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Explorers & Heliophysics Projects Division (EHPD)

Mission Assurance Requirements (MAR)

Mission Risk Classification – NPR 7120.5 Class C

EHPD
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Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

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Signature/Approval Page

Prepared by:

electronic signature available at/online at https://ehpdmis.gsfc.nasa.gov

Robert Calvo
Chief Safety and Mission Assurance Officer
Mission Assurance Branch, Code 383

Date

Reviewed by:

electronic signature available at/online at https://ehpdmis.gsfc.nasa.gov

Shane Hynes
Systems Engineer
Mission Systems Engineering Branch, Code 599

Date

Approved by:

electronic signature available at/online at https://ehpdmis.gsfc.nasa.gov

Joseph Burt
Deputy Program Manager, Technical
Explorers and Heliophysics Projects Division, Code 460

Date

electronic signature available at/online at https://ehpdmis.gsfc.nasa.gov

Gregory Frazier
Deputy Program Manager (Explorers)
Explorers and Heliophysics Projects Division, Code 460

Date

electronic signature available at/online at https://ehpdmis.gsfc.nasa.gov

Michael Delmont
Deputy Program Manager (LWS & STP)
Explorers and Heliophysics Projects Division, Code 460

Date

electronic signature available at/online at https://ehpdmis.gsfc.nasa.gov

Nicholas Chrissotimos
Associate Director, Explorers and Heliophysics Projects Division, Code 460

Date

Concurred by:

electronic signature available at/online at https://ehpdmis.gsfc.nasa.gov

Jesse Leitner
Chief Engineer, Safety and Mission Assurance Directorate, Code 300

Date

Preface

This Explorers & Heliophysics Projects Division signature-controlled Mission Assurance Requirements document was developed in support of NASA Flight Payloads with a Risk Classification of C per NPR 8705.4.

All of the requirements in this document assume the use of the word "shall" unless otherwise stated.

Important Note:

Within this document there are a few locations (listed below) with tailoring notes in red. Tailoring sections/notes will be finalized at the time of contract award/mission selection.

Section 3.2: Pending launch location
Section 3.3.4 / DID 3-4 Instrument Safety Assessment Report (ISAR): Pending
Section 3.3.4 / DID 3-4 Safety Data Package (SDP): Pending *

* Spacecraft Developers who are responsible for instrument developer contracts shall flow down the MAR requirements with DID 3-4 Instrument Safety Assessment Report, deleting DID 3-4 Safety Data Package.

Questions or comments concerning this document should be addressed to:

EHPD Configuration Management Office
Mail Stop: 460
Goddard Space Flight Center
Greenbelt, Maryland 20771

Change History Log

Revision	Effective Date	CCR #	CCB/ERB Approval Date	Description of Changes
-	9/14/2016	EHPD-CCR-0001	9/14/2016	Initial Release

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1 GENERAL

This Mission Assurance Requirements (MAR) document is a Class C MAR in accordance with the requirements of NPR 7120.5 as a Class C mission. Each proposal will be evaluated against its individual total cost, risk, and merit values.

1.1 Systems Safety and Mission Assurance Program

Developer MAIP and MAR Compliance Matrix draft is due with Concept Study Report (CSR) - see Appendix A.

The developer shall prepare, document, and implement a Mission Assurance Implementation Plan (MAIP).

The MAIP shall cover:

a. Flight hardware and software that is designed, built, or provided by the developer and its subcontractors or furnished by the government, from project initiation through launch and mission operations
b. The ground support equipment that interfaces with flight items to the extent necessary to assure the integrity and safety of flight items
c. The ground data system to the extent necessary to assure performance as required by the Statement of Work

The mission assurance requirements compliance matrix shall accompany the MAIP submittal (DID 1-1) – identify variances along with supporting rationale for internal processes and procedures, as well as alternate standards that are proposed as alternatives to those specified. A sufficiently documented alternative process in the MAIP can take the place of a waiver/deviation. While the MAIP represents how the contractor will meet the MAR Requirements using their internal documentation, it does not supersede those requirements. Note: All changes between draft MAIP/compliance matrix (submitted with CSR) and final MAIP/compliance matrix will need to be highlighted and supported with rationale.

1.2 Management

The developer shall designate a manager for assurance activities. The assurance manager shall not be responsible for project costs and schedules other than those pertaining to assurance activities. The manager shall have direct access to management that is independent of project management and the functional freedom and authority to interact with all elements of the project.

1.3 Requirements Flowdown

The developer shall apply system safety and mission assurance requirements to subcontractors and suppliers to the extent necessary to ensure the delivered product meets performance requirements and this MAR. The developer MAIP needs to include specifics of the subcontractor requirements flowdown and oversight process in support of this project. Developer shall provide sub-tier component suppliers' MAIP/Compliance Matrix response to the the government.

1.4 Suspension of Work Activities

The developer shall direct the suspension of any work activity that presents a hazard, imminent danger, or future hazard to personnel, property, or mission operations resulting from unsafe acts or conditions that are identified by inspection, test, or analysis.

1.5 Contract Data Requirements List (CDRL)

The CDRL identifies Data Item Descriptions (DID) for deliverables. The developer shall deliver data items per the requirements of the applicable CDRL/DID. DIDs listed in Appendix A

The developer shall perform work in accordance with the following definitions:

a. Deliver for approval: The GSFC Project approves the deliverable within the specified period of time before the developer proceeds with the associated work.
b. Deliver for review: The GSFC Project reviews the deliverable and provides comments with the specified period of time before the developer proceeds with the associated work. The developer can continue with the associated work while preparing a response to the GSFC comments unless directed to stop work.
c. Deliver for information: For GSFC Project information only. The developer continues with the associated work.

Note: The developer may combine deliverables if the requirements for the individual deliverables are addressed

1.6 Surveillance

The developer shall grant access for National Aeronautics and Space Administration (NASA) and NASA assurance representatives to conduct an audit, assessment, inspections, or survey upon notice. The developer shall supply documents, records, equipment, and a suitable work area within the developer's facilities.
Note: See Federal Acquisition Regulations (FAR) Parts 46.103, 46.104, 46.202-2, 46.4, and 46.5 for government quality assurance requirements at contractor facilities. See FAR Part 52.246 for inspection clauses by contract type.

1.7 Use of Inherited Products

For inherited products, defined as those that were previously developed and exist (e.g., spares), will be build-to-print (BTP), or are available as commercial-off-the-shelf (COTS), the developer may follow an inherited items review process. With this process the Government reviews risk for using the product that is based on established prior history, changes in design, environment or operations, and information regarding the processes used to develop the product and data supplied by developer (DID 1-2). The government evaluates if developer's risks are acceptable. The developer shall assume ownership and responsibility for risk mitigation.

To follow this process, the developer shall provide the data specified in DID 1-2.

The developer shall participate in Technical Interchange Meetings (TIMs) to substantiate the baseline risk and potential risk mitigation strategies for inherited products.
Use of this process does not relieve the developer from meeting contractual performance and functional requirements.

1.8 Government Mandatory Inspection Points (GMIPS)

The developer/sub-tier supplier shall plan for the following GMIPS listed below (activities shall be accompanied by work instructions, drawings, etc.):

a. Circuit Card/Hardware Assemblies - Final Solder / Pre Conformal Coating and Staking
b. Circuit Card/Hardware Assemblies - Post Conformal Coating, Potting, Staking
c. Harness – pre integration (pre staking or potting)
d. Unit/component, subsystem, and top level assembly – witness final assembly
e. Mechanical – final assembly and acceptance test
f. Rework and repairs to flight hardware
g. Software acceptance test
h. **Test – TBD** (addressed at time of contract) / Acceptance and Environmental Test

These GMIPS are for generic planning purposes. Additional GMIPS may be required based on the specifics of the development effort.

2 QUALITY MANAGEMENT SYSTEM

2.1 General

The developer shall have a quality management system that meets the intent of SAE AS9100 Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing or ISO 9001 Quality Management System.

2.2 Supplemental Quality Management System Requirements

2.2.1 Control of Nonconforming Product

The developer shall have a documented closed loop system for identifying, reporting, and correcting product nonconformances. The system shall ensure that the adequacy of corrective action is determined by audit or test, that objective evidence is collected, and that preventive action is implemented to preclude recurrence.

2.2.2 Material Review Board (MRB)

The developer/subcontractors shall have a documented process for the establishment and operation of a MRB to process nonconformances, including the definitions of major and minor nonconformances. The developer shall appoint an SMA MRB chairperson who is responsible for implementing the MRB process and functional and project representatives as MRB members. The MRB shall include the GSFC CSO or their designee, who shall be a voting member with approval authority on all major (repair and use as is disposition) MRBs involving flight products.

The government representative shall have access to the applicable documentation in advance of the scheduled MRB. The developer shall inform the government of MRB actions (DID 2-1).

The MRB shall use the following disposition actions:

a. Scrap — the product is not usable
b. Re-work — the product will be re-worked to conform to existing requirements
c. Return to supplier — the product will be returned to the supplier
d. Repair — the product will be repaired using a repair process approved by the MRB
e. Use as is — the product will be used as is, MRB approval required

2.3 Anomaly Reporting and Disposition

The developer shall have a documented process for anomaly reporting and disposition. The process will establish an anomaly review board (ARB) whose membership shall include the GSFC CSO or their designee, as a voting member with approval authority for proposed actions on all major anomalies. Major anomalies are those that have resulted in hardware or software test failures and damage or potential damage to hardware. Examples of major anomalies are overvoltage or over current conditions, exceedance of test limits resulting in overstress, blown fuses, and unexpected system responses.

The process shall require major anomalies to be submitted to the ARB and the government (DID 2-2). The developer shall report major hardware anomalies beginning with the first application of power at the component level or end item (if below component level), major software anomalies beginning with flight software acceptance testing and when interfacing with flight hardware, and major mechanical system anomalies beginning with the first operation. The developer shall assess the failure risk ratings and failure effect risk ratings for major anomalies (see DID 2-2 for criteria) and identify those that have a failure effect risk rating of 2 or 3 and a failure corrective action risk rating of 3 or 4 as a significant residual risk.

The developer may disposition minor anomalies with an appropriate subset of the ARB. Minor anomalies are those that have not resulted in hardware failure or have caused no damage or stress to hardware or required no change in flight software. Examples of minor anomalies are those that can be resolved immediately, procedural errors, database problems, operator errors, and exceedance of test limits that do not affect the end item.

Note: A component is defined as a functional subdivision of a subsystem and generally as a self-contained combination of items performing a function necessary for the subsystem's operation.

3 SYSTEM SAFETY

3.1 General

The developer shall document and implement a system safety program, support the ELV Safety Review Process as defined in paragraph 2.4 of NPR 8715.7 Expendable Launch Vehicle Payload

Safety Program, meet launch service provider requirements, and launch range safety requirements.

Specific safety requirements include the following:

a. The developer shall incorporate three independent inhibits in the design (dual failure tolerant) if a system failure may lead to a catastrophic hazard. A catastrophic hazard prelaunch is defined as a payload-related hazard, condition, or event occurring prior to launch (on ground) that could result in a mishap causing fatal injury to personnel or loss of ground facility. A catastrophic hazard post-launch is defined as a payload-related hazard, condition or event occurring post-launch (airborne) through payload separation that could result in a mishap causing fatal injury (including fatal injuries to the public) or loss of flight termination system.
b. The developer shall incorporate two independent inhibits in the design (single failure tolerant) if a system failure may lead to a critical hazard. A critical hazard is defined as a condition that may cause a severe injury or occupational illness to personnel or major property damage to facilities.
c. The developer shall adhere to specific detailed safety requirements, including compliance verification that must be met for design elements with hazards that cannot be controlled by failure tolerance. The process by which safety is incorporated into these design elements (e.g., structures and pressure vessels) is called "Design for Minimum Risk".

3.2 Mission Related Safety Requirements Documentation

Tailoring Note: Delete subsections that do not apply to the mission. Verify applicability and existence of specific foreign safety requirement documents before including them in the contract. Also, verify and add as necessary the applicable safety documents to Appendix C.

The developer shall implement launch range safety requirements as applicable for the specific launch site. The most stringent applicable safety requirement shall take precedence in the event of conflicting requirements.

