SPECIFICATION
SUPPLIER MISSION ASSURANCE REQUIREMENTS FOR CLASS C/D PROGRAMS

SEAKR

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Author:	M. Strus	Contract Number:	
Approver:	K. Breitenstein	SEAKR	

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TABLE OF CONTENTS

1 INTRODUCTION

This document establishes Supplier Mission Assurance (MA) requirements for Class C/D programs for general or program use at SEAKR Engineering, LLC.

1.1 OBJECTIVE

The program's MA objective is to balance application of assurance disciplines and risk in a manner to assure safe and reliable product design, build, integration, test, and on-orbit operation consistent with contract requirements. Timely and effective implementation of these activities adds significant value towards achieving mission success.

1.2 SCOPE

This document applies to space flight and ground support equipment (GSE) and software developed and operated for the program. These MA requirements establish the methods and controls required to rapidly develop a payload for a Class C mission as defined by NASA NPR 8705.4, Risk Classification for National Aeronautics and Space Administration (NASA) Payloads. Additional inputs are garnered from TOR-2011(8591)-21 Mission Assurance Guidelines for A-D Mission Risk Classes, which defines a Class C Mission Profile to have a (a) moderate risk acceptance, (b) moderate to low complexity and cost, and (c) fairly short mission life less than 5 years.

2 APPLICABLE DOCUMENTS

2.1 MILITARY/INDUSTRY SPECIFICATION AND STANDARDS

The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the applicable issues of these documents shall be those in effect on the date of the procurement. All other requirements shall default to Industry Standards.

541-PC-8072.1.2	Goddard Space Flight Center Fastener Integrity Requirements
AFSPCMAN 91-710	Range Safety User Requirements Manual
ANSI/ESD S20.20-2014	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment
ANSI/NCSL Z540-1	General Requirements for the Competence of Testing and Calibration Laboratories
AS5553	Counterfeit Electronic Parts: Avoidance, Detection, Mitigation, and Disposition
AS6462	Fraudulent/Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition Verification Criteria
ASM2700	Passivation of Corrosion Resistant Steels
ASTM A967	Chemical Passivation Treatments for Stainless Steel Parts
ASTM E595	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.
DOD-HDBK-343	General Guidelines for Electronic Equipment
EEE-INST-002	Instructions for EEE Parts Selection, Screening, Qualification, and Derating
GEIA-STD-0005-2	Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems
GEIA-STD-0006	Requirements for Using Solder Dip to Replace the Finish on Electronic Piece Parts
IPC/WHMA-A-620 -S	Requirements and Acceptance for Cable and Wire Harness Assemblies, Space Addendum
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards (Class 3/A requirements)
IPC-6013	Qualification and Performance Specification for Flexible Printed Boards (Class 3 requirements)
IPC-A-610	Acceptability of Electronics Assemblies
IPC-J-STD-001	Joint Industry Standard, Space Applications Electronic Hardware Addendum to J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies (Class 3 Requirements)
IPC-J-STD-004	Requirements for Soldering Fluxes,
IPC-J-STD-005	Requirements for Soldering Pastes,

IPC-J-STD-006	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications,
IPC-TM-650	Test Methods Manual
ISO/IEC 17025	General Requirements for the Competence of Testing and Calibration Laboratories
MIL-HDBK-454	Military Handbook: General Guidelines for Electronic Equipment
MIL-PRF-31032	General Specification for Printed Circuit Board/Printed Wiring Board
MIL-PRF-55110	General Specification for Rigid Printed Wiring Board or
MIL-STD-1580	Test Method Standard: Destructive Physical Analysis (DPA) for Electronic Electromagnetic, and Electromechanical
MIL-STD-202	Test Method Standard Electronic and Electrical Component Parts
MIL-STD-883J	Test Method Standard Microcircuits
MIL-STD-975	Electrical, Electronic and Electromechanical Parts List
MSFC-HDBK-527	Materials Selection List for Space Hardware Systems
MSFC-STD-3029	Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments
NASA NPR 8705.4	Risk Classification for NASA Payloads
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
PEM-INST-001	Instructions for Plastic Encapsulated Microcircuit (PEM) Selection Screening, and Qualification
TOR-2011(8591)-21	Mission Assurance Guidelines for A-D Mission Risk Classes
TOR-2013-00297	Electrical Design Worse Case Circuit Analysis – Guidelines and Draft Standard

2.2 ORDER OF PRECENDENCE

The following order of precedence shall apply in the event of a conflict between the procurement document(s), the text of this document and the references cited herein.

1. Purchase Order (PO)
2. Assembly Drawing or Source Control Drawing (SCD)
3. Test Procedure
4. This specification
5. Other applicable documents referenced herein

2.3 ABBREVIATIONS

Acronyms are defined at first point of use within this document and defined below.

