Standard on Printed Board Design (Class 3) - IPC-2222 Sectional Design Standard for Rigid Organic Printed Boards (Class 3) - IPC-2223 Sectional Design Standard for Flexible Printed Boards (Class 3) - IPC-2225 Sectional Design Standard for Organic Multichip Modules (MCM-L) and MCM-L Assemblies (Class 3) - IPC-2226 Sectional Design Standard for High Density Interconnect (HDI) Printed Boards - IPC-2228 Sectional Design Standard for High Frequency (RF/Microwave) Printed Boards - IPC-6011 Generic Performance Specifications for Printed Boards (Class 3) - IPC-6012 Qualification and Performance Specification for Rigid Printed Boards - IPC-6012xS Space and Military Avionics Applications Addendum to IPC-6012x, Qualification and Performance Specification for Rigid Printed Boards - IPC-6013 Qualification and Performance Specification for Flexible Printed Boards (Class 3) - IPC-6015 Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures (Class 3) - IPC-6017 Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices - IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards - IPC-6018xS Space and Military Avionics Applications Addendum to IPC-6018x, Qualification and Performance Specification for High Frequency (Microwave) Printed Boards - MIL-PRF-55110 Performance Specification PWB, Rigid, General Specification For - MIL-PRF-31032 Performance Specification PCB/PWB, General Specification For	
Place/Time/Purpose of Delivery:	

- When an alternate standard or criteria as defined by 6.3.2 of GSFC-STD-8001 has been used or will be used to design, manufacture, test, or inspect PCBs for flight, flight spare and custom mission critical support hardware, the supplier shall provide the Program office a report of that alternate standard or criteria for GSFC review and approval. - The report shall include the full requirements set and indicate any items that are not explicitly specified within the alternate standard (i.e., designer's decisions) or are exceptions to the standard default requirements.
Preparation Information: Notify GSFC or the GSFC-certified testing lab regarding shipment of alternate standard report.

DID B PCB Lot Acceptance and Quality Conformance Testing Results

Title: PCB Lot Acceptance and Quality Conformance Testing Results	DID No.: B
MAR Paragraph: x.x.x	

Use:

Data results of PCB lot acceptance and quality conformance testing are evaluated to verify supplier compliance to quality assurance requirements.

Reference Documents:

- GSFC-STD-8001 Standard Quality Assurance Requirements for PCBs
- IPC-6011 Generic Performance Specifications for Printed Boards
- IPC-6012 Qualification and Performance Specification for Rigid Printed Boards
- IPC-6012xS Space and Military Avionics Applications Addendum to IPC-6012x, Qualification and Performance Specification for Rigid Printed Boards
- IPC-6013 Qualification and Performance Specification for Flexible Printed Boards
- IPC-6015 Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures
- IPC-6017 Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices
- IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards
- IPC-6018xS Space and Military Avionics Applications Addendum to IPC-6018x, Qualification and Performance Specification for High Frequency (Microwave) Printed Boards
- MIL-PRF-55110 Performance Specification PWB, Rigid, General Specification For
- MIL-PRF-31032 Performance Specification PCB/PWB, General Specification For

Place/Time/Purpose of Delivery:

- Testing results shall be delivered as soon as practicable following board fabrication and prior to PWA population.
- The microsections associated with supplier acceptance testing shall be made available to the project upon request.

Preparation Information:

The supplier shall deliver to the Program office the lot data acceptance package, for all verification tests required by and defined in the standard and the procurement instructions imposed on the PCB vendor by the supplier. The delivered results shall provide resolution that is commensurate with the requirement (e.g., quantitative if the requirement is quantitative, “pass/fail” if the requirement is defined in this manner).

Notify GSFC regarding shipment of testing data package.

The lot data acceptance package shall be assembled as a record of the PCB lot’s compliance with the requirements of GSFC-STD-8001 and as a minimum include:

i. Additions or exceptions to the requirements herein
ii. Approved waivers
iii. Design review results
iv. Drawing and Drawing Notes
v. Lot information and supplier acceptance test data
vi. Review of supplier acceptance test data by GSFC
vii. Test coupon information
viii. Structural integrity analysis report
    a. Unique report identifier
    b. Date of report
    c. Revision number of report
    d. Accept/reject criteria used
    e. Test data, citing the number, type and location of defects and non-conformances observed
    f. Photographs with scale of cited non-conformances observed
    g. Traceability of defects and non-conformances found to the parent panel
    h. Anomalies discovered which are not defined in the procurement requirements
    i. Pictures with measurement of any cited non-conformances
    j. Final result of the analysis: Conforming or Non-conforming
ix. Results of incoming visual inspection of PCBs
x. Approval by GSFC SMA for acceptance of the PCB lot when applicable

DID C Printed Circuit Board (PCB) Test Coupons

Title: Printed Circuit Board (PCB) Test Coupons	DID No.: C
MAR Paragraph: x.x.x	

Use:

PCB test coupons are evaluated to validate that the represented PCBs meet the structural integrity requirements deemed suitable for use in space flight and mission critical ground applications.