ELV Eastern Test Range (ETR) or Western Test Range (WTR) Missions

a. NASA-STD 8719.24 (with Annex) NASA Expendable Launch Vehicle Payload Safety Requirements
b. NASA-STD-8719.8 Expendable Launch Vehicle Payload Safety Review Process
c. KNPR 8715.3 KSC Safety Practices Procedural Requirements (applicable at KSC property, KSC-controlled property, and offsite facility areas where KSC has operational responsibility)
d. NPR 8715.7 Expendable Launch Vehicle Payload Safety Program
e. Launch Site Facility-specific Safety Requirements, as applicable (e.g., Astrotech)
f. SSP 50835 ISS Pressurized Volume Hardware Common Interface Requirements Document (Dragon)
g. SSP 57012 ISS FRAM Based Payload Common Launch Interface Requirements Document (IRD)

Wallops Flight Facility (WFF) Missions

a. NASA-STD 8719.24 (with Annex) NASA Expendable Launch Vehicle Payload Safety Requirements

b. RSM-2002 Range Safety Manual for GSFC/WFF

Japanese Missions
a. NASA-STD 8719.24 (with Annex) NASA Expendable Launch Vehicle Payload Safety Requirements, as negotiated with JAXA and GSFC SMA Directorate
b. JMR 002 Launch Vehicle Payload Safety Requirements
c. JERG-1-007 Safety Regulations for Launch Site Operations/Flight Control Operations
d. KDP-99105 Safety Guide for H-II/H-IIA Payload Launch Campaign

European Missions
a. NASA-STD 8719.24 (with Annex) NASA Expendable Launch Vehicle Payload Safety Requirements, as negotiated by each project with ESA and GSFC SMA Directorate
b. ECSS-E-10A Space Engineering – System Engineering
c. ECSS-Q-40-02 Space Product Assurance – Hazard Analysis
d. ECSS-Q-40 Space Product Assurance: Safety
e. CSG-NT-SBU-16687-CNES Payload Safety Handbook
f. CNES/P N°2010-1 of December 2010 Operation of the Guiana Space Centre Facilities

Russian Missions
a. P32928-103 Requirements for International Partner Cargoes Transported on Russian Progress and Soyuz Vehicles

International Space Station Mission-related Safety Requirements (Flight and Ground)
a. SSP 51700 Payload Safety Policy and Requirements for the International Space
b. SSP 30599 ISS Safety Review Process
c. NSTS/ISS 18798 Interpretations of NSTS/ISS Payload Safety Requirements

3.3 System Safety Deliverables

3.3.1 System Safety Plan

The developer shall prepare a System Safety Program Plan (SSPP) that describes the tasks and activities of system safety management and engineering required to identify, evaluate, and eliminate or control hazards to the hardware, software, and system design by reducing the associated risk to an acceptable level throughout the system life cycle, including launch range safety requirements (DID 3-1).

3.3.2 Safety Requirements Compliance Checklist

The developer shall document and implement a Safety Requirements Compliance Checklist to demonstrate that the payload is in compliance with NASA and range safety requirements (DID 3-2). The developer shall document non-compliances to safety requirements in waivers per section 3.3.7 of this document.

3.3.3 Hazard Analyses

3.3.3.1 Preliminary Hazard Analysis

The developer shall perform a Preliminary Hazard Analysis (PHA) to obtain an initial risk assessment and to identify safety critical areas of a concept or system. The developer will base the PHA on the best available data, including mishap data from similar systems and other lessons learned.

The developer shall evaluate hazards associated with the proposed design or function for severity, control approach (fault tolerance or design for minimum risk), and operational constraints. The developer shall identify safety provisions and alternatives that are needed to eliminate hazards or reduce their associated risk to an acceptable level.

The developer shall deliver the PHA with **Preliminary ISAR (DID 3-4) or SDP I (DID 3-4)** to the Project Office for review.

3.3.3.2 Operations Hazard Analysis (OHA) and Hazard Verification Tracking Log (VTL)

The developer shall document, implement, and maintain an Operations Hazard Analysis (OHA) and a Hazard Verification Tracking Log (VTL) to demonstrate that hardware operations, test equipment operations, and integration and test (I&T) activities comply with facility safety requirements and that hazards associated with those activities are mitigated to an acceptable level of risk (DID 3-3). The developer shall update and maintain the Hazard Verification Tracking Log during I&T activities to track open issues.

3.3.3.3 Lifting Device Safety Requirements

The developer shall implement the following safety requirements for lifting devices and equipment when performing NASA work at non-NASA facilities:

a. Ensure that for critical lifts overhead cranes, winches, and hoists have dual holding brakes and dual upper limit switches (dual upper limit switches do not apply to chain hoists) installed as defined in NASA Standard 8719.9A Standard for Lifting Devices and Equipment, paragraphs 5.4.1 and 5.4.2 respectively. A single holding brake in combination with a motor drive that automatically tests the holding ability of the brake prior to every release of the brake is acceptable as a second brake as long as the crane has a notification device to alert operator of failure of the braking system.
b. Perform periodic load testing in accordance with paragraph 4.5 of NASA-STD-8719.9A for the following lifting devices and equipment: overhead cranes; mobile cranes and derricks; hooks hydra-sets and load measuring devices; and slings and riggings.
c. After the initial proof test of the lifting device or equipment (LDE), a load test of the rated safe working load (SWL) LDE shall be performed every four years. Proof tests will be 125% of the SWL for Lifting Devices, such as overhead and mobile cranes and include aerial platforms used near critical hardware. Proof tests will be at 200% of the SWL for Lifting Equipment, such as shackles, turnbuckles and so forth. A load test will be at 100% of the

labeled SWL for all LDE. If the LDE is de-rated to a lower SWL because of a lower proof or load test, the LDE shall be labeled as this new SWL and only be used to the maximum capacity as such.

d. Perform NDT inspections using an American Society of Nondestructive Testing (ASNT) or equivalently trained inspector on critical lifting hardware/equipment on critical welds (weld failure would result in failure of hardware) after initial proof test and load testing.
e. Label and tag lifting devices and equipment per NASA-STD-8719.9 paragraph 4.8.or other acceptable means.

3.3.3.4 Operating and Support Hazard Analysis

The developer shall perform and document an Operating and Support Hazard Analysis (O&SHA) to evaluate activities for hazards introduced during testing, transportation, storage, integration, and prelaunch operations at the launch site. The primary purpose is to evaluate the adequacy of procedures used to eliminate, control, or mitigate identified hazards so as to ensure implementation of safety requirements for personnel, procedures, and equipment used during activities at the launch site. The results of the O&SHA shall be submitted as a part of the Intermediate & Final ISARs (DID 3-4) or SDP II and SDP III (DID 3-4).

3.3.4 Tailor Note: Delete the non-applicable title and paragraph and the related DID

Instrument Safety Assessment Report (ISAR)

The developer shall generate an ISAR to document the comprehensive evaluation of the risk being assumed prior to the testing or operation of an instrument. The spacecraft developer will use the ISAR as an input to the Safety Data Package (SDP) (DID 3-4).

Safety Data Package (SDP)

The developer shall prepare an integrated SDP to document the results of hazard analyses identifying the prelaunch, launch and ascent hazards associated with the flight system, ground support equipment, and their interfaces in hazard reports (DID 3-4).

3.3.5 Verification Tracking Log (VTL)

The developer shall document and implement a VTL that documents a Hazard Control and Verification Tracking process as a closed-loop system to ensure that safety compliance has been satisfied per applicable launch range safety requirements. The developer shall document in the VTL the process of verifying the control of all hazards by test, analysis, inspection, similarity to previously qualified hardware, or any combination of these activities. The developer shall ensure verifications that are listed on the hazard reports reference the specific test/analysis/inspection reports with a summary of the pertinent results. The developer shall make results of these tests/analyses and inspections available for government review.

The VTL shall identify hazard controls that are not verified as closed and delivered to the Project Office with the **final ISAR (DID 3-4) or SDP III (DID 3-4)**. Regular updates to this log shall be provided to the Project Office electronically for review until all hazard controls are verified as closed.

3.3.6 Hazardous Procedures for Payload I&T and Pre-launch Processing

The developer shall document and implement hazardous procedures that comply with applicable facility safety requirements when performing integration and test activities and pre-launch activities at the launch site (DID 3-5). The developer shall document hazardous procedures that will be implemented when performing integration and test activities and pre-launch activities at the processing facilities and launch site. The developer shall ensure that the procedures comply with applicable facility safety requirements. The developer shall provide safety support for hazardous operations at the launch site.

3.3.7 Safety Waivers

The developer shall request waivers for variations from the applicable safety requirements per paragraph 1.4 of NPR 8715.7 Expendable Launch Vehicle (ELV) Payload Safety Program. The waiver form is available at URL http://kscsma.ksc.nasa.gov/ELVPayloadSafety/Forms.html.

3.3.8 Orbital Debris Assessment Report (ODAR) and End of Mission Plan (EOMP)

The developer shall provide the information necessary for the development of the ODAR and the EOMP deliveries per the content defined in NASA-STD 8719.14, Processing for Orbital Debris (DID 3-6).

3.3.9 NASA Expendable Launch Vehicle (ELV) Payload Safety Program Forms

The developer shall prepare NASA Expendable Launch Vehicle Payload Safety Forms. The forms are available at URL http://kscsma.ksc.nasa.gov/ELVPayloadSafety/Forms.html.

3.3.10 Mishap Reporting and Investigation

The developer shall prepare a Pre-Mishap Plan that describes appropriate mishap and close call notification, reporting, recording, and investigation procedures in accordance with NPR 8621.1 NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Record Keeping. The developer shall report accidents, test failures, or other mishaps and close calls promptly to NASA. The developer shall promptly investigate so as to determine the root cause.

4 RELIABILITY

4.1 Reliability Program

The developer shall document and implement an RPP using both qualitative and quantitative techniques to support decisions regarding mission success and safety throughout system development (DID 4-1). The developer shall include in the RPP a detailed approach to the

analysis of hardware and software for their contributions to system reliability and mission success, incorporating performance data from inherited systems, in addition to the specifications and performance data of the system under development.

4.2 FMEA and Critical Items List (CIL)

The developer shall perform a FMEA that addresses flight hardware and software that is designed, built, or provided by their organization or subcontractors, from project initiation through launch and mission operations, and includes likelihood, cause, detection/ mitigation, and, effects of each failure mode (at the local, subsystem, and system/mission levels) to the interface level for existing systems and box/functional level for modified/new systems. As a result a CIL shall be prepared and maintained for severity categories 1, 1R, 1S, and 2, per Table 4.1 (DID 4-2). The developer shall identify and analyze single point failure modes resulting in severity categories 1, 1R, 1S, or 2 to determine the root cause, corresponding mitigation actions, and retention rationale. The developer shall identify and assess any known common cause failure modes and causes for category 1R and 2R items. The developer shall address the ground system that interfaces with flight equipment to the extent necessary to assure the integrity and safety of flight items. The developer shall identify and address safety critical software, as defined in NASA-STD-8719.13.

In performing the likelihood part of this analysis the developer shall predict the likelihood score from 1-5 for each failure mode, using the *Technical Likelihood* criteria shown in Table 4-2, to facilitate risk assessment using the FMEA results. Each likelihood prediction can be based on qualitative assessment and/or failure rate data from other analyses (i.e., system predictions) in order to score each failure mode for the mission duration.

Table 4.1 Severity Categories

Category	Severity	Description
1	Catastrophic	Failure modes that could result in loss of life, or permanently disabling or injuring of personnel, (flight or ground), and/or complete loss of flight or ground systems.
1R		Failure modes of identical or equivalent redundant hardware or software elements that could result in Category 1 effects if all failed.
1S		Failure in a safety or hazard monitoring system that could cause the system to fail to detect a hazardous condition or fail to operate during such condition and lead to Category 1 consequences.

2	Critical	Failure modes that could result in loss of one or more mission objectives as defined by the GSFC project or causes severe injury or occupational illness.
2R		Failure modes of identical or equivalent redundant hardware or software that could result in Category 2 effects if all failed.
3	Significant	Failure modes that could cause degradation to mission objectives.
4	Minor	Failure modes that could result in insignificant or no loss to mission objectives

Table 4-2 Likelihood Rankings

Likelihood	Safety (Estimated likelihood of safety event occurrence)	Technical (Estimated likelihood of not meeting performance requirements)	Cost/Schedule (Estimated likelihood of not meeting cost or schedule commitment)
5 Very High	($P_{SE} > 10^{-1}$)	($P_T > 50\%$)	($P_{CS} > 75\%$)
4 High	($10^{-2} < P_{SE} \leq 10^{-1}$)	($25\% < P_T \leq 50\%$)	($50\% < P_{CS} \leq 75\%$)
3 Moderate	($10^{-3} < P_{SE} \leq 10^{-2}$)	($15\% < P_T \leq 25\%$)	($25\% < P_{CS} \leq 50\%$)
2 Low	($10^{-5} < P_{SE} \leq 10^{-3}$)	($2\% < P_T \leq 15\%$)	($10\% < P_{CS} \leq 25\%$)
1 Very Low	($10^{-6} < P_{SE} \leq 10^{-5}$)	($0.1\% < P_T \leq 2\%$)	($2\% < P_{CS} \leq 10\%$)

4.3 Fault Tree Analysis (FTA)

The developer shall perform qualitative fault tree analyses to address mission failure, and degraded modes of operation (DID 4-3). The fault tree analyses shall address both hardware and software contributions to loss of mission scenarios.

4.4 Parts Stress Analysis

The developer shall perform parts stress and derating analyses for electrical, electronic, and electromechanical (EEE) parts in accordance with GSFC EEE-INST-002 Instruction for EEE Parts Selection, Screening, Qualification, and Derating (DID 4-4).

4.5 Limited Life Items

The developer shall document and implement a plan to identify through analysis and manage limited life items (in MAIP). Records shall be maintained for limited-life and presented at PDR, CDR, and PSR (DID 4-6).