AEC	Automotive Electronics Council
BHR	Build History Record
CAGE	Commercial and Government Entity
CCA	Circuit Card Assembly
CDR	Critical Design Review
CofC	Certificate of Conformance
CM	Configuration Management
CORR	Corrosion Rating
CRES	Corrosion Resistant Steel
CVCM	Collected Volatile Condensable Material
DDD	Displacement Damage Dose
DPA	Destructive Physical Analysis
EEE	Electrical, Electronic, Electromagnetic
EIDP	End Item Data Package
ELDRS	Enhanced Low Dose Radiation Sensitivity
EMI/EMC	Electromagnetic Interference/Electromagnetic Compatibility
ESD	Electro-Static Discharge
FMECA	Failure Modes, Effects, and Criticality Analysis
FOD	Foreign Object Debris
GIDEP	Government-Industry Data Exchange Program
GSE	Ground Support Equipment
Hi-Rel	Higher Reliability
IAW	In Accordance With

LDC	Lot Date Code
MA	Mission Assurance
MAP	Mission Assurance Plan
MAPTIS	Materials and Process Technical Information System
MIP	Mandatory Inspection Point
MLCC	Multi-layer Chip Capacitor
MODE	Mission Operations Design & Environments
MRB	Material Review Board
MSL	Moisture Sensitivity Level
NASA	National Aeronautics and Space Administration
NSMAR	Non-Standard Material Approval Request
NSPAR	Non-Standard Part Approval Request
OEM	Original Equipment Manufacturer
PCN	Product Change Notice
PDR	Preliminary Design Review
PFR	Problem Failure Report
PMP	Parts, Material, and Process
PMPCB	Parts, Materials and Processes Control Board
PO	Purchase Order
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management System
RVCM	Requirement Verification Compliance Matrix
SCAR	Supplier Corrective Action Request
SCC	Stress Corrosion Cracking
SCD	SEAKR Control Drawing
SEE	Single Event Effects
SOW	Statement of Work
SW/FW/GW	Software/Firmware/Gateware
TID	Total Ionizing Dose
TML	Total Mass Loss
UAI	Use-As-Is

3 MISSION ASSURANCE REQUIREMENTS

Supplier's MA program shall adhere to the guidelines for Class C, as delineated herein, to achieve the intended mission duration and reliability objectives defined in the product specification.

3.1 READINESS REVIEWS

Supplier shall conduct readiness reviews in accordance with Statement of Work (SOW) requirements.

Supplier shall assure that readiness review action items are tracked to closure.

3.1.1 Authorization to Proceed Review

At each readiness review, Supplier will

- assess mission assurance planning maturity,
- confirm that planning is sufficient to execute the program with acceptable risk, and
- verify that Supplier's MA/Quality team is ready to execute.

3.2 RISK MANAGEMENT

Supplier shall implement a risk and opportunity management plan to meet contractual requirements as defined in the SOW, verifiable by audit or request.

3.3 QUALITY ASSURANCE SYSTEM

Supplier shall maintain a Quality Management System (QMS) in compliance with the most current version of AS9100 or IS09001. A QMS certification issued by a 3rd Party Registrar is preferred and shall be made available to SEAKR upon request.

3.4 QUALITY ASSURANCE APPROACH

Supplier shall plan and execute a quality assurance program that is compliant with AS9100 that provides adequate inspection, testing, and verification of products and services in full compliance with the purchase order requirements and all applicable specifications/standards.

Supplier should develop an internal Mission Assurance Plan (MAP) that will ensure the mission assurance requirements are defined and satisfied throughout all phases of project performance and are continuously maintained in the fabricated articles. This MAP will provide oversight for the early detection of actual or potential deficiencies, system incompatibility, marginal quality, and trends or conditions that could result in unsatisfactory performance.

Supplier shall appoint a quality lead to manage, enforce, and carry out the quality assurance requirements and tasks for the program. The program quality lead is expected to participate in quality status reporting, meetings, metric collection, and other collaborative activities with SEAKR when warranted.

3.4.1 Sub-tier Suppliers Management Quality Requirements

Supplier shall maintain a Quality Management System (QMS) in compliance with the most current version of AS9100 or IS09001. A QMS certification issued by a 3rd Party Registrar is preferred and shall be made available to SEAKR upon request.

Supplier is responsible for adequate and effective control over all sub-tier Suppliers and Suppliers. The requirements of this specification, PO, SOW and any other applicable requirements shall be imposed on sub-tier Suppliers where applicable to ensure the quality and reliability of their products.

3.5 SUPPLIER SURVEILLANCE

Supplier surveillance may be performed when warranted by product complexity, high risk assessment, quality and delivery history, and other factors.

3.5.1 Supplier Assessment

SEAKR reserves the right to perform Supplier assessments to

(a) audit Supplier's QMS,

(b) determine the capability and competency of Supplier to meet the requirements of the purchase order,

(c) verify that corrective action measures have been implemented after a nonconformance, and/or

(d) conduct performance surveillance to meet the requirements of the purchase order.

3.5.2 Supplier Mandatory Inspection Points (MIPs)

SEAKR or its 3rd party representative reserve to right to perform MIPs on flight products as indicated by the SOW. Supplier shall incorporate appropriate hold points in assembly flow and provide SEAKR with appropriate notification as defined by the PO/SOW.