Reference Documents:

- GSFC-STD-8001 Standard Quality Assurance Requirements for PCBs
- IPC-2221 Generic Standard on Printed Board Design
- IPC-2222 Sectional Design Standard for Rigid Organic Printed Boards
- 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-2226 Sectional Design Standard for High Density Interconnect (HDI) Printed Boards
- IPC-2228 Sectional Design Standard for High Frequency (RF/Microwave) Printed Boards
- IPC-6011 Generic Performance Specifications for Printed Boards
- IPC-6012 Qualification and Performance Specification for Rigid Printed Boards
- IPC-6012xS Space and Military Avionics Applications Addendum to IPC-6012x, Qualification and Performance Specification for Rigid Printed Boards
- IPC-6013 Qualification and Performance Specification for Flexible Printed Boards
- IPC-6015 Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures
- IPC-6017 Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices
- IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards
- IPC-6018xS Space and Military Avionics Applications Addendum to IPC-6018x, Qualification and Performance Specification for High Frequency (Microwave) Printed Boards
- MIL-PRF-55110 Performance Specification PWB, Rigid, General Specification For
- MIL-PRF-31032 Performance Specification PCB/PWB, General Specification For

- Place/Time/Purpose of Delivery:
- Coupon specimens do not need to be submitted for single-sided PWBs, shall be submitted per lot for double-sided boards, and shall be submitted per panel for all other board types.
- The system developer or supplier shall provide minimum set of coupons, as defined by the latest version of the IPC-2221.
- Coupon specimens should be submitted with sufficient A, B, A/B coupons, or their equivalent per IPC-2221 for both unstressed and thermally stressed micro sectioned coupon evaluation per sect. 3.6 of the applicable IPC-60XX specification.
- If the represented PCB design contains a blind, buried, or micro via, the developer shall provide additional B or A/B coupons for each contained feature for thermally stressed evaluation.

- The system developer or supplier may submit either custom coupons or qualification boards in lieu of the aforementioned coupons. Custom coupons shall comply with IPC-2221 and contain, at a minimum, two sets of three holes, one in the X and one in the Y dimensional planes, as well as a set of three holes to evaluate blind, buried, and micro via structures if contained in the represented panel. If ENIG or ENEPIG are used as a final finish, the coupon shall contain a pad with minimum size of 0.060 in x 0.060 in for the plating measurement.
- The system developer or supplier shall provide supporting manufacturing documentation with the coupons that is traceable to the flight boards, including the performance specification and product classification to which the board was fabricated; type of printed board; board drawing or drawing notes; relevant deviations, waivers, or additional fabrication requirements; panel map; indication if there are blind, buried, or micro vias present; number of board layers; base material information; PCB part number and revision level; lot date code; serial number and Vendor ID (CAGE Code if a US vendor).
- In the case that a GSFC-approved or a third party testing lab is used, the system developer or supplier shall deliver the test results to GSFC with the end item data package.
- The developer does not need to submit coupons for single-sided PCBs and double-sided PCBs with no plated through holes or vias.
- Coupons are required per lot for double-sided boards with plated through holes or vias and per panel for all other board types.
- If the developer submits to GSFC or to a GSFC-approved laboratory a qualification board for destructive physical analysis instead of the coupons required above, they shall provide supporting manufacturing information traceable to the flight boards per GSFC Form 23-16, including the board drawing or drawing notes. The test vehicle shall comply with IPC-2221 and contain at a minimum two sets of three holes, one each in the X and Y dimensional planes, as well as a set of three holes to evaluate blind, buried, and micro via structures if contained in the represented panel. If ENIG or ENEPIG is a final finish, the test vehicle shall contain a pad with a minimum size of 0.060 in x 0.060 in for the plating measurement.
- The developer shall store remnants and coupon microsections.

Preparation Information:

DID D Printed Circuit Board (PCB) Coupon Evaluation Report

Title: Printed Circuit Board (PCB) Coupon Evaluation Report	DID No.: D
MAR Paragraph: x.x.x	

Use:

PCB test coupons are evaluated to validate that PCBs are suitable for use in space flight and mission critical ground applications. The laboratory report provides the information needed to decide to use the PCBs associated with the coupons. The laboratory report also necessitates a risk assessment when non-conformances are observed.