Limited Life items are generally defined as items subject to wear-out that have a limited shelf life, operational life, or cycle life whose life expectancy is less than 2x the required life to assess the risk and /or the mitigation plans for continued use of the item; factoring in the wear caused by atomic oxygen, solar and trapped radiation, shelf-life, extreme temperatures, thermal cycling, and mechanical wear / fatigue, and/or refurbishment/ maintenance plans. Potential limited-life items shall include, but not necessarily be limited to: selected consumables; structures; mechanisms; batteries; seals; thermal control surfaces; solar arrays; and, electromechanical mechanisms

4.6 Worst-Case Analysis

The developer shall perform worst-case analyses (WCA) for circuits (DID 4-5)

5 SOFTWARE ASSURANCE

5.1 Applicable Software Definitions

When identifying, developing, verifying, and maintaining software, the developer shall apply the following definitions:

a. Software - Computer programs, procedures, scripts, rules, and associated documentation pertaining to the development and operation of a computer system. Software includes commercial–off-the-shelf (COTS) software, government-off-the-shelf (GOTS) software, modified-off-the-shelf (MOTS) software, custom software, reused software, heritage software, auto-generated code, and code executed on microprocessors.
b. Mission-Critical Software - Software that can cause, contribute to, or mitigate the loss of capabilities that are essential to the primary mission objectives or can damage flight hardware under development. The software reliability assessment and analysis is focused on failure modes specific to mission ending effects and programmatic threats during integration and test, launch, and nominal operations.
c. Safety-Critical Software - Software that can cause, contribute to, or mitigate human safety hazards or damage to facilities. The software safety assessment and analysis is focused on hazards specific to personnel and facility safety during integration and test, launch, and nominal operations (applicable only to International Space Station (ISS) payloads that have constant human presence) and re-entry/recovery (where applicable).

Note: The above definitions for Mission and Safety Critical Software are derived from Safety Critical as defined by the NASA Software Standard. The delineation is meant only to provide clarification for organizations with separate processes for assessing pre-separation and post-separation hazards and failures. Both categories of software must comply with the NASA-STD-8719.13 Software Safety Standard, which requires assessment of the entire lifecycle for potential injury, major damage, or mission failure.

All references to the developer shall include the prime software developer, as well as any subcontractors tasked in the development process.

5.2 Software Assurance Program

The developer shall plan and document the software assurance program in a Software Assurance Plan (DID 5-1). The plan will address the disciplines of Software Quality, Software Safety, Software Reliability, and Software Verification and Validation (V&V), and detail the role of assurance and their activities in ensuring quality products and processes for each discipline. The plan will include the software assurance processes, procedures, tools, and techniques to be used commensurate with the Software Classification Assessment. The plan will address software assurance the necessary collaboration between software assurance, system safety, system reliability, and software engineering.

The developer shall identify the person responsible for directing and managing the software assurance program and interfacing with government assurance personnel.

5.2.1 Software Quality

The developer shall evaluate software processes and work products as defined by NPR 7150.2 NASA Software Engineering Requirements and commensurate with the software classification. The developer shall identify and document noncompliance issues, communicate the results of quality assurance activities, maintain records, and ensure disposition of non-compliances.

5.2.2 Software Safety Analysis

The developer shall independently identify safety critical software modules and functions per the definitions provided in Section 5.1 and provide the following supporting analysis, design and test of the software in accordance with NASA-STD-8719.13, Software Safety Standard:

a. Review hazard analysis for the completeness and accuracy in its coverage of software.
b. Verify traceability between software requirements and hazard analyses.
c. Ensure that changes to safety critical software or its interfaces are evaluated for impact to existing hazard analysis and associated controls and mitigations.
d. Verify that design controls, test plans and procedures, and operational constraints for safety critical software are consistent with controls and mitigations identified in hazard analysis and verification log.

5.2.3 Software Reliability Analysis

The developer shall independently identify mission critical software modules and functions per the defintions provided in section 5.1, and provide the following support to the analysis, design and test of the software in accordance with NASA-STD-8719.13, the NASA Software Safety Standard:

a. Review reliability analysis for the completeness and accuracy in its coverage of software
b. Verify traceability between software requirements and reliability analyses
c. Ensure that changes to mission critical software or its interfaces are evaluated for impact to existing reliability analysis and associated fault management specifications.
d. Verify that design controls, test plans and procedures, and operational constraints for mission

critical software are consistent with corrective actions and retention rationale identified in the CIL.

5.2.4 Verification and Validation

The developer shall review the software section of the Verification and Validation Plan/Test Plan and review and support walkthroughs of test procedures. The developer shall witness or review results of software testing, review software discrepancy reports, and review software delivery documentation.

5.3 Surveillance of Software Development, Maintenance, and Assurance Activities

The developer shall provide access to the software engineering deliverables, process documentation, and work products defined in the Statement of Work, Software Acquisition Management Plan, or the project-approved tailoring of the NASA Software Engineering Requirements (NPR 7150.2).

The developer shall provide access to the following software assurance artifacts:
a. Schedule of software assurance reviews, audits, and assessments of the developer's processes and products
b. Software process and product standards and evaluation criteria
c. Results from process and product audits performed
d. Software Assurance Status Reports

6 WORKMANSHIP

6.1 General

The developer shall implement a workmanship program to assure that electronic packaging technologies, processes, and workmanship meet mission objectives for quality and reliability per the requirements of the following standards:

a. NASA-STD-8739.1 Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies
b. NASA-STD-8739.4 Crimping, Interconnecting Cables, Harnesses, and Wiring
c. NASA-STD-8739.5 Fiber Optic Terminations, Cable Assemblies, and Installation
d. NASA-STD-8739.6, Implementation Requirements for NASA Workmanship Standards
e. GSFC-STD-6001, Ceramic Column Grid Array Design and Manufacturing Rules for Flight Hardware
f. IPC-J-STD-001xS, Joint Industry Standard, Space Applications Electronic Hardware Addendum (except Chapter 10 of IPC-J-STD-001F)
g. IPC-2221 Generic Standard on Printed Board Design
h. IPC-2222 Sectional Design Standard for Rigid Organic Printed Boards
i. IPC-2223 Sectional Design Standard for Flexible Printed Boards
j. IPC-2225 Sectional Design Standard for Organic Multichip Modules (MCM-L) and MCM-L Assemblies

k. IPC-6011 Generic Performance Specification for Printed Boards (Class 3 requirements)
l. IPC-6012DS Qualification and Performance Specification for Rigid Printed Boards. For boards that include high-density interconnect (HDI) technologies with pin spacing of 1 mm or less, the employment of filleting or ‘‘tear drops’’ is preferred and Class 2 requirements are acceptable for the following parameters:
    i. Wrap plating (in accordance with 3.6.2.11.1 or 3.6.2.11.3 of IPC-6012D).
    ii. Protrusions (bumps) or depressions (dimples) in blind copper filled microvias (per 3.6.2.11.3 of IPC-6012D).
    iii. Material Fill (other than copper plating) (per 3.6.2.18 of IPC-6012D).
m. MIL-PRF-55110, Performance Specification: Printed Wiring Board, Rigid, General Specification For
n. ECSS-Q-ST-70-10 Qualification of Printed Circuit Boards
o. IPC-6013 Qualification and Performance Specification for Flexible Printed Boards (Class 3 requirements)
p. MIL-PRF-50884, Performance Specification: Printed Wiring Board, Flexible or Rigid-Flex, General Specification For
q. IPC-6015 Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures
r. IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards (Class 3 requirements)

6.2 Design and Process Qualification

The developer shall perform and document qualification of designs and processes that are not covered by or do not conform to the above standards, including the establishment of quality controls and inspections for non-standard configurations and submit a waiver request for government approval.

6.3 Electrostatic Discharge Control (ESD)

The developer shall prepare and implement an ESD control program that conforms to the requirements of ANSI/ESD S20.20, Protection of Electrical and Electronic Parts, Assemblies and Equipment [Excluding Electrically Initiated Explosive Devices] (made available upon request).

6.4 Splices, Circuit Board Trace Cuts, and Jumper Wires

The developer shall not incorporate splices, board trace cuts, or jumper wires that result from repairs or design changes into flight hardware, including previously developed hardware, unless approved by the MRB.

6.5 Printed Wiring Board (PWB) Test Coupons

The developer shall provide sufficient detail in the procurement instructions to ensure that PWB test coupons are fabricated for each design and that sufficient numbers are produced to meet requirements for testing per IPC-2221 Generic Standard on Printed Board Design, to satisfy required supplier acceptance testing per the selected standard from section 6.1, and for GSFC (or GSFC approved laboratory) micro-sectioning evaluations. The developer shall provide printed wiring board test coupons that are directly traceable to each board that is intended for use in

hardware for structural integrity analysis to the GSFC or to a GSFC- approved facility (DID 6-1). Coupon reports generated at GSFC or at a GSFC approved facility that indicate non-conformances to requirement will be processed per developers approved MRB process. Any non-conformance being considered for flight use shall be processed per major MRB, requiring GSFC approval. The developer shall seek to identify the root cause of the nonconformance and appropriate corrective action prior to beginning a replacement production run. The developer shall not populate printed circuit boards (PCBs) until all approvals to proceed are granted.

6.6 Use of Water Soluble Flux

The developer shall comply with the requirements of GSFC-STD-8002 GSFC Standard Quality Assurance Requirements for the Use of Water Soluble Flux (DID 6-2).

7 EEE PARTS

7.1 General

The developer shall document and implement a Parts Control Plan (PCP) utilizing Level 1, Level 2 or Level 3 parts per the requirements of GSFC EEE-INST-002 Instruction for EEE Parts Selection, Screening, Qualification, and De-rating (DID 7-1).

Plastic-encapsulated Microcircuits (PEMs) may be used per the process prescribed in EEE-INST-002, section M4, when accepted by the PCB and no hermitic alternates are available.

The PCP shall address all EEE component radiation effects in accordance with project requirements.

Note: Reference GSFC-EEE-INST-002 Section 5.1/5.2 for Part Type Categories

7.2 Nonstandard Parts

Non-standard parts are parts that do not have a military specification part number or Source Control Drawing (SCD) that reflects the required reliability level for a Level 1, Level 2, or Level 3 mission per the EEE-INST-002. Non-standard parts shall be documented, evaluated and approved by the PCB.

7.3 Parts Control Board

The developer shall establish a process for the planning, management, and coordination of the selection, application, and procurement requirements of EEE parts. This process shall be implemented through a Parts Control Board (PCB) and shall be described in the Parts Control Plan (PCP).

The developer shall identify the person responsible for directing and managing the EEE parts program, chairing parts control board, and interfacing with government assurance personnel.

The Project Parts Engineer (GSFC) shall be an active/voting member of the PCB.

7.4 Re-use of EEE Parts

The developer shall require approval of the MRB to re-use EEE parts that have been installed and removed.

7.5 Master EEE Parts List

The developer shall develop and maintain a Master EEE Parts List (DID 7-2).

8 MATERIALS AND PROCESSES

8.1 General

The developer shall prepare and implement a Materials and Processes (M&P) Selection, Control, and Implementation Plan (DID 8-1). As part of the plan, the developer shall implement an M&P Control Board process or equivalent developer process, which defines the planning, management, and coordination of the selection, application, procurement, control, and standardization of M&P for the contract and for directing the disposition of M&P nonconformance and problem resolutions.

NASA-STD-6016 (or equivalent developer's standard) shall form the basis for the requirements of the project's M&P Requirements. Tailoring of NASA-STD-6016 or the direct use of the developer's standard is allowed, and shall address application, launch site, and platform (e.g., ISS) specific M&P requirements. The developer shall document the tailoring in the M&P Selection, Control, and Implementation Plan to provide the degree of conformance with and the method of implementation of the requirements (NASA-STD-6016).

The Project Materials and Processes Engineer (GSFC) shall be an active/voting member of the Materials and Processes Control Board or equivalent developer process.

8.2 Materials Identification and Usage List (MIUL)

The developer shall prepare a materials identification and usage list (DID 8-2).

8.3 Non-destructive Evaluation (NDE) Plan

The developer shall implement a non-destructive evaluation plan for the procedures and specifications used in the inspection of materials per the requirements outlines in NASA-STD-6016 Standard Materials and Processes Requirements for Spacecraft.

9 CONTAMINATION CONTROL and FOREIGN OBJECT DEBRIS CONTROL

9.1 Contamination Control and Foreign Object Debris Prevention Control Plan

The developer shall prepare and implement a Contamination Control and Foreign Object Debris Prevention Control program (DID 9-1).

10 METROLOGY AND CALIBRATION

10.1 Metrology and Calibration Program

The developer shall comply with one of the following standards for the calibration of measuring and test equipment:

a. ANSI/NCSL Z540.1-1994 (R2002) Calibration Laboratories & Measuring & Test Equipment - General Requirements
b. ANSI/NCSL Z540.3-2006 Requirements for the Calibration of Measuring and Test Equipment
c. ISO 17025-2002 General requirements for the competence of testing and calibration laboratories

10.2 Use of Calibrated and Non-calibrated Instruments

The developer shall maintain the calibration of test and measuring equipment and safety instruments used for: acceptance testing; inspection; maintenance; flight hardware qualification; measurement where accuracy is essential for the safety of personnel or the public; telecommunication, transmission, and test equipment where exact signal interfaces and circuit confirmations are essential to mission success; development, testing, and special applications where the specifications, end products, or data are accuracy sensitive, including instruments used in hazardous and critical applications.

The developer shall calibrate any article of equipment used to take measurements to meet accuracy requirements within the project to one of the standards in 10.1. The developer may calibrate torque wrenches per one of the standards in 10.1 or may verify against a calibrated torque tester prior to use. The developer shall record the measurements that require accuracy in applicable project build documents (e.g., WOAs, job orders, task sheets or test plans), including the article of calibrated equipment used to take the measurement and its calibration end date.