Typical MIPs are listed below:

a. Pre-close out of electronics boxes or features that cannot be inspected in the final assembled state
b. Post solder
c. Pre and post conformal coat
d. Pre-testing
e. Final inspection

3.5.3 Source Inspection

SEAKR or its 3rd party representative reserves the right to conduct source inspection before product test and delivery of production hardware, including all production/process documentation in accordance with the PO. SEAKR reserves the right to evaluate the test setup and observe the product tests and test documentation for all hardware deliverables.

3.6 CONFIGURATION MANAGEMENT

Supplier shall establish and maintain a configuration management method for controlling the configuration of all designed hardware, software, specifications, test procedures, and documentation, which includes a change classification and impact assessment process.

Supplier shall identify when an item is formally released and placed under change control.

Supplier shall ensure effective levels of peer review, release and revision control, and technical and product baseline control are implemented on program and technical work products.
All changes shall be incorporated into each deliverable component prior to delivery and demonstrated via inspection records included in the End Item Data Package (EIDP) as defined in Section 10.

4 FAILURE REPORTING, ANALYSIS, AND CORRECTIVE ACTION SYSTEM

Supplier shall have a formal closed-loop incident/failure reporting system for deliverable hardware, software, and ground support equipment.

4.1.1 Failure/Mishap Notification

Any failures or other incidents that have the potential for adversely impacting the performance of the subcontract shall be reported to SEAKR within 48 hours. Examples of such items include:

- Serious accidents or incidents resulting in damage to the deliverable hardware
- Any issues or problems occurring after the start of Run for Record qualification, proto-qualification or acceptance testing
- Safety accident/incident reports to hardware or personnel
- Strikes or transportation tie-ups that could delay the program
- Natural disasters affecting program performance
- Lower-tier Supplier events that could delay the program (including any of the above)
- Any other event largely affecting production/manpower (pandemic, supply chain, etc.)

Supplier shall notify SEAKR of the matter by telephone or email and follow with a written report. SEAKR reserves the authority to authorize Supplier to proceed after Failure/Mishap.

4.1.2 Failure Documentation

Supplier shall document such an event on a Problem Failure Report (PFR) in Supplier's format. The completed PFR shall be submitted to SEAKR for review and, at a minimum, shall describe:

a) Failure type, nature of problem, and configured item identification
b) Assessment of configured item's performance, lifetime, or ability to meet program requirements and any associated risks
c) Test conditions, test equipment, and environmental conditions at the time of failure
d) Symptoms and root cause(s), including potential impact on other hardware/software

e) Analysis and verification approach and results
f) Any rework or retest performed, including any repeat (penalty) testing to reverify requirements
g) Final disposition and corrective and preventive action recommendation

This reporting includes support, as requested by SEAKR, on failures, returns, or troubleshooting expertise on delivered products/services that are part of Supplier's responsibility including any of their interfaces.

4.1.3 Parts Failure Analysis

Part failures occurring after the start of Run for Record qualification, proto-qualification or acceptance testing shall be reported to SEAKR's Parts, Materials and Processes Control Board (PMPCB). Supplier will be required to complete a failure analysis to determine the root cause, flight lot impact determination, reach back, and reach across.

4.2 NONCONFORMING MATERIAL

Supplier shall have established procedures for the identification, isolation, disposition, and tracking of nonconforming parts or materials in accordance with AS9100 or ISO9001 requirements. Any part or material found to be discrepant shall not be used in the fabrication and assembly of hardware without prior written approval from SEAKR.

4.2.1 Deviations/Waivers and Nonconformances

Engineering changes, deviation and waivers shall be implemented per Supplier's standard practices.

Deviations/waivers are defined as a notification from Supplier to SEAKR for a condition that is noted prior to the start of product assembly or manufacturing and may or may not require a Material Review Board (MRB). Supplier shall submit a deviation/waiver for all changes which affect the form, fit, function, or safety of the end item to SEAKR for approval. Deviations and waivers to the PO, engineering drawings, BOM, test procedures, or this specification require prior written approval from SEAKR Engineering. Written approval for any deviation or waiver shall be listed on the PO prior to delivering product and shall be documented and supplied as part of the End Item Data Package (EIDP). Engineering changes that don't affect the form, fit, function or safety of the end item shall be documented in Supplier's Configuration Management system.

A Nonconformance is defined as a defect that occurs after the start of product assembly or manufacturing that will result in an disposition of Repair or Use-As-Is (UAI).

Deviations and waivers to the PO, engineering drawings, BOM, test procedures, or this specification require prior written approval from SEAKR Engineering. Written approval for any deviation or waiver shall be listed on the PO prior to delivering product and shall be documented and supplied as part of the EIDP as defined in Section 10.

4.2.2 Disposition of Nonconforming Material

Any deviations from drawings, specifications, or SEAKR requirements that cannot be returned to engineering requirements per rework must be submitted to SEAKR for consideration.

All Repair and UAI dispositions concerning nonconforming material shall be provided to the SEAKR Material Review Board (MRB). The disposition, including any alternative direction, must be approved in writing by SEAKR prior to shipment. Standard repairs are allowable once submitted and approved by SEAKR.