Reference Documents:

- GSFC-STD-8001 Standard Quality Assurance Requirements for PCBs
- IPC-6011 Generic Performance Specifications for Printed Boards
- IPC-6012 Qualification and Performance Specification for Rigid Printed Boards
- IPC-6012xS Space and Military Avionics Applications Addendum to IPC-6012x, Qualification and Performance Specification for Rigid Printed Boards
- IPC-6013 Qualification and Performance Specification for Flexible Printed Boards
- IPC-6015 Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures
- IPC-6017 Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices
- IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards
- IPC-6018xS Space and Military Avionics Applications Addendum to IPC-6018x, Qualification and Performance Specification for High Frequency (Microwave) Printed Boards
- MIL-PRF-55110 Performance Specification PWB, Rigid, General Specification For
- MIL-PRF-31032 Performance Specification PCB/PWB, General Specification For

Place/Time/Purpose of Delivery:

- The system developer or supplier shall deliver test coupon reports for conforming or non-conforming product to GSFC as soon as practicable for information and review.
- In the case that a GSFC-approved or third-party testing lab is used; the system developer or supplier shall deliver the test results to GSFC with the end item data package.

Preparation Information:

The developer shall provide reports from GSFC or a GSFC-approved laboratory for PCB test coupons that are directly traceable to each board that is intended for use in hardware for evaluation.

- The supplier should use the GSFC Coupon Submittal Form (GSFC 23-16) for documentation and delivery of design characteristics associated with the coupon report.
- If the GSFC Coupon Submittal Form (GSFC 23-16) is not used, the system developer or supplier shall provide supporting manufacturing documentation with the coupons that is traceable to the flight boards, including the performance specification and product classification to which the board was fabricated; type of printed board; relevant deviations, waivers, or additional fabrication requirements; indication if there are blind, buried, or micro vias present; base material information; PCB part number and revision level; lot date code; serial number and Vendor ID (CAGE Code if a US vendor).
- The submittal package shall include a copy of the board drawing or drawing notes; stackup, panel map; and number of board layers if not otherwise included.

Note5: Final dispositions for populating PCBs after structural integrity coupon analysis will come from GSFC project.

DID E Printed Circuit Board Procurement Plan

Title: Printed Circuit Board Procurement Plan	DID No.: E
MAR Paragraph: x.x.x	
Use: Supplies information that will be used to verify requirements, indicate manufacturing readiness, and determine additional assurance methods as necessary.	
Reference Documents: - GSFC-STD-8001 Standard Quality Assurance Requirements for PCBs - IPC-2221 Generic Standard on Printed Board Design - IPC-6011 Generic Performance Specifications for Printed Boards - IPC-6012 Qualification and Performance Specification for Rigid Printed Boards - IPC-6012xS Space and Military Avionics Applications Addendum to IPC-6012x, Qualification and Performance Specification for Rigid Printed Boards - IPC-6013 Qualification and Performance Specification for Flexible Printed Boards - IPC-6015 Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures - IPC-6017 Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices - IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards - IPC-6018xS Space and Military Avionics Applications Addendum to IPC-6018x, Qualification and Performance Specification for High Frequency (Microwave) Printed Boards - MIL-PRF-55110 Performance Specification PWB, Rigid, General Specification For - MIL-PRF-31032 Performance Specification PCB/PWB, General Specification For	
Place/Time/Purpose of Delivery: • Provide preliminary information on flight printed boards thirty (30) days prior to CDR for approval. • Provide changes to the plan a minimum of fourteen (14) days prior to printed board manufacturing for approval.	
Preparation Information: For all printed boards to be used in flight, flight spare and custom mission critical support hardware, the procurement plan shall contain: • Name of next higher-level assembly (box or subsystem) • Printed board assembly name • Part number and revision level • Indication as being a new or heritage design • Description of design complexity, to include:	

  - Number of layers
  - Overall board thickness
  - Most complex via stack-up
  - Use of micro-vias
  - Use of via-in-pad
  - Line width and spacing
  - Maximum voltage in application
  - Base material (IPC-4101 designation or trade name)
  - Applicable printed board design standard
  - Applicable printed board performance standard
  - Fabrication notes or procurement specifications
- Note of any waiver or deviation affecting printed board requirements or acceptability
- Printed board vendor(s) or candidates
- Quantity required for flight build
- Minimum quantity required for spares

The procurement information will ensure that boards and test coupons are fabricated for each design in a quantity sufficient to meet testing requirements per IPC-2221 Generic Standard on Printed Board Design and satisfy vendor acceptance testing per IPC-601X.