The developer is not required to calibrate an article of test and measuring equipment if the accuracy of the equipment's signals or measurements has been verified to meet minimum requirements against calibrated instruments or intrinsic standards, using a documented measurement procedure. The developer shall perform verification within a timeframe that has been demonstrated to provide appropriate levels of reliability, in the same facility, and under the same conditions that will be encountered during the process. If this method is employed, the developer shall record the following items in the work order, test plan, or procedure:

- Measurement process or procedure used to perform the verification
- Unambiguous identification of the item(s) being verified (Model/Part Number and Serial/Asset Number, or in the case of a multi-unit configuration, a Model/Part/Drawing number and configuration listing that provides identification of all verified sub components)
- Measurement parameters that must be verified
- Acceptance limits for each parameter being verified
- Actual measurements at each parameter being verified
- Verification status (pass/fail)

- Traceability
  - Unambiguous identification of calibrated instruments utilized, including the end date of its calibration, or
  - Type and method of verification against an intrinsic standard (examples are ice baths, monochromatic light source, etc.)

The developer shall limit the use of non-calibrated and non-verified instruments to applications where substantiated accuracy is not required and for indication-only purposes in non-hazardous, non-critical applications.

11 GIDEP ALERTS AND PROBLEM ADVISORIES

11.1 Government-Industry Data Exchange Program (GIDEP)

The developer shall participate in GIDEP per the GIDEP Operations Manual S0300-BT-PRO-010 and GIDEP Requirements Guide S0300-BU-GYD-010 (Note: these documents are available through (http://www.gidep.org).

11.2 Alert Disposition

The developer shall review the following, hereafter referred to collectively as Alerts, for affects on EEE parts, materials, equipment and software used in NASA products: GIDEP Alerts; GIDEP SAFE-ALERTS; GIDEP Problem Advisories; GIDEP Agency Action Notices; NASA Advisories.

When the developer identifies an item in their design, inventory, or assembly that is documented in an Alert, the developer shall disposition the item and Alert through the Material Review Board as a major nonconformance.

11.3 GIDEP Reporting

The developer shall prepare and submit failure experience data and safety issue reports per the requirements of S0300-BT-PRO-010 and S0300-BU-GYD-010 whenever failed or nonconforming items that are available to other buyers.

11.4 Review Reporting

The developer shall report the status of NASA products that are affected by Alerts or by significant EEE parts, materials, and safety problems at monthly status reviews, parts control board meetings, program milestone reviews and readiness reviews (see Section 7). The developer shall include a summary of the review status for EEE parts and materials lists and of actions taken to eliminate or mitigate negative effects.

12 END ITEM ACCEPTANCE DATA PACKAGE

The developer shall submit an end item acceptance data package (DID 12-1).

Appendix A: Data Item Descriptions

Important Note: All DIDs become CDRLs at the time of contract award

Title: Mission Assurance Implementation Plan / Compliance Matrix	**DID No.: 1-1**
MAR Paragraph: 1.1	**CDRL No.:**

Use:

- Documents the developer's compliance with the contractual system safety and mission assurance requirements.

Reference Documents:

Place/Time/Purpose of Delivery:

- Deliver draft MAIP and compliance matrix with Concept Study Report
- Deliver final MAIP and compliance matrix to the Project Office sixty (60) days after start of Phase B for approval
- Deliver updates to the plan to the Project Office thirty (30) days prior to implementation for approval

Preparation Information:

1. The Mission Assurance Implementation Plan / Compliance Matrix shall cover:
   a. All flight hardware and software that is designed, built, or provided by the developer and its subcontractors, or furnished by the government, from project initiation through launch and mission operations
   b. The ground system that interfaces with flight equipment to the extent necessary to assure the integrity and safety of flight items
   c. The ground data system
   d. The Mission Assurance Compliance Matrix (below) shall identify variances and acceptance rationale for processes, procedures, and standards that are proposed as alternatives.
   e. The Matrix shall include traceability to the vendor's internal documentation (number, title and revision) being used in lieu of the referenced and applicable documents in this MAR.

   Note: All changes between draft MAIP/compliance matrix (submitted with CSR) and final MAIP/compliance matrix will need to be highlighted and supported with rationale.

Mission Assurance Compliance Matrix

Note: Delete one of the two entries in paragraph 3.3.4 and DID 3-4 of this table to correspond with the tailoring selection made for Paragraph 3.3.4 of the MAR.

- Enter *Yes* or *No* regarding compliance with the requirements.
- A response of ***Yes*** indicates full compliance with the requirements. The Comment column shall be used to indicate how compliance will be achieved, e.g., through a specified requirements document or equivalent procedure.
- A response of ***No*** indicates less than full compliance with the requirements and requires an entry in the Comment column to explain the deviation from full compliance.

Paragraph or DID	Title	Comply Y / N	Document Number, Title, Revision and Comments
1 General			
1.1	System Safety and Mission Assurance Program		
1.2	Management		
1.3	Requirements Flowdown		
1.4	Suspension of Work Activities		
1.5	Contract Data Requirements List		
1.6	Surveillance		
1.7	Use of Inherited Products		
1.8	Government Mandatory Inspection Points		
DID 1-1	Mission Assurance Implementation Plan / Compliance Matrix		
DID 1-2	Use of Inherited Products		

Paragraph or DID	Title	Comply Y / N	Document Number, Title, Revision and Comments
2 Quality Management System			
2.1	General		
2.2	Supplemental Quality Management System Requirements		
2.2.1	Control of Nonconforming Product		
2.2.2	Material Review Board		
2.3	Anomaly Reporting and Disposition		
DID 2-1	Reporting of MRB Actions		
DID 2-2	Anomaly Report		
3 System Safety			
3.1	General		
3.2	Mission Related Safety Requirements Documentation		
3.3	System Safety Deliverables		
3.3.1	System Safety Program Plan		
3.3.2	Safety Requirements Compliance Checklist		
3.3.3	Hazard Analyses		
3.3.3.1	Preliminary Hazard Analysis		
3.3.3.2	Operations Hazard Analysis (OHA) and Hazard Verification Tracking Log (VTL)		

Paragraph or DID	Title	Comply Y / N	Document Number, Title, Revision and Comments
3.3.3.3	Lifting Devices Safety Requirements		
3.3.3.4	Operating and Support Hazard Analysis		
3.3.4	Instrument Safety Assessment Report ***or*** Safety Data Package		
3.3.5	Verification Tracking Log		
3.3.6	Hazardous Procedures for Payload I&T and Pre-Launch Processing		
3.3.7	Safety Waivers		
3.3.8	Orbital Debris Assessment Report (ODAR) and End of Mission Plan (EOMP)		
3.3.9	NASA Expendable Launch Vehicle (EVL) Payload Safety Program Forms		
3.3.10	Mishap Reporting and Investigation		
DID 3-1	System Safety Program Plan		
DID 3-2	Safety Requirements Compliance Checklist		
DID 3-3	Operations Hazard Analysis and Hazard Verification Tracking Log		
DID 3-4	Instrument Safety Assessment Report ***or*** Safety Data Package		

Paragraph or DID	Title	Comply Y / N	Document Number, Title, Revision and Comments
DID 3-5	Hazardous Procedures for Payload I&T and Pre-Launch Processing		
DID 3-6	Input to Orbital Debris Assessment Report and End of Mission Plan		
4 Reliability			
4.1	Reliability Program Plan		
4.2	FMEA and Critical Items List (CIL)		
4.3	Fault Tree Analysis		
4.4	Parts Stress Analysis		
4.5	Limited Life Items		
4.6	Worst-Case Analysis		
DID 4-1	Reliability Program Plan		
DID 4-2	FMEA and Critical Items List (CIL)		
DID 4-3	Fault Tree Analysis		
DID 4-4	Parts Stress Analysis		
DID 4-5	Worst Case Analysis		
DID 4-6	Limited Life Items List		
5 Software Assurance (Flight and Ground Segments)			
5.1	Applicable Software Definition		
5.2	Software Assurance Program		
5.2.1	Software Quality		

Paragraph or DID	Title	Comply Y / N	Document Number, Title, Revision and Comments
5.2.2	Software Safety Analysis		
5.2.3	Software Reliability Analysis		
5.2.4	Verification and Validation		
5.3	Surveillance of Software Development, Maintenance, and Assurance Activities		
DID 5-1	Software Assurance Plan		
6 Workmanship			
6.1	General		
6.2	Design and Process Qualification		
6.3	Electrostatic Discharge Control (ESD)		
6.4	Splices, Circuit Board Trace Cuts, and Jumper Wires		
6.5	Printed Wiring Board (PWB) Test Coupons		
6.6	Use of Water Soluble Flux		
DID 6-1	Printed Wiring Board Test Coupons		
DID 6-2	Use of Water Soluble Flux		
7 EEE Parts			
7.1	General		
7.2	Nonstandard Parts		
7.3	Parts Control Board		
7.4	Re-use of EEE Parts		
7.5	Master EEE Parts List		

Paragraph or DID	Title	Comply Y / N	Document Number, Title, Revision and Comments
DID 7-1	EEE Parts Control Plan		
DID 7-2	Master EEE Parts List		
8 Materials and Processes			
8.1	General		
8.2	Materials Identification and Usage List (MIUL)		
8.3	Non-destructive Evaluation (NDE) Plan		
DID 8-1	Materials & Processes Selection, Control, and Implementation Plan		
DID 8-2	Materials Identification and Usage List		
9 Contamination Control			
9.1	Contamination Control and Foreign Object Debris Prevention Control Plan		
DID 9-1	Contamination Control and Foreign Object Debris Prevention Control Plan and Data		
10 Metrology and Calibration			
10.1	Metrology and Calibration Program		
10.2	Use of Non-calibrated Instruments		
11 GIDEP Alerts and Problem Advisories			
11.1	Government-Industry Data Exchange Program (GIDEP)		

Paragraph or DID	Title	Comply Y / N	Document Number, Title, Revision and Comments
11.2	Alert Disposition		
11.3	GIDEP Reporting		
11.4	Review Reporting		
12 End Item Acceptance Data Package			
12	End Item Acceptance Data Package		
DID 12-1	End Item Acceptance Data Package		

Title: Use of Inherited Products	**DID No.: 1-2**
MAR Paragraph: 1.7	**CDRL No.:**

Use:
- Government Risk Evaluation of Inherited Products

Reference Documents:

Place/Time/Purpose of Delivery:
- Initial Inherited Items Package: Thirty (30) days after contract award for review
- Final Inherited Items Package: Thirty (30) days after System Requirements Review for approval

Preparation Information:
Inherited Items Package submissions must be accompanied by Developers Major MRB Form or Waiver for items not meeting MAR requirements.

1. The developer shall provide the data specified in Table 1-1 to substantiate the product's baseline and risk of use. The developer may provide additional available information from Table 1-2 to reduce the risk.

2. The developer shall participate in Technical Interchange Meetings (TIMs) to substantiate the baseline risk and potential risk mitigation strategies for inherited products.

Important Note: Use of this process does not relieve the developer from meeting contractual performance and functional requirements.

No.	Table 1-1: Data Needed for Inherited Products
1	List of inherited products and statement of approach to use – rebuild, modification of previous build, or use of existing product
2	Summary results of qualification, acceptance, and/or prototype/proto-flight testing completed, or comparison of current qualification/proto-qualification requirements and what was performed/realized on the inherited design, including environments, required design margins, and life
3	Flight history of the products and specific attributes for each flight, including environments (compare previous environment to current, including duty cycle and general concept of operations)
4	Ground and on-orbit anomaly and failure history including the determination of root causes or information that root cause was not determined. Ground anomalies may be restricted to major anomalies, where component performance requirements were violated
5	Reliability analyses performed for the most recent version of the product
6	Identification of significant changes in manufacturing from qualified product to current product (facility, process, sub-tier supplier, testing changes, company change of ownership, etc.), and any changes in design or materials, including electronic parts, printed circuit boards, and standards used (changing from an older revision of a standard to the latest revision need not be discussed).

No.	Table 1–2: Supplement Information for Inherited Product
1	Deviations of each product from original design (white wires, cut traces, splices, etc., if not objectively clear to be part of the design) and reasons for each deviation. If the design has been qualified on a previous GSFC project in the same environment and same risk posture, then the deviations may be declared relative to the previously qualified design.
2	Specifications and/or standards used to develop the products (e.g., IPC, J-STD, NASA, or GSFC requirements, including fastener integrity approach, or company standards). For products with minimal prior flight history, company standards or detailed synopses of such should be provided, if such are used to develop the product
3	Previous as-built parts list, including lot date codes, and the differences for new inherited item. This should include evidence that Government Industry Data Exchange Program (GIDEP) alerts and advisories have been properly dispositioned, if the parts have already been procured. Note that GIDEP should always be used as an aid in procuring new parts or pulling parts from inventory. Reference to prior project deliveries to GSFC is acceptable, in which case, an amendment may be delivered to indicate any changes
4	Known obsolete parts that will be supplied from existing inventory, including the quantity required and the quantity available. If available, include the sparing plan (quantity required, quantity available, and sparing philosophy)
5	Materials list and approved Material Usage Agreements (MUAs). Materials list includes lot date codes and evidence that GIDEP alerts and advisories have been properly dispositioned, if the materials have already been procured. Such evidence should be encompassed in GIDEP closure records for each of the items that have impacts. Reference to prior project deliveries to GSFC is acceptable, in which case, an amendment may be delivered to indicate any changes
6	List of major electrical and mechanical analyses completed and summary of results

Title: Reporting of MRB Actions	**DID No.: 2-1**
MAR Paragraph: 2.2.2	**CDRL No.:**

Use:

- Report MRB actions to the project office.