The following is SEAKR's definition of relevant dispositions.

a) Rework: A disposition process that eliminates the defect and returns a product to full conformance. Supplier is given authority to execute reworks without SEAKR approval.
b) Repair: A disposition process that reduces the defect but does not return the product to full conformance. This disposition requires SEAKR MRB approval before proceeding.
c) UAI: A disposition process that allows for the use of the nonconforming product in its existing condition for its intended purpose with no additional processing to eliminate or reduce the specific nonconformance. This disposition requires SEAKR MRB approval before proceeding.
d) Scrap: Supplier may scrap hardware if there is no impact to SEAKR's schedule or costs. Where there is impact, SEAKR written approval to scrap hardware is required.

4.2.3 Formal Root Cause and Corrective Action

SEAKR reserves the right to issue a Supplier Corrective Action Request (SCAR) to Supplier when a nonconforming deliverable has been identified or when root cause and corrective action must be taken to prevent the future occurrence of nonconforming deliverable hardware. Timelines stated with the SCAR for closure shall be followed.

4.3 ELECTROSTATIC DISCHARGE (ESD) AND MOISTURE SENSITIVITY CONTROL

Supplier shall implement and maintain electrostatic discharge control procedures that conform to ANSI/ESD S20.20 Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment or equivalent.

Electrical and electronic parts storage shall comply with the moisture sensitivity level (MSL) associated with each part. All goods will be placed in conductive or static-dissipative packages, tubes, carriers, conductive bags, etc., for storage and/or shipment. The packaging must be clearly labeled to indicate that it contains ESD materials and where applicable, the proper MSL.

4.4 MATERIAL AND PRODUCT HANDLING AND STORAGE

Handling and storage procedures shall be instituted to prevent part, material, and product degradation, and to enable easy identification and control of parts or materials. These procedures

shall be retained through inspection, kitting, and assembly. The following criteria shall be met as a minimum for establishing handling and storage procedures for parts, materials, and products:

a) Control of environment (temperature, humidity, contamination, and pressure)
b) Measures and facilities to segregate/protect parts and materials routed to different locations
c) Provisions for protective cushioning (as required) on storage area shelves, and in storage and transportation containers
d) Protective features of transportation equipment designed to prevent packages from being dropped or dislodged in transit
e) Protective bench surfaces on which parts and materials are handled during operations such as test assembly, inspection, and organizing kits.
f) Required use of gloves, finger cots, tweezers, or other means when handling parts to protect the parts from contact by bare hands
g) Provisions for protection of parts susceptible to damage by ESD

4.5 CLEANLINESS AND CONTAMINATION CONTROL

Contamination controls must be established to eliminate possible particular matter that could be detrimental to a part or component. Operational areas, work items, tools, parts, and assemblies must remain clean and clear of Foreign Object Debris (FOD). Supplier shall implement a cleanliness control plan which includes requirements for cleanliness inspections, defines visually clean levels, and establishes cleaning operations prior to key manufacturing steps. This control plan shall be available for review to SEAKR upon request.

4.6 PRESERVATION, PACKAGING, PACKING AND SHIPPING

Supplier shall ensure deliverable hardware is packaged to protect the parts from damage and contamination during shipment. Polyethylene packaging with anti-static film coatings, such as ‘pink poly’, are prohibited from directly contacting deliverable hardware. Supplier shall provide shipping containers and notify SEAKR if containers are to be returned.

Packaging shall comply with the ESD controls per **Section 4.3**. Supplier shall label external packaging in accordance with best practices and where applicable contract requirements and indicate when the item is temperature sensitive, moisture sensitive, ESD sensitive, shock sensitive, or hazardous.

Supplier shall ensure that deliverable hardware is properly labeled with SEAKR part number and Serial Number (where applicable).

4.7 SOFTWARE ASSURANCE

Deliverable software/firmware/gateware (SW/FW/GW) including products contained in deliverable hardware and used to test deliverable hardware shall be controlled for traceability.

4.7.1 Development

Supplier shall have a documented Development Process for SW/FW/GW including peer reviews at key points early in the development cycle. SEAKR may perform evaluations of this process during the software development life cycle.

SW/FW/GW development shall be documented and controlled as necessary to provide evidence the software is adequately designed and requirements are met. Each delivered release shall include:

- Documentation identifying all source code, libraries, tooling, and any other dependencies
- An associated User's Guide which provides the functions, operations, states and modes of the deliverable. Commands, Telemetry, and installation procedures shall be fully described.
- SW/FW/GW shall be identified by a release number and unique version number.
- Source code for all released versions of software shall be archived and retained for the duration of the program.
- Prior to integration with Run for Record deliverable hardware, software shall be released and placed under configuration control

4.7.2 Software Problem/Failure Reporting and Analysis

Suppliers shall have a formal closed-loop problem/failure reporting system for SW/FW/GW problems and failures.

Problem/failure reporting may be informal up to the time of integration with Run for Record flight hardware. After flight SW/FW/GW integration with start of Run for Record hardware integration, problem/failure reporting shall be similar to that described in **Section 4**.

5 PARTS AND MATERIALS

Parts, Material, and Process (PMP) controls shall be established by the Supplier for delivered hardware throughout contract performance.

5.1 ROLES AND RESPONSIBILITIES

5.1.1 Parts, Materials, and Processes Control Board (PMPCB)

Supplier will establish a PMPCB with SEAKR. The PMPCB will provide internal management oversight on the use of PMP items in deliverable hardware. PMP that do not comply with the requirements herein shall be considered non-standard, and non-standard PMP shall be submitted to the PMPCB for review and approval. At a minimum, the PMPCB will consist of Supplier's PMPCB Chairperson or delegate, Quality Engineer, the Component and/or Materials Engineer, and an assigned representative(s) from SEAKR. Other subject matter experts from Mechanical or Design Engineering may be assigned to the PMPCB as needed to support select content reviews and approvals.

5.1.1.1 Nonstandard Approvals

When required, Supplier shall submit a Non-Standard Part Approval Request (NSPAR) or Non-Standard Material Approval Request (NSMAR) to PMPCB for review and approval. Supplier's format may be used for these waiver approvals. NSPARs and NSMARs are required for all non-standard PMP.

5.1.1.2 PMPCB Authority

The PMPCB ensures that all PMP approved are generally suitable for use in hardware required to meet the reliability performance requirements. The PMPCB will have the authority to approve technical changes to the baseline detailed in this plan.

5.2 PARTS, MATERIALS AND PROCESSES REPORTING

5.2.1 Selection Requirements

Supplier is responsible for the selection of PMP used in their design application, and PMP should be selected on the basis of demonstrated performance in the design application, reliability, radiation tolerance, producibility and handling, delivery schedule, and cost. Additional factors such as technology insertion, part obsolescence, and lifecycle cost should also be considered.

5.2.2 As-Designed Configured Article List

Supplier will prepare, maintain, and deliver an As-Designed Parts, Materials, and Processes List. The As-Designed PMP List will identify all EEE components, mechanical piece parts / hardware, polymeric materials, and standard manufacturing processes that are intended to be used by Supplier and its vendors, and will be submitted for PMPCB review and approval at Preliminary Design Review (PDR) and Critical Design Review (CDR). The PMP List shall be delivered at PDR and CDR, and will include the following information at a minimum:

- End-Item Part Number
- Supplier and/or Industry designations

- Contractor Specifications and Revisions
- Manufacturer/Supplier
- Key Performance Parameters or Ratings such as Total Ionizing Dose (TID), Displacement Damage Dose (DDD), Enhanced Low Dose Radiation Sensitivity (ELDRS), Single Event Effects (SEE) tolerance, temperature limits, limited-life, and others as required
- Key Material Ratings or Properties such as Stress Corrosion Cracking (SCC), Corrosion (CORR), Total Mass Loss (TML), and Collected Volatile Condensable Material (CVCM))
- Associated Waiver ID/PMPCB Approval Record for Non-Standard Items

Supplier's internal process and format for As-Designed PMP List may be utilized. Supplier's quality organization will inspect the list at each update and verify conformance to this document.

5.2.3 As Built Configured Article List

Supplier will maintain an As-Built Parts, Materials, and Processes List for each delivered, box-level flight unit. The As-Built PMP List will identify all EEE components, mechanical piece parts / hardware, polymeric materials, and manufacturing processes used on each box-level unit throughout the production program. This list shall be provided in a preliminary form to SEAKR at the conclusion of integration. After test and modification (if any) the PMP List will be finalized and delivered to the SEAKR.

5.3 ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PARTS

EEE Parts shall be selected based on their suitability for the application addressing performance, reliability, schedule and cost objectives. In particular, part availability that is necessary to meet the program's rapid deployment objectives will be strongly assessed when selecting components. Where possible, parts shall be selected in accordance with NASA EEE-INST-002, Level 3 or as an equivalent, or higher grade. These parts are generally covered by Military standards or specifications (Qualified Manufacturers List [QML] – Qualified Parts Lists [QPL]), Defense Logistics Agency (DLA) drawings, NASA standards, or manufacturer's Hi-Rel/Space equivalent specifications.

In addition, parts that have traditionally been considered "non-standard" for space applications may be selected, consistent with meeting Class C type mission objectives. This may include automotive grade parts, radiation tolerant parts that have been targeted by the manufacturers for "commercial space" applications, or purely commercial parts that have been vetted by PMPCB. In the case of commercial part usage, preference is given to manufacturers that produce similar parts that are qualified to Mil or Hi-Rel standards.

5.3.1 Standard EEE Parts

EEE parts shall be considered standard if they meet the following requirements:

- Parts compliant to the requirements of EEE-INST-002 Instructions for EEE Parts Selection, Screening, Qualification, and Derating, Level 3 or equivalent. Higher grade parts are acceptable.

- Automotive grade parts that are qualified to Automotive Electronics Council (AEC) standards
- Radiation Tolerant "commercial space" grade devices that are screened and qualified to manufacturer defined requirements, and that are from a Manufacturer that produces similar parts to qualified Military or Hi-Rel standards

5.3.2 Non-Standard EEE Parts

EEE parts that do not meet the requirements of **Section 5.3.1** are considered Non-Standard, and require PMPCB approval. Non-standard devices have part level testing and qualification programs that vary by manufacturer and part type. As a result, these devices are typically mass produced, so they may be inherently reliable and appropriate for the mission objectives in many cases.