Reference Documents:

- SAE AS9100 Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing

Place/Time/Purpose of Delivery:

- Major MRB actions: Notify project CSO when generated (within 24 hours of occurence), for meetings, status change, and approval
- Minor MRB actions: Available via electronic reporting system

Preparation Information:

1. Developer's MRB System shall be made available (remotely) electronically to GSFCs project team.
2. The developer shall document the MRB action per the developer's MRB system form, which shall contain at a minimum:
   a. MRB Classification (major/minor)
   b. Dates (opened, closed, etc.)
   c. Condition Observed
   d. Cause
   e. Corrective Action Taken
   f. Preventive Action

Title: Anomaly Report	**DID No.: 2-2**
MAR Paragraph: 2.3	**CDRL No.:**

Use:

- Document anomalies, investigative activities, rationale for closure, and corrective and preventive actions.

Reference Documents:

- SAE AS9100 Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing

Place/Time/Purpose of Delivery:

- Major Anomaly: Notify project CSO within 24 hours of the initial event, prior to meetings, and approval.
- Minor Anomaly: Available via electronic reporting system.

Preparation Information:

1. Developer's Anomaly Reporting System shall be made available (remotely) electronically to GSFC's project team.
2. Document anomalies, changes in status, or proposed closures shall identify the following information:
   a. Identification of project, system, or sub-system
   b. Identification of failed item (e.g., assembly, sub-assembly, or part)
   c. Description of item
   d. Identification of next higher assembly
   e. Description of anomaly, including activities leading up to anomaly, if known
   f. Names and contact information of individuals involved in anomaly
   g. Date and time of anomaly
   h. Status of item
   i. Contact information for personnel who originated the report
   j. Date of original submission
   k. Anomaly cause (include investigation steps, activity, and ARB notes/authorization)
   l. Corrective and Preventive actions implemented (include ARB notes/authorization)
   m. Retesting performed and results
   n. Other items affected
   o. Risk ratings – the numerical ratings for failure effect risk and corrective action risk per the following criteria:

Failure Effect Risk Rating – indicates the potential impact of the anomaly on hardware or software performance if it occurred during the mission. Redundancy shall be ignored in establishing this rating. The project shall assign a failure effect risk rating per the following criteria: and corresponding numerical values:

1 Negligible or no effect on mission, system or instrument performance, reliability or safety.

2 Moderate or significant effect on the mission, system or instrument performance, reliability or safety, defined as: an appreciable change in functional capability, an appreciable degradation of engineering or science telemetry, causing significant operational difficulties or constraints, or causing a reduction in mission lifetime.

3 Catastrophic or major degradation to mission, system or instrument performance, reliability or safety.

Corrective Action Rating – indicates the confidence in the root cause and the corrective action. The project shall assign a failure corrective action risk rating per the following criteria:

1 Recurrence very unlikely – the root cause of the anomaly has been determined with confidence by analysis or test. Corrective action has been determined, implemented, and verified with certainty. There is a very low probability of recurrence.

2 Recurrence unlikely – the root cause of the anomaly has not been determined with confidence. However, some corrective action has been determined, implemented, and verified to the extent that there is a very low probability of recurrence.

3 Recurrence possible – the root cause is considered known and understood with confidence. Corrective action has not been determined, implemented, or verified with certainty. There exists a possibility that the anomaly may recur.

4 Recurrence credible – the root cause has not been determined with confidence. Corrective action has not been determined, implemented, or verified with certainty. There exists a possibility that the anomaly may recur.

Title: System Safety Program Plan	**DID No.: 3-1**
MAR Paragraph: 3.3.1	**CDRL No.:**

Use:

- The System Safety Program Plan (SSPP) describes the tasks and activities of system safety management and engineering required to identify, evaluate, and eliminate or control hazards to the hardware, software, and system design by reducing the associated risk to an acceptable level throughout the system life cycle.

Reference Documents:

- NPR 8715.7 Expendable Launch Vehicle Payload Safety Program
- NASA-STD-8715.7 Expendable Launch Vehicle Payloads Safety Program
- NASA-STD 8719.24 (with Annex), NASA Expendable Launch Vehicle Payload Safety Requirements
- NASA-STD-8719.9 Lifting Devices and Equipment

Place/Time/Purpose of Delivery:

- Deliver preliminary plan to the Project Office at SRR for information.
- Deliver final plan to the Project Office forty-five (45) days prior to PDR for review.

Preparation Information:

1. The developer shall prepare a SSPP that describes the development and implementation of a system safety program that complies with the requirements of NPR 8715.7, the launch service provider, and launch range safety. The developer shall:
   a. Define the roles and responsibilities of personnel
   b. Define the required documentation, applicable requirements documents, and completion schedules for analyses, reviews, and safety packages
   c. Address support for Safety Reviews, Safety Working Group Meetings and TIMs
   d. Provide for early identification and control of hazards to personnel, facilities, support equipment, and the flight system during product development, including design, fabrication, test, transportation, and ground activities.
   e. Address compliance with the launch range safety requirements
   f. Include a safety review process that meets the requirements of NASA-STD-8715.7 Expendable Launch Vehicle Payloads Safety Program
   g. Address compliance with industrial safety requirements imposed by NASA and OSHA design and operational needs (e.g., NASA-STD-8719.9 Lifting Devices and Equipment as applicable) and contractually imposed mission unique obligations

Title: Safety Requirements Compliance Checklist	**DID No.: 3-2**
MAR Paragraph: 3.3.2	**CDRL No.:**

Use:

- The checklist indicates for each requirement whether the proposed design is compliant, non-compliant but meets intent, non-compliant, or if the requirement is not applicable. An indication other than compliant will include rationale.

  Note: the developer shall submit safety waivers for non-compliant design elements using the NASA ELV Payload Safety Waiver Request NF1827 (found on the NASA ELV Payload Safety Web site at http//:kscsma.ksc.nasa.gov/ELVPayloadSafety/Default.html under the “ELV Payload Safety Forms” button)

Reference Documents:

- NASA-STD 8719.24 (with Annex), NASA Expendable Launch Vehicle Payload Safety Requirements
- Reference MAR Section 3.2, Mission Related Safety Requirements Documentation

Place/Time/Purpose of Delivery:
- Deliver Preliminary version to the Project Office forty-five (45) days prior to PDR for review.
- Deliver Final version to the Project Office forty-five (45) days prior to CDR for review.

Preparation Information:
1. The developer shall prepare a compliance checklist of all design, test, analysis, and data submittal requirements. The following shall be included:
   a. Criteria and requirement.
   b. System
   c. Indication of compliance, noncompliance, or not applicable
   d. Rationale for indications other than compliant
   e. Resolution
   f. Reference
   g. Copies of Range Safety and NASA approved non-compliances, including waivers and equivalent levels of safety certifications

Title: Operations Hazard Analysis and Hazard Verification Tracking Log	**DID No.: 3-3**
MAR Paragraph: 3.3.3.2	**CDRL No.:**

Use:
- The Operations Hazard Analysis (OHA) and Hazard Verification Tracking Log (VTL) shall demonstrate that hazards related to the operation of hardware and test equipment during integration and test activities have been addressed with respect to facility safety requirements.

Reference Documents:
- GSFC 500-PG-8715.1.2 AETD Safety Manual (for operations at GSFC)
- NASA-STD-8719.9 Standard for Lifting Devices and Equipment

Place/Time/Purpose of Delivery:
- Deliver the OHA and Hazard VTL for flight hardware to the Project Office forty-five (45) days prior to Systems Integration Review or Pre-Environmental Review for review

  (Note: OHA controls for engineering test units undergoing environmental tests shall be presented in accordance with local safety authorities 45 days prior to test performance)

Preparation Information:
1. The OHA shall include the following information:
   a. Introduction – a summary of the major findings of the analysis and the proposed corrective actions and definitions of special terms, acronyms, and abbreviations.
   b. System Description – a description of system hardware and configuration, with a list of subsystem components and schedules for integration and testing
   c. Analysis of Hazards
   d. List of real or potential hazards to personnel, equipment, and property during I&T processing
   e. The following information shall be included for each hazard:
      - System Component/Phase – the phase and component with which the analysis is concerned; e.g., system, subsystem, component, operating/maintenance procedure, or environmental condition.
      - System Description and Hazard Identification, Indication:
        - A description of expected results from operating the component/subsystem or performing the operating/maintenance action
        - A complete description of the actual or potential hazard resulting from normal actions or equipment failures; indicate whether the hazard will cause personnel injury and equipment damage.
        - A description of warning indicators for the operator/crew that includes all means of identifying the hazard to operational/maintenance personnel.
        - A description of the safety hazards of software controlling hardware systems where the hardware effects are safety critical.
      - Effect on System – the detrimental effects of an uncontrolled hazard on the system

- Risk Assessment.
- Caution and Warning Notes – a list of warnings, cautions, procedures required in operating and maintenance manuals, training courses, and test plans
- Status/Remarks – the status of actions to implement hazard controls.

f. References (e.g., test reports, preliminary operating and maintenance manuals, and other hazard analyses)

Tailoring note: Delete either this or the following DID per the tailoring of Paragraph 3.3.4

Title: Instrument Safety Assessment Report (ISAR)	**DID No.: 3-4**
MAR Paragraph: 3.3.4	**CDRL No.:**

Use:

- The Instrument Safety Assessment Report (ISAR) documents the comprehensive evaluation of the risk being assumed prior to the testing or operation of an instrument. The spacecraft developer will append the ISAR as an input to the Safety Data Package (SDP) and will verify inhibit controls ultimately used in whole or part to control instrument hazards at the observatory level.

Reference Documents: ***Tailor per Section 3.2 Selection – Add document references***

- NASA-STD 8719.24 (with Annex), NASA Expendable Launch Vehicle Payload Safety Requirements

Place/Time/Purpose of Delivery:

- Deliver the Preliminary ISAR to the Project Office thirty (30) days prior to instrument PDR for review.
- Deliver the Intermediate ISAR to the Project Office thirty (30) days prior to instrument CDR for review.
- Deliver the Final ISAR to the Project Office thirty (30) days prior to instrument PSR for approval.

Preparation Information:

The ISAR will identify safety features of the hardware, software, and system design as well as procedural, hardware, and software related hazards that may be present in the instrument. This includes specific procedural controls and precautions that should be followed. The ISAR will include the following information:

1. The safety criteria and methodology used to classify and rank hazards, including assumptions upon which the criteria or methodologies were based or derived
2. The results of hazard analyses and tests used to identify hazards in the system including:
   a. Those hazards that still have a residual risk and the actions that have been taken to reduce the associated risk to a level contractually specified as acceptable
   b. Results of tests conducted to validate safety criteria, requirements, and analyses
   c. Hazard reports documenting the results of the hazard analyses to include a list of all significant hazards along with specific safety recommendations or precautions required to ensure safety of personnel, property, or the environment. NOTE: Identify whether or not the risks may be expected under normal or abnormal operating conditions.
   d. Any hazardous materials generated by or used in the system
   e. The conclusion that all identified hazards have been eliminated or their associated risks controlled to levels contractually specified as acceptable and that the instrument is ready to test, operate, or proceed to the next phase
3. In order to aid the spacecraft developer in completing an orbital debris assessment of the instrument it is necessary to identify any stored energy sources in instruments (pressure vessel, Dewar, etc.) as well as any energy sources that can be passivated at end of life.

Tailoring note: Delete either this or the preceding DID per the tailoring of Paragraph 3.3.4

Title: Safety Data Package (SDP)	**DID No.: 3-4**
MAR Paragraph: 3.3.4	**CDRL No.:**

Use:

- The SDP provides a description of the payload design to support hazard analysis results, hazard analysis method, and other applicable safety related information. The developer shall include hazard analyses

identifying the prelaunch, launch and flight hazards associated with the flight system, ground support equipment, and their interfaces. The developer shall take measures to control or minimize hazards.

- In addition to identifying hazards, the SDP documents controls and verification methods for each hazard in Hazard Reports, which are included in a separate appendix. The analysis shall be updated as the hardware progresses through design, fabrication, and test. A list of hazardous/toxic materials with material safety data sheets and a description of the hazardous and safety critical operations associated with the payload shall be included in the final SDP.
- The safety assessment shall begin early in the program formulation process and continue throughout all phases of the mission lifecycle through safe separation from the launch vehicle. The spacecraft or instrument Project Manager shall demonstrate compliance with these requirements and shall certify to GSFC and the launch range, through the SDP, that all safety requirements have been met.

Reference Documents: ***Tailor per Section 3.2 Selection – Add document references***

- NASA-STD 8719.24 (with Annex), NASA Expendable Launch Vehicle Payload Safety Requirements

Place/Time/Purpose of Delivery:

- Deliver the SDP I to the Project Office forty-five (45) days prior to Mission PDR for review.
- Deliver the SDP II to the Project Office forty-five (45) days prior to Mission CDR for review.
- Deliver the SDP III to the Project Office one hundred twenty (120) days prior to shipment for approval.

NOTE: SDP I shall include necessary launch range safety requirements tailoring (see DID 3-2).