When a non-standard part is submitted for SEAKR approval, Supplier shall provide a review and summary of the risk-based approach used to evaluate each part type or part family. This risk evaluation process may include the following:

- Review of the manufacturer's screening and qualification data
- Review of the manufacturer's ongoing reliability testing
- Review of previous flight heritage on a program that envelopes this program’s mission duration, radiation, and reliability requirements
- Review of the manufacturer's process control data
- Review of previous screening yield (Supplier or manufacturer data)
- Obtaining Mean Time Between Failures (MTBF) or FIT (Failure in Time) rate data for each part type or part family
- Review of Supplier internal or publicly available data to determine inherent reliability of various parts technologies
- Review of materials data to determine if prohibited materials are present
- Obtaining radiation qualification data for active parts
- The use of plastic parts is acceptable after thorough review. Parts qualified per Automotive Electronics Council (AEC-QXXX) are acceptable with Production Part Approval Process (PPAP) Level 3 documentation
    - Additional qualification and testing per EEE-INST-002, Level 3, PEM-INST-001 Instructions for Plastic Encapsulated Microcircuit (PEM) Selection Screening, and Qualification, or an alternative specification may be required at PMPCB discretion

- The use of Cu bonds will be reviewed per guidelines in AEC-Q006 Qualification Requirements for Components Using Copper (Cu) Wire Interconnections. Inputs into the reliability model shall be approved by Supplier's Reliability Lead
- PMPCB shall be notified prior to incorporation of parts into the design (at PDR)
- Summary of a Qualification by Similarity approach, as defined by **Section 5.8**

All EEE parts that complete the PMPCB approval process are considered qualified. Parts qualification may be achieved using manufacturer's generic qualification data, qualification by similarity, by review of the manufacturer's on-going product family reliability program, by review of the part type generic industry data, and/or qualification/design verification testing at the unit/assembly level. Lot-specific qualification testing at the part level will not be required unless determined necessary by PMPCB, when a specific part type presents an unacceptable reliability risk.

5.3.3 Connectors

Connectors will be evaluated for space heritage and against all material prohibited in this plan. Connectors with space heritage and from Suppliers with space legacy product lines should be heavily preferred. Connectors without space heritage that possess any of the following shall not be allowed without PMPCB approval:

1. 30 gauge or smaller wire terminations
2. < 25,000th of an inch spacing between pc tail contact to contact distance
3. Compliant pins
4. Connectors plated with cadmium or high zinc content or silver plating. (Nickel plating is preferred).

5.3.4 Derating of Electrical Parts

Standard derating will be applied to all electrical parts in accordance with (IAW) EEE-INST-002 and TOR-2013-00297 Electrical Design Worse Case Circuit Analysis – Guidelines and Draft Standard, with any conflicts between the two deferring to the most conservative approach.

5.3.5 Destructive Physical Analysis (DPA)

Destructive Physical Analysis (DPA) is not required for parts used on Class C programs. DPA may be required on selected parts or specific LDCs of selected parts at the discretion of the PMPCB as a way of part approval, acceptance, failure analysis, and/or risk assessment for the production lot.

If required, DPA shall be performed in accordance with MIL-STD-1580, Test Method Standard: Destructive Physical Analysis (DPA) for Electronic Electromagnetic, and Electromechanical or an equivalent alternative specification. The DPA samples will be representative of the production lot date code and will have completed all 100% processing steps. Use of non-catastrophic screening failures for DPA is acceptable. This practice is encouraged for hybrid circuits and other high value parts.

5.4 MATERIALS AND PROCESSES SELECTION

Only qualified hardware, materials, and processes shall be used on production hardware. Prohibited and Restricted materials and/or processes defined by **Sections 5.6 - 5.8.8** shall be submitted to PMPCB for approval.

5.5 STANDARD MATERIALS AND PROCESSES

Materials and processes that meet the one or both of the following criteria shall be considered standard, an do not require additional PMPCB approvals:

- Materials or processes that meet all requirements of NASA-STD-6016 and the exceptions noted herein
- Materials or processes used in the same design/application, with previous flight heritage on a program that envelopes this program's mission duration, radiation, and reliability requirements

5.6 NON-STANDARD MATERIALS AND PROCESSES

Hardware, materials, or processes that do not meet the requirements of **Section 5.5** are considered non-standard, and require PMPCB approval. Non-standard materials or processes can be used in a variety of applications with highly variable levels of risk, and as a result, may be appropriate for the mission objectives in many cases.

When a non-standard material or process is submitted for PMPCB approval, Supplier shall provide a review and summary of the risk-based approach used to evaluate the material and or process. This risk evaluation process may include the following:

- Testing of items at a higher level of assembly to Program requirements and qualification levels designated by the specification
- Supplier audit by quality and certification of Supplier's qualification test data for the specific application
- Satisfactory completion of tests on items used on engineering or qualification model
- Summary of a Qualification by Similarity approach, as defined by **Section 5.8**.

5.7 MATERIALS AND PROCESSES SELECTION CRITERIA

5.7.1 Fasteners

Fastener selection may be guided by MIL-HDBK-454 (Guideline 12) Military Handbook: General Guidelines for Electronic Equipment. Flight hardware fasteners are not to be re-used. Installation of all fasteners shall be done in accordance with NASA-STD-6012 or equivalent. Fasteners are not to have stress levels above 160 KSI unless approved by PMPCB. Nuts or bolts where a single failure could result in injury to personnel or damage to property or flight hardware by dropping or losing control of the load are considered critical, and shall meet the requirements

of 541-PC-8072.1.2, Goddard Space Flight Center Fastener Integrity Requirements for critical fasteners.

All fasteners shall utilize positive locking features. Specified preload is typically the primary locking feature. Deformed thread, locking inserts, staking, thread locking adhesive, etc. are typical positive locking features. Torque stripe is not considered a locking feature.

5.7.2 Corrosion Control

Metals that are not "A' rated with respect to corrosion resistance per Materials and Process Technical Information System (MAPTIS), MSFC-HDBK-527, Materials Selection List for Space Hardware Systems, or an equivalent standard shall be protected from corrosion by applying appropriate protective surface finishes, by controlling the corrosive environment factor, or by other design solutions.

Use of materials that are not rated "A" for stress corrosion cracking (SCC) per MAPTIS, MSFC-HDBK-527 standard, or not in Table 1 of MSFC-STD-3029 Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments shall require PMPCB approval, with the following exceptions:

- Alloys used for electrical, thermocouple, magnet, and similar non-structural electrical or electronic applications shall be exempt from SCC requirements
- Alloys which are used in bearing applications that are only loaded in compression shall be exempt from SCC requirements.
- The alloy is used at stress levels below the established SCC threshold for the alloy.

5.7.2.1 Corrosion Resistant Steels

Corrosion resistant steel (CRES) mechanical parts shall be passivated in accordance with ASM2700, Passivation of Corrosion Resistant Steels, ASTM A967, Chemical Passivation Treatments for Stainless Steel Parts, or an equivalent standard, with the exception of helical inserts, lockwire, clamp loop, or drawn wire.

CRES 400 series shall be passivated, plated, or otherwise coated to control corrosion, except when used as dowel pins or in bearing applications.

5.7.3 Outgassing

Materials and finishes shall exhibit a total mass loss (TML) of not more than 1.0 percent and shall have collected volatile condensable material (CVCM) of not more than 0.1 percent when tested in accordance with ASTM E595, Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment. Additionally, the following material applications, where materials have a TML in excess of 1.0% and CVCM > 0.1%, do not require PMPCB approval:

- The material meets TML/CVCM requirements after vacuum or thermal baking
- The material has TML content greater than 1.0% and the amount in excess of 1.0% can be proven to be from absorbed water vapor
- The material is an identification marking ink

- The material is a primer used as an undercoating
- The material is used in an application that limits the exposed surface area (< 5 in^2) or overcoated by conformal coat or alternative encapsulation material that is outgassing compliant
- Outgassing data and/or analysis for plastic encapsulated microcircuits (PEMs), that will be conformally coated on flight production hardware is not required

Data taken from MSFC-HDBK-527 or MAPTIS may be used to verify outgassing compliance in place of materials testing. Materials that do not meet outgassing criteria as defined herein shall be submitted to PMPCB for approval.

5.7.4 Tin Mitigation

Supplier shall develop a mitigation strategy for any devices with pure tin terminations or Sn terminations with >97% Sn by weight. It is recommended Supplier perform tin mitigation IAW GEIA-STD-0005-2, Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems and GEIA-STD-0006, Requirements for Using Solder Dip to Replace the Finish on Electronic Piece Parts, and perform all post-dip testing necessary to ensure proper electrical performance in accordance with the original manufacturer specifications. Oversight of this process will be developed by Supplier and must be available for PMPCB review upon request.

5.7.4.1 Robotic Hot Solder Dip (RHSD)

Devices with pure tin (Sn) terminations should be solder dipped in accordance with GEIA-STD-0006. Semi-automatic or purely manually dipping processes are not permitted without PMPCB approval.

5.7.5 Printed Circuit Boards (PCBs)

PCBs shall meet the requirements of IPC-6012, Class 3 for Rigid Boards and IPC-6013, Class 3 for Rigid-Flex Boards, and shall be procured from a Fabricator with active and maintained certifications MIL-PRF-55110, General Specification for Rigid Printed Wiring Board or MIL-PRF-31032 General Specification for Printed Circuit Board/Printed Wiring Board. Alternative PCB fabricators may be permitted with PMPCB approval, with evidence of Supplier audit.

PCBs having microvias in design shall undergo lot-specific D-Coupon testing, in accordance with IPC-TM-650 Test Methods Manual, 2.6.27A and 2.6.7C for Reflow Simulation Testing and Thermal Shock Testing, respectively. Supplier's design authority is responsible for ensuring an appropriate number of D-coupons are on the fabricator's manufacturing panel, that the coupons are representative of the various propagated via structures in the specific board design (microvias, buried vias, blind vias, filled through vias, etc.), and that the correct testing parameters are flown down to the fabricators D-Coupon Testing Lab Supplier.