Preparation Information:

1. Introduction: State the purpose of the safety data package.
2. System Description: This Paragraph may be developed by referencing other program documentation such as technical manuals, System Program Plan, System Specification.
3. System Operations:
   a. A description of the procedures for operating, testing, and maintaining the system, including the safety features and controls.
   b. A description of special safety procedures needed to assure safe operations, test and maintenance, including emergency procedures.
   c. A description of anticipated operating environments and specific operator skills.
   d. A description of special facility requirements or personal equipment to support the system.
4. Systems Safety Engineering Assessment: This Paragraph shall include;
   a. A summary of the criteria and methodology for classifying and ranking hazardous conditions.
   b. A description of the analyses and tests performed to identify inherent hazardous conditions, including the software safety analysis
   c. A separate appendix documenting the Hazard Reports by subsystem or major component level with the Hazard Reports being listed in alphanumeric order based on the chosen Hazard Report numbering scheme.
      - A discussion of the actions taken to eliminate or control these items.
      - A discussion of the effects of these controls in terms of fault tolerance, design for minimum risk, and severity level of potential mishaps.
      - A discussion of the results of tests conducted to validate safety criteria requirements and analyses, including a reference to the specific test/analysis/inspection reports that provide this verification. These reports shall be made available to the Project office upon request.
5. Conclusions and Recommendations: This Paragraph shall include;
   a. A list of significant hazards and specific safety controls.
   b. For hazardous materials:
      - Material identification as to type, quantity, and hazards.
      - Safety precautions and procedures for use, storage, transportation, and disposal.
      - A copy of the Material Safety Data Sheet (OSHA Form 20 or DD Form 1813).
   c. Appropriate radiation forms/analysis.
   d. Reference material to include a list of all pertinent references such as Test Reports, Preliminary Operating Manuals and Maintenance Manuals
   e. Recommendations applicable to the safe interface of this system with the other system(s).

f. A statement signed by the developer's System Safety Manager and Program Manager certifying that all identified hazards have been eliminated or controlled and that the system is ready to test, operate, or proceed to the next acquisition phase

Title: Hazardous Procedures for Payload I&T and Pre-launch Processing	**DID No.: 3-5**
MAR Paragraph: 3.3.6	**CDRL No.:**

Use:

- Documents hazardous procedures and associated safeguards that the developer will use for integration and test activities and pre-launch activities that comply with the applicable safety requirements of the installation where the activities are performed.

Reference Documents:

- NASA-STD 8719.24 (with Annex), NASA Expendable Launch Vehicle Payload Safety Requirements
- KNPR 8715.3, KSC Safety Practices Procedural Requirements (as applicable)
- GSFC 500-PG-8715.1.2 AETD Safety Manual, for GSFC I&T operations (as applicable)

Place/Time/Purpose of Delivery:

- Deliver Payload I&T Hazardous Procedures to the Project Office seven (7) days before first use for review.
- Deliver Launch Range Hazardous Procedures to the Project Office sixty (60) days prior to first use for review.
- Deliver Launch Range Hazardous Procedures to Range Safety forty-five (45) days prior to first use for review.

Preparation Information:

1. The developer shall document the hazardous procedures and associated safeguards that will be used for integration and test activities and pre-launch activities. The safeguards will comply with the applicable safety requirements for the installation where the activities will be performed.

Title: Input to Orbital Debris Assessment Report (ODAR) and End of Mission Plan (EOMP)	**DID No.: 3-6**
MAR Paragraph: 3.3.8	**CDRL No.:**

Use:

- Ensure NASA requirements for post mission orbital debris control and end of mission planning are met.

Reference Documents:

- NASA-STD-8719.14 Process for Limiting Orbital Debris (Appendix A for ODAR, & Appendix B for EOMP)

Place/Time/Purpose of Delivery:

ODAR

- Deliver preliminary ODAR inputs to the Project Office fifteen (15) days prior to mission PDR for information.
- Deliver ODAR interim inputs to the Project Office sixty (60) days prior to mission CDR for information.
- Deliver the final/updated ODAR and EOMP inputs to the Project Office 90 days prior to PSR for information.

EOMP

- Deliver initial draft EOMP inputs to the Project Office sixty (60) days prior to mission CDR for information.
- Deliver inputs to Prelaunch EOMP to the Project Office ninety (90) days prior to PSR for information.

Preparation Information:

1. NASA-STD-8719.14 Process for Limiting Orbital Debris Appendix A (ODAR) and Appendix B (EOMP) provide details on what information is required for the Project Office to complete these analyses

   NOTE: Orbital Debris Assessment Software is available for download from Johnson Space Center at URL: http://sn-callisto.jsc.nasa.gov/mitigate/das/das.html

Title: Reliability Program Plan	**DID No.: 4-1**
MAR Paragraph: 4.1	**CDRL No.:**

Use:

- Planning and implementation of reliability activities.

Reference Documents:

- NPD 8720.1, NASA Reliability and Maintainability (R&M) Program Policy
- NASA-STD-8729.1, Planning, Developing and Managing an Effective Reliability and Maintainability (R&M) Program.
- NPR 8705.4 Risk Classification for NASA Payloads

Place/Time/Purpose of Delivery:

- Deliver draft plan to the Project Office thirty (30) days prior to the Systems Requirements Review for information.
- Deliver Final plan to the Project Office within thirty (30) days following the Systems Requirements Review for review.
- Deliver activity reports related to implementation of the plan at milestone reviews beginning with the Systems Requirements Review for information.

Preparation Information:

1. The Reliability Program Plan shall include:
   a. A discussion of how the developer intends to implement and comply with Reliability program requirements.
   b. Charts and statements describing organizational responsibilities and functions conducting each task to be performed as part of the Program.
   c. A summary (matrix or other brief form) that indicates for each requirement, the organization responsible for implementing and generating the necessary documents.
   d. Identify the approval, oversight, or review authority for each task.
   e. Narrative descriptions, time or milestone schedules, and supporting documents describing the execution and management plan for each task.
   f. Documentation, methods, procedures, and reporting specific to each task in the plan.

Title: FMEA and Critical Items List (CIL)	**DID No.: 4-2**
MAR Paragraph: 4.2	**CDRL No.:**

Use:

- Used to evaluate design against requirements, to identify single point failures and hazards, and to identify modes of failure within a system design for the early mitigation of potential catastrophic and critical failures.

Reference Documents

- NPR 8705.4 Risk Classification for NASA Payloads

Place/Time/Purpose of Delivery:

- Deliver preliminary FMEA and CIL to the Project Office thirty (30) days before PDR for review.
- Deliver updated FMEA and CIL to the Project Office thirty (30) days prior to CDR and each subsequent milestone review up to Launch Readiness Review for approval.

Preparation Information:

1. The developer shall:
   a. Analyze failure modes resulting in severity categories 1, 1R, 1S, 2, or 2R to determine the potential cause, corresponding mitigation actions, and retention rationale.
   b. For each item on the CIL that is not addressed by having a Corrective Action taken which reduces the severity category to a 3 or 4, there shall be a retention rationale prepared/recorded which contains

data that supports the premise that the risk presented by inclusion of the item in the design has been minimized by one or more of the following: detailed evaluation of probability of occurrence; proper design controls, inspections, and tests; and that no adverse failure history exists. The rationale also will contain data that describes operational constraints caused by occurrence of the failure and any measures that can be taken to restore the function on orbit.

c. Identify and assess common cause failure modes and causes for category 1R and 2R items
d. Address flight hardware and software that is designed, built, or provided by their organization or subcontractors, from project initiation through launch and mission operations.
e. Address the ground system that interfaces with flight equipment to the extent necessary to assure the integrity and safety of flight items.
f. Identify and address safety critical software, as defined in Section 5.

2. The FMEA Report shall include the following:
   a. A discussion of the approach of the analysis, methodologies, assumptions, results, conclusions, and recommendations.
   b. Objectives
   c. Level of the analysis
   d. Ground rules
   e. Functional description
   f. Functional block diagrams
   g. Reliability block diagrams
   h. Equipment analyzed
   i. Data sources used
   j. Problems identified
   k. Corrective actions
   l. Work sheets identifying failure modes, causes, severity category, and effects at the item, next higher level, and mission level, detection methods, and mitigating provisions.
   m. Critical Items List (CIL) for severity categories 1, 1R, 1S, and 2, including item identification, cross-reference to FMEA line items, and retention rationale. Appropriate retention rationale may include design features, historical performance, acceptance testing, manufacturing product assurance, corrective action recommendation/elimination of undesirable failure modes, proper design controls, and failure detection methods. The rationale also will contain data that describes operational constraints caused by occurrence of the failure and any measures that can be taken to restore the function on orbit where known.

Title: Fault Tree Analysis (FTA)	**DID No.: 4-3**
MAR Paragraph: 4.3	**CDRL No.:**

Use:

- Used to assess mission failure from the top-level perspective. Undesired top-level states are identified and combinations of lower-level events are considered to derive credible failure scenarios. The technique provides a methodical approach to identify events or environments that can adversely affect mission success and provides an informed basis for assessing system risks.

Reference Documents

- NASA Fault Tree Handbook with Aerospace Applications (http://www.hq.nasa.gov/office/codeq/doctree/fthb.pdf)
- NPR 8705.4 Risk Classification for NASA Payloads
- NPR 8715.3 NASA General Safety Program Requirements

Place/Time/Purpose of Delivery:

- Deliver preliminary qualitative mission FTA report to Project Office thirty (30) days prior to PDR for review.
- Deliver final qualitative mission FTA report to Project Office thirty (30) days prior to CDR for approval.

▪ Deliver qualitative mission FTA report to Project Office within thirty (30) days of updates/changes for approval.
Preparation Information: 1. The mission FTA Report shall contain: a. Analysis ground rules including definitions of undesirable end states b. References to documents and data used c. Fault tree diagrams d. Results and conclusions

Title: Parts Stress Analysis	**DID No.: 4-4**
MAR Paragraph: 4.4	**CDRL No.:**
Use: ▪ Provides EEE parts stress analyses for verifying circuit design conformance to derating requirements; demonstrates that environmental operational stresses on parts comply with project derating requirements.	
Reference Documents ▪ GSFC EEE-INST-002 Instruction for EEE Parts Selection, Screening, Qualification, and Derating	
Place/Time/Purpose of Delivery: ▪ Deliver Parts Stress Analysis Report to Project Office forty-five (45) days prior to CDR for review. ▪ Deliver revisions to Parts Stress Analysis Report to the Project Office within thirty (30) days of changes for review.	
Preparation Information: 1. The Parts Stress Analysis Report shall contain: 1. Analysis ground rules 2. Reference documents and data used 3. Results and conclusions including: - Design trade study results - Parts stress analysis results impacting design or risk decisions 4. Analysis worksheets; the worksheets at a minimum shall include: - Part identification (traceable to circuit diagrams) - Assumed environmental (consider all expected environments) - Rated stress - Applied stress (consider all significant operating parameter stresses at the extremes of anticipated environments) - Ratio of applied-to-rated stress	

Title: Worst Case Analysis	**DID No.: 4-5**
MAR Paragraph: 4.8	**CDRL No.:**
Use: ▪ Demonstrate design margins in electronic and electrical circuits, optics, and electromechanical and mechanical items.	
Reference Documents: ▪ NPD 8720.1, NASA Reliability and Maintainability (R&M) Program Policy. ▪ NASA-STD-8729.1, Planning, Developing and Managing an Effective R&M Program. ▪ NPR 8705.4, Risk Classification for NASA Payloads	
Place/Time/Purpose of Delivery: ▪ Deliver Worst Case Analysis Report to Project Office thirty (30) days prior to CDR for review.	

▪ Deliver revisions to Worst Case Analysis Report to Project Office within thirty (30) days for review.
Preparation Information: 1. The Worst Case Analysis Report shall include the following: a. Address worst case conditions performed on each component. b. Discuss how each analysis includes the mission life. c. Discuss consideration of critical parameters at maximum and minimum limits. d. The effect of environmental stresses on the operational parameters being evaluated.

Title: Limited-Life Items List	**DID No.: 4-6**
	CDRL No.:
MAR Paragraph: 4.6	
Use: ▪ Tracks the selection and application of limited-life items and the predicted impact on mission operations for safety critical functions only.	
Related Documents: ▪ None	
Place/Time/Purpose of Delivery: ▪ Deliver Limited-Life Items Analysis & List to the Project Office thirty (30) days prior to PDR for review. ▪ Deliver updates to the Project Office no later than thirty (30) days after changes are made for review.	
Preparation Information: 1. The developer shall prepare and maintain a list of critical life-limited items and their predicted impact on mission operations. a. The list shall include expected life, required life, duty cycles, and rationale for selecting and using the item. b. The list shall be develop via analysis of predicted/expected versus required life of all potential limited life items which may include such items as structures, thermal control surfaces, solar arrays, electromechanical mechanisms, batteries, compressors, seals, bearings, valves, tape recorders, momentum wheels, gyros, actuators and scan devices. c. The environmental or application factors that may affect the items include such things as atomic oxygen, solar radiation, shelf-life, extreme temperatures, thermal cycling, wear and fatigue.	

Title: Software Assurance Plan	**DID No.: 5-1**
MAR Paragraph: 5.2	**CDRL No.:**
Use: ▪ Documents the developers' Software Assurance roles and responsibilities and surveillance activities to be performed as outlined in the NASA Software Assurance Standard.	
Reference Documents: ▪ NASA-STD-8739.8, NASA Standard for Software Assurance ▪ NASA-STD-8719.13, NASA Software Safety Standard ▪ IEEE Standard 730-2002, Software Quality Assurance Plans ▪ NPR 7150.2 NASA Software Engineering Requirements	
Place/Time/Purpose of Delivery: ▪ Deliver preliminary plan to the Project Office thirty (30) days prior to SRR for information. ▪ Deliver final plan to the Project Office forty-five (15) days prior to PDR for review. ▪ Deliver updates to the Project Office thirty (30) days prior to implementation for review.	

Preparation Information:

1. The Software Assurance Plan (SAP) shall address the following:
   a. Purpose
   b. Scope
   c. Reference documents and definitions
   d. Assurance Organization and Management – including roles and responsibilities
   e. Assurance Activities by discipline
      - Software Quality (process and product)
      - Software Safety
      - Software Reliability
      - Software Verification and Validation
   f. Assurance Activities for Complex Programmable Logic Devices
   g. Reviews: Peer reviews and milestone reviews
   h. Assurance tools, techniques, and methodologies
   i. Software Assurance Program Metrics
   j. Problem Reporting and Corrective Action
   k. Assurance records, collection, maintenance, and retention
   l. Training
   m. Requirements Compliance Matrix (NASA-STD-8739.8 Appendix C)
   n. SAP Change procedure and history

Title: Printed Circuit Board (PCB) Coupon / Evaluation Reports	**DID No.: 6-1**
MAR Paragraph: 6.5	**CDRL No.:**

Use:

- PCB test coupons are evaluated to validate that PCBs are suitable for use in space flight and mission critical ground applications. The laboratory reports provide the information needed to decide to use or reject the PCBs.

Reference Documents:

- IPC-6011 Generic Performance Specifications for Printed Boards (Class 3 Requirements)
- GSFC Form 23-16 GSFC PCB Coupon Submittal Form

s. IPC-6012DS Qualification and Performance Specification for Rigid Printed Boards. For boards that include high-density interconnect (HDI) technologies with pin spacing of 1 mm or less, the employment of filleting or ‘‘tear drops’’ are preferred and Class 2 requirements are acceptable for the following parameters:
   i. Wrap plating (in accordance with 3.6.2.11.1 or 3.6.2.11.3 of IPC-6012D).
   ii. Protrusions (bumps) or depressions (dimples) in blind copper filled microvias (per 3.6.2.11.3 of IPC-6012D).
   iii. Material Fill (other than copper plating) (per 3.6.2.18 of IPC-6012D).

- IPC-6013 Qualification and Performance Specification for Flexible Printed Boards (Class 3 Requirements)
- IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards (Class 3 Requirements)
- MIL-PRF-50884, Performance Specification: Printed Wiring Board, Flexible Rigid-Flex, General Specification For
- MIL-PRF-55110, Performance Specification: Printed Wiring Board, Rigid, General Specification For
- IPC-2221 Generic Stand on Printed Board Design
- ECSS-Q-ST-70-10 Qualification of Printed Circuit Boards

Place/Time/Purpose of Delivery:

- The developer shall notify and deliver test coupons and supporting manufacturing information traceable to the flight boards (GSFC Form 23-16) to GSFC or a GSFC approved laboratory as soon as practicable for approval.
- If a GSFC-approved laboratory is used for coupon evaluation, the developer shall deliver the laboratory results to GSFC Project CSO upon receipt.

Note: Coupon specimens do not need to be submitted for single-sided PWBs or double-sided PWBs that don't contain any plated through holes or vias.

Note: If a GSFC-approved laboratory is used for coupon evaluation, the developer shall store remnants and coupon microsections.

Preparation Information:

1. Notify GSFC regarding shipment of PWB test coupons to either GSFC or GSFC-approved laboratory.
2. The developer shall provide:
   a. Coupon specimens with sufficient A, B, A/B coupons, or their equivalent per IPC-2221 for both unstressed and thermally stressed micro-sectioned coupon evaluation per section 3.6 of the applicable specification.
   b. If the represented PWB 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.
   c. M coupon or equivalent if a specialty plating is used (e.g., ENIG, ENIPIG).
   d. Supporting manufacturing documentation that is traceable to the flight boards and that includes: the specification to which the board was produced; board drawing or drawing notes; class of printed board; type of printed board; indication if there are blind, buried, or micro vias present; laminate information; part number; serial number and Vendor ID (CAGE Code for a US manufacturer).

Notes:

1. Custom coupons or a qualification board may be submitted instead of the coupons required above. 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.

Title: Use of Water Soluble Flux	**DID No.: 6-2**
MAR Paragraph: 6.6	**CDRL No.:**

Use:

- Documents the compliance of the developer's processes and procedures for the use of water soluble flux with GSFC requirements.

Reference Documents:

Place/Time/Purpose of Delivery:

- Deliver the applicable qualification or delta qualification documentation and test vehicles to the Project Office thirty (30) days prior to first use for approval

Preparation Information:

1. The supplier shall provide documentation and test vehicles per the requirements of GSFC-STD-8002 GSFC Standard Quality Assurance Requirements for the Use of Water Soluble Flux for the appropriate Mission Risk Class.

Title: EEE Parts Control Plan	**DID No.: 7-1**
MAR Paragraph: 7.1	**CDRL No.:**

Use:

- Development and implementation of an EEE parts control plan that addresses the system requirements for mission lifetime and reliability.

Reference Documents

- GSFC EEE-INST-002 Instructions for EEE Parts Selection, Screening, Qualification, and Derating

- S-311-M-70 Specification for Destructive Physical Analysis
- SAE AS5553 Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition

Place/Time/Purpose of Delivery:

- Submit the PCP to the project office thirty (30) days after contract award for approval

Preparation Information:

1. The PCP shall address the following:
   a. EEE Parts control per GSFC EEE-INST-002 Instructions for EEE Parts Selection, Screening, Qualification, and Derating
   b. Parts control program organization and management
   c. Shelf life control plan
   d. Parts application derating
   e. Supplier and manufacturer surveillance
   f. Procedures regarding application specific integrated circuits, gate arrays, system-on-chip, and custom integrated circuits
   g. Incoming inspection and test
   h. Sparing policies
   i. Destructive physical analysis per S-311-M-70 Specification for Destructive Physical Analysis
   j. Defective parts controls program.
   k. Handling, preservation, and packing
   l. Contamination control
   m. Alternate quality conformance inspection and small lot sampling
   n. Traceability and lot control
   o. Failure analysis
   p. Counterfeit parts control plan per AS5553 Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
   q. Radiation hardness assurance program, which shall address: total ionizing dose; displacement damage (total non-ionizing dose); destructive and non-destructive single-event effects; single-event effect rates; proton hardness/tolerance
   r. Parts Control Board Operations
      - Organization and membership
      - Meeting schedule and notices
      - Distribution of meeting agenda, notes, and minutes
      - Review and approval responsibilities and processes
      - Documentation and records

Title: Master EEE Parts List	**DID No.: 7-2**
MAR Paragraph: 7.5	**CDRL No.:**

Use:

- Tracking EEE parts from preliminary design through final flight hardware fabrication

Reference Documents:

Place/Time/Purpose of Delivery:

- Obtain Parts Control Board approval for each of the phases listed below
- Submit EEE parts additions/changes to the to the Parts Control Board for approval (prior to use)

Preparation Information:

1. The developer shall maintain the Master EEE Parts List in a searchable electronic format – with access granted to GSFC Project Parts Engineer.
2. The developer shall generate and maintain a Master Parts List with the minimum information listed below for the various stages throughout the projects lifecycle:
   Phase A/B: Initial Parts Identification List shall contain the following
   a. Flight component identity to the circuit board level

b. Complete part number (i.e. Defense Supply Center Columbus part number, Specification Control Drawing part number, with all suffixes)
c. Manufacturer's Generic Part number
d. Manufacturer (not distributor)
e. Part Description (please include meaningful detail)
f. Federal Supply Class
g. Procurement Specification
h. Comments and clarifications, as appropriate
i. Estimated quantity required (for procurement forecasting)

Phase B: Parts that are approved for flight use shall be updated to include the following information

a. Procurement Part Number
b. Flight Part Number (if different from the procurement part number)
c. Package Style/Designation
d. Single Event Latch-up (SEL) Hardness/Tolerance and Data Source
e. Single Event Upset (SEU) Hardness/Tolerance and Data Source
f. Total Ionizing Dose (TID) Hardness/Tolerance and Data Source
g. Displacement Damage Hardness/Tolerance (total non-ionizing dose) and Data Source
h. Proton Hardness/Tolerance and Data Source
i. PCB Status
j. PCB Approval Date
k. PCB Required Testing/Evaluations

Phase C: Once a design is approved for build the parts list shall be updated to reflect the as designed configuration

o Assembly Name/Number
a. Next Level of Assembly
b. Need Quantity
c. Reference Designator(s)
d. Item number (if applicable)

Phase C/D: Once flight hardware fabrication has completed the list shall be updated to reflect the as built configuration

a. Assembly serial number
b. Item revision
c. Next Level of Assembly serial number
d. Lot/Date/Batch/Heat/Manufacturing Code, as applicable
e. Manufacturer's Cage Code (specific plant location when relevant)
f. Distributor/supplier, if applicable
g. Part number
h. Part serial number (if applicable)

Title: Materials and Processes Selection, Control, & Implementation Plan	**DID No.: 8-1**
MAR Paragraph: 8.1	**CDRL No.:**

Use:

- Defines the implementation of NASA-STD-6016 with prescribed changes as described in the Preparation Information.

Reference Documents:

- NASA GSFC/JSC Materials and Processes Inter-center Agreement (Dated 1992) – ISS Payloads Only
- NASA-STD-6008 NASA Fastener Procurement, Receiving Inspection, and Storage Practices for Spaceflight Hardware
- NASA-STD-6016 Standard Materials and Processes Requirement for Spacecraft
- GEIA-STD-0005-1
- GEIA-STD-0005-2
- 541-PG-8072.1.2 Goddard Space Flight Center Fastener Integrity Requirements

Place/Time/Purpose of Delivery:
- Provide to the Project Office sixty (60) days after contract award for approval.

Preparation Information:
The plan shall address each paragraph in Section 4 of NASA-STD-6016, with the changes prescribed below, and describe the method of implementation and degree of conformance for each applicable requirement. If tailoring of the requirements is planned or necessary, alternate approaches to NASA-STD-6016 may be submitted in the plan, which meet or exceed the stated requirements. This tailoring approach will allow for the approval of alternate requirements.

The plan shall address the following:
1. Conformance to the requirements of NASA-STD-6016 with the changes prescribed below and a description of the method of implementation.
2. Organizational authority and responsibility for review and approval of Materials and Processes (M&P) specified prior to release of engineering documentation.
3. Identification and documentation of M&P.
4. Procedures and data documentation for proposed test programs to support materials screening and verification testing.
5. Materials Usage Agreement (MUA) procedures.
6. The process for submitting a MUA for a material or process that does not meet the requirements of NASA-STD-6016 or developer's standard and does not affect reliability or safety when used. MUAs that effect safety will require GSFC Project approval.
7. Determination of material design properties, including statistical approaches to be employed.
8. Identification of process specifications used to implement requirements in NASA-STD-6016.
9. In addition to the requirements of paragraph 4.2.2.11, the developer shall address the requirements of GEIA-STD-0005-1 and GEIA-STD-0005-2 for solders and surface finishes that are less than 3% lead by weight. The LFCP shall comply with the Level "2C" requirements set.
10. In paragraph 4.1.2, the developer may use GFSC forms or the developer's equivalent forms in lieu of the MAPTIS format.
11. The developer may use the GSFC outgassing database (URL http://outgassing.nasa.gov) in addition to MAPTIS (URL http://outgassing.nasa.gov).
12. Prescribed changes to NASA-STD-6016:
    a. Instead of NASA-STD-6008, the developer may use 541-PG-8072.1.2 or a demonstrated successful developer practice for procuring, receiving and storing fasteners used for spaceflight hardware with counterfeit protections.
    b. Paragraph 4.2.6.6 does not apply. Note: The contamination control plan shall be defined per DID 9-1.
    c. The developer shall meet the applicable launch site requirements documented in paragraph 3.2 of the Spacecraft MAR.
    d. In addition to the requirements of paragraph 4.2.3.6, the developer shall provide the vacuum bake out schedule for materials that fail outgassing requirements with the MIUL or provide an MUA.

Title: Materials Identification and Usage List (MIUL)	**DID No.: 8-2**
MAR Paragraph: 8.2	**CDRL No.:**

Use:
- Establishes the Materials Identification and Usage List (MIUL).

Reference Documents:
- NASA-STD-6016 Standard Materials and Processes Requirement for Spacecraft

Place/Time/Purpose of Delivery:
- Provide to the Project Office thirty (30) days prior to PDR for review
- Provide to the Project Office thirty (30) days prior to CDR approval
- Provide updates to the Project Office within thirty (30) days of identification for review

Preparation Information:

1. Soldering flux shall be included in the MIUL.
2. Solvents used for cleaning flight electronic assemblies, other than isopropyl alcohol or deionized water shall be included in the MIUL.
3. The MIUL documentation approach shall be defined in the Materials and Processes Selection, Control, and Implementation Plan (see DID 8-1).

Title: Contamination Control and Foreign Object Debris Prevention Control Plan and Data	**DID No.: 9-1**
MAR Paragraph: 9.1	**CDRL No.:**

Use:
- To establish contamination allowances, methods for controlling contamination, and record test results
- To provide guidance regarding the prevention and control of foreign object debris with respect to flight hardware

Reference Documents:
- GSFC-STD-7000 General Environmental Verification Standard (GEVS)
- GSFC-STD-1000 Rules for the Design, Development, Verification, and Operation of Flight Systems
- ASTM E595 Standard Test Methods for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
- ASTM E1548 Standard Practice for Preparation of Aerospace Contamination Control Plans
- Outgassing Data for Selecting Spacecraft Materials (URL: http://outgassing.nasa.gov/)
- NAS 412 Foreign Object Damage/Foreign Object Debris (FOD) Prevention
- NASA-STD-6016 Standard Materials and Processes Requirements for Spacecraft
- ISO 146441-1 Cleanrooms and Associated Controlled Environments – Classification of Air Cleanliness
- IEST-STD-CC1246E Product Cleanliness Levels and Contamination Control Program

Place/Time/Purpose of Delivery:
- Provide to the Project Office thirty (30) days before PDR for GSFC review.
- Provide to the Project Office thirty (30) days before the CDR for approval.
- Final thermal vacuum bakeout results provided to the Project Office within thirty (30) of completion for review.
- Provide preliminary cleaning procedures for all external surfaces thirty (30) days before PDR for review
- Provide updated cleaning procedures for all external surfaces thirty (30) days before CDR for review
- Provide contamination certificate of compliance with End Item Acceptance Data Package (DID 12-1).

Preparation Information:
1. The developer shall provide: material properties data; design features; test data; system tolerance of degraded performance; methods to prevent degradation. The items below shall be addressed in the plan:

a. Provide CCP in accordance with ASTM E1548 or standard Vendor CCP.
b. Defines beginning-of-life and end-of-life requirements for all flight parts and flight assemblies.
c. Defines methods and procedures to measure and maintain acceptable cleanliness levels during each phase of the program. This includes, but is not limited to protective covers, environmental constraints, purges, cleaning/monitoring procedures, etc.
d. Provide material properties data; design features; test data; system tolerance of degraded performance; and methods to prevent degradation.
e. Identifies facilities and environmental parameters (i.e. air quality, controls for atmospheric contaminants, temperature, and relative humidity) during fabrication, build, integration and test, storage, transportation, and launch.
f. Includes a contamination-monitoring plan for thermal vacuum and bake-out tests. This includes: vacuum test data, QCM and cold-finger location and temperature, pressure data, system temperature profile and shroud temperature, and bake-out requirement (if applicable).
g. Identifies design features of shipping containers. The design features should prevent the exceedance of contamination requirements for flight parts and flight assemblies during shipment and storage.
h. List efforts/controls to prevent electrostatic damage.
i. Indicates methods and frequency for monitoring and certifying cleanliness levels (and accretions) of flight hardware.
j. Provides a contamination-training program, to address facility operations and personnel handling of flight hardware.
k. Defines overall vent location and orientation policy, indicating how unintentional venting is avoided. (All applicable drawings should show vent locations that comply with venting analysis.)
l. Identifies cleaning procedures, inspection methods, and types of bagging material to be used for parts and flight assemblies.
m. Lists a schedule for cleaning and housekeeping activities, including a reference of procedures.
n. Defines criteria for materials selection and acceptance relative to contamination control. The criteria includes outgassing as a function of temperature and time, the nature of outgassing chemistry, and areas, weight, location, view factors of critical surfaces.
o. Provide a data package on test results for materials and as-built products.
p. Address the preservation of product with respect to foreign object debris prevention per the requirements of NAS 412 Foreign Object Damage/Foreign Object Debris (FOD) Prevention and ASTM-E1548-09.

Title: End Item Acceptance Data Package	**DID No.: 12-1**
MAR Paragraph: 12	**CDRL No.:**

Use:

- The End Item Acceptance Data Package documents the design, fabrication, assembly, test, and integration of the hardware and software being delivered and is included with the end item delivery.

Reference Documents:

Place/Time/Purpose of Delivery:

- Provide the End Item Acceptance Data Package to the Project seven (7) days prior to end item delivery for approval.
- Note: End Item Acceptance Data Package should be maintained throughout the projects life cycle and available during inspections, acceptance test, and upon request.

Preparation Information:

1. The developer prepares the End Item Acceptance Data Package as part of design development and implementation such that it is completed prior to delivery.
2. The following items shall be included:
   a. The deliverable item name, serial number, part number, and classification status (e.g., flight, non-flight, ground support, etc.).

b. Appropriate approval signatures (e.g., developers quality representative, product design lead, government Representative, etc.)
c. List of shortages or open items at the time of acceptance with supporting rationale.
d. As-built serialization
e. As-built vs. As-designed configuration (revisions)
f. In-process Work Orders (available for review at developers--not a deliverable)
g. Final assembly and test Work Order
h. Major MRB records
i. Major Anomaly/problem failure reports with root cause and corrective action dispositions
j. Acceptance testing procedures and report(s), including environmental testing
k. Trend data
l. Master EEE parts list (Final - PCB approved)
m. As-built materials identification and usage list
n. Chronological history, including:
    - Total operating hours and failure-free hours of operation
    - Total number of mechanical cycles and remaining cycle life
o. Limited life items, including data regarding the life used and remaining
p. As-built final assembly drawings and parts list
q. PWB coupon results
r. Photographic documentation of hardware (pre and post-conformal coating for printed wiring assemblies, box or unit, subsystem, system, harness, structure, etc.)
s. Waivers
t. Certificate of Compliance, including contamination certificates of compliance, which is signed by management

Appendix B: Abbreviations and Acronyms

ABPL	As-Built Parts List	NPR	NASA Procedural Requirement
ADPL	As-Designed Parts List	O&SHA	Operating and Support Hazard Analysis
AF	Air Force	ODAR	Orbital Debris Assessment Report
ANSI	American National Standards Institute	OHA	Operations Hazard Analysis
ASCII	American Standard Code for Information Interchange	OSHA	Occupational Safety and Health Administration
ASIC	Application Specific Integrated Circuit	PADS	Netlist from automated electronic design software tool
ASME	American Society of Mechanical Engineers	PAL	Programmable Array Logic
ASNT	American Society of Non-Destructive Testing	PAPL	Project Approved Parts List
CCB	Change Control Board	PCB	Parts Control Board
CDRL	Contact Data Requirements List	PDF	Portable Document Format
CIL	Critical Items List	PIL	Parts Identification List
COTS	Commercial Off The Shelf Software	PLA	Programmable Logic Array
DID	Data Item Deliverable	RPP	Reliability Program Plan
EEE	Electrical, Electronic, and Electro-mechanical	SCORE	Signature Control Request
ELV	Expendable Launch Vehicle	SDP	Safety Data Package
EOMP	End of Mission Plan	SRP	System Review Program
ESD	Electro-Static Discharge	SSPP	System Safety Program Plan
FAR	Federal Acquisition Requirements	STD	Standard
FMEA	Failure Modes and Effects Analysis	TBD	To Be Determined
FMECA	Failure Modes and Effects Criticality Analysis	TBR	To Be Revised
FPGA	Field Programmable Gate Array	TBS	To Be Scheduled
FTA	Fault Tree Analysis	TDMS	Technical Data Management System
GIDEP	Government-Industry Data Exchange Program	V&V	Verification & Validation
GOTS	Government Off The Shelf Software	VHDL	VSIC Hardware Description Language
GSFC	Goddard Space Flight Center	VTL	Verification Tracking Log
I&T	Integration & Test		
IPC	International trade association for electronic assemblies		
ISAR	Instrument Safety Assessment Report		
IV&V	Independent Verification & Validation		
KSC	Kennedy Space Center		
MAR	Mission Assurance Requirements		
MGC	Netlist from automated electronic design software tool		
MIUL	Material Identification and Usage List		
MOTS	Modified Off The Shelf Software		
MRB	Material Review Board		
MUA	Material Usage Agreement		
NASA	National Aeronautics and Space Administration		
NCCCO	National Commission for Certification of Crane Operators		
NDE	Non-Destructive Evaluation		

Appendix C: Document List

Document Number	Title
	NASA Fault Tree Handbook with Aerospace Applications (http://www.hq.nasa.gov/office/codeq/doctree/fthb.pdf)
	NASA GSFC/JSC Materials and Processes Inter-center Agreement (Dated 1992) – ISS Payloads Only
ANSI/ESD S20.20	Protection of Electrical and Electronic Parts, Assemblies and Equipment [Excluding Electrically Initiated Explosive Devices]
ANSI/NCSL Z540.1-1994 (R2002)	Calibration Laboratories & Measuring & Test Equipment - General Requirements
ANSI/NCSL Z540.3-2006	Requirements for the Calibration of Measuring and Test Equipment
ASTM E595	Standard Test Methods for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
ASTM E1548	Standard Practice for Preparation of Aerospace Contamination Control Plans
CNES/P N°2010-1	December 2010 Operation of the Guiana Space Centre Facilities
CSG-NT-SBU-16687	CNES Payload Safety Handbook
ECSS-E-10	Space Engineering – System Engineering
ECSS-Q-40	Space Product Assurance: Safety
ECSS-Q-40-02	Space Product Assurance – Hazard Analysis
ECSS-Q-ST-70-10	Qualification of Printed Circuit Boards
Federal Acquisition Regulations	Parts 46.103, 46.104, 46.202-2, 46.4, 46.5, and 52.246
GEIA-STD-0005-1	Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-Free Solder
GEIA-STD-0005-2	Standard for Mitigating the effects of Tin Whiskers in Aerospace and High Performance Electronic Systems
GSFC 500-PG-8715.1.2	AETD Safety Manual, I&T Operations (for Operations at GSFC)
GSFC EEE-INST-002	Instruction for EEE Parts Selection, Screening, Qualification, and De-rating
GSFC FORM 23-16	GSFC PCB Coupon Submittal Form
GSFC-STD-1000	Rules for the Design, Development, Verification, and Operation of Flight Systems
GSFC-STD-6001	Ceramic Column Grid Array Design and Manufacturing Rules for Flight Hardware
GSFC-STD-7000	General Environmental Verification Standard
GSFC-STD-8002	GSFC Standard Quality Assurance Requirements for Use of Water Soluble Flux
IEEE Standard 730-2002	Software Quality Assurance Plans
IEST-STD-CC1246E	Product Cleanliness Levels and Contamination Control Program
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-6011	Generic Performance Specification for Printed Boards
IPC-6012DS	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-6018	Microwave End Product Board Inspection and Test
IPC-J-STD-001-S	Joint Industry Standard, Space Applications Electronic Hardware Addendum
ISO 146441-1	Cleanrooms and Associated Controlled Environments – Classification of Air Cleanliness

Document Number	Title
ISO 17025-2002	General requirements for the competence of testing and calibration laboratories
ISO 9001	Quality Management System
JERG-1-007	Safety Regulations for Launch Site Operations/Flight Control Operations
JMR-002	Launch Vehicle Payload Safety Standard
KDP-99105	Safety Guide for H-II/H-IIA Payload Launch Campaign
KNPR 8715.3	KSC Safety Practices Procedural Requirements (applicable at KSC property, KSC-controlled property, and offsite facility areas where KSC has operational responsibility)
KNPR 8715.3	KSC Safety Practices Procedural Requirements
MIL-PRF-50884	Performance Specification: Printed Wiring Board, Flexible or Rigid-Flex, General
MIL-PRF-55110	Performance Specification: Printed Wiring Board, Rigid, General Specification For
NAS 412	Foreign Object Damage/Foreign Object Debris (FOD) Prevention
NASA-STD-6008	NASA Fastener Procurement, Receiving Inspection, and Storage Practices for Spaceflight Hardware
NASA-STD-6016	Standard Materials and Processes Requirement for Spacecraft
NASA-STD-8715.7	Expendable Launch Vehicle Payload Safety Program
NASA-STD-8719.8	Expendable Launch Vehicle Payload Safety Review Process
NASA-STD-8719.9	Standard for Lifting Devices and Equipment
NASA-STD 8719.14	Process for Limiting Orbital Debris
NASA-STD 8719.24	(with Annex) NASA Expendable Launch Vehicle Payload Safety Requirements
NASA-STD-8719.13	NASA Software Safety Standard
NASA-STD-8729.1	Planning, Developing, and Managing and Effective R&M Program
NASA-STD-8739.1	Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic 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
NASA-STD-8739.8	NASA Standard for Software Assurance
NPD 8720.1	NASA Reliability and Maintainability (R&M) Program Policy
NPR 7120.2	NASA Software Engineering Requirements
NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NPR 7150.2	NASA Software Engineering Requirements
NPR 8705.4	Risk Classification for NASA Payloads
NPR 8715.3	NASA General Safety Program Requirements
NPR 8715.7	Expendable Launch Vehicle Payload Safety Program
NPR 8621.1	NASA Procedural Requirements for Mishap and Close Call Reporting
NSTS/ISS 18798	Interpretations of NSTS/ISS Payload Safety Requirements
P32928	Requirements for International Partner Cargoes Transported on Russian Progress and Soyuz Vehicles
RSM-2002	Range Safety Manual for GSFC/WFF
S-311-M-70	Specification for Destructive Physical Analysis
S0300-BT-PRO-010	GIDEP Operations Manual
S0300-BU-GYD-010	GIDEP Requirements Guide
SAE AS5553	Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
SAE AS9100	Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing
SSP-30599	ISS Safety Review Process
SSP-50835	ISS Pressurized Volume Hardware Common Interface Requirements Document (Dragon)
SSP 51700	Payload Safety Policy and Requirements for the ISS
SSP 57012	ISS FRAM Based Payload Common Launch Interface Requirements Document