Stacked microvias, microvias less than 5 mil in diameter, or a target microvia design ratio exceeding 0.7:1 are prohibited in production hardware without PMPCB approval.

5.8 QUALIFICATION BY SIMILARITY

When approved by PMPCB, qualification of parts, materials and/or processes by usage history or similarity, may be accomplished by any of the following:

- **History**: A PMP item can be considered qualified if it has been successfully used in (1) identical applications, or (2) a different application where the derating environmental conditions and other qualification parameters are fully documented and more severe than the proposed application. The same manufacturer must have built the higher reliability (Hi-Rel) part in the same facility using the same materials and processes to an equivalent source control drawing and have documented evidence of historical data.
- **Similarity**: A Hi-Rel part can be considered qualified if it is similar to a part type family with similar construction and foot print for which qualification test data exists, and the test data (1) satisfies the requirements for the intended application, (2) is available and is less than 2 years old relative to the lot date code of parts used in identical applications. To be considered similar, the part will be made by the same manufacturer on the same manufacturing line.
- **Existing Test Data**: Parts and materials can be qualified by existing test data, which meets the requirements, specified in its intended application. Lot specific data indicates that mission critical parts have the same lot date code as the qualification samples. Lot specific data is acceptable in place of qualification testing when it meets the program system, subsystem, or assembly requirements.

5.8.1 PMP Controls and Traceability and Management

Quality assurance practices should use guidance from DOD-HDBK-343, General Guidelines for Electronic Equipment for Class C experimental hardware. Supplier should maintain the same Supplier controls as used for traditional Level 1 or Level 2 parts programs wherever possible with heightened focus on counterfeit parts and nefarious modified electronic components. These controls include ordering parts from the original manufacturer or authorized distributors, requiring Certificate of Conformance (CofC) and material certifications documentation, maintaining lot date number of and/or lot date code traceability, performing incoming inspections, and completing verification of prohibited materials. Test reports shall be traceable to the materials tested, and Supplier shall maintain the reports on file for SEAKR review upon request.

5.8.1.1 Lot Date Codes (LDCs)

No parts manufactured more than 5 years prior to contract issuance will be incorporated into the design without a comprehensive search for alerts using Government-Industry Data Exchange Program (GIDEP) and other industry alert databases (pre-CDR). GIDEP alerts determined by Supplier to have a form, fit, or functional impact shall not be incorporated into the design without the prior approval of the PMPCB.

5.8.2 EEE Part Re-Life

EEE parts identified which have been in inventory for more than 7 years based on the lot-date-code (LDC) will be re-certified prior to kitting. Re-certification may be extended on a lot-by-lot basis following the successful completion of solderability testing per MIL-STD-202, Test Method Standard Electronic and Electrical Component Parts, Method 208 on two (2) samples from the lot under evaluation. Parts stored in a dry nitrogen environment are exempt from this 7-year re-life evaluation.

5.8.3 Material Shelf Life

For materials, Supplier should identify specific temperature and humidity requirements and any associated limitations on life, such that materials can be stored and controlled accordingly. Materials will be stored and handled IAW the manufacturer's suggested recommendation or IAW the shelf life requirements in the detailed specifications. Expired material shall not be used for any assembly without prior written approval from SEAKR Engineering. Re-certification of material will be performed no more than 2 times without PMPCB approval.

5.8.4 Re-Use of Parts and Materials

Parts and materials which have been installed in an assembly, and then removed from the assembly for any reason, are not to be reinstalled in any flight, qualification or proto-qualification hardware item without prior PMPCB, and Material Review process approval. Approval for reuse will be based on the submission of evidence that this practice does not degrade the system performance.

5.8.5 Hazardous and Toxic Materials

All parts and materials will be reviewed for hazardous and toxic containing materials. The use of these materials will be compatible with AFSPCMAN 91-710, Range Safety User Requirements Manual. Hazardous or toxic materials not meeting these requirements should be submitted to PMPCB for approval.

5.8.6 Obsolescence Management

Supplier shall maintain a standard process for the periodic review of all EEE parts and materials, for obsolescence over the life of the production program.

5.8.7 Government-Industry Data Exchange Program (GIDEP) and Product Alerts

GIDEP Alerts are issued by Government contractors to document potential part, material, or design problems discovered with Government qualified parts or materials. SEAKR will supply GIDEP alerts to Suppliers for review, processing and response. Supplier shall monitor GIDEP alerts and product change notices (PCNs) affecting any parts or materials intended for use in deliverable hardware.

5.8.8 Prohibited Materials

The use of the following PMP is prohibited without prior approval from PMPCB:

1. Pure cadmium, magnesium, zinc, or selenium, except internal to hermetically sealed devices

2. Silver brazing alloys containing cadmium or zinc
3. Brass containing zinc in a vacuum environment, unless over-plated with an approved material such as nickel or gold.
4. Ozone depleting halogenated hydrocarbons in any process (e.g., Freon or Trichloroethane)
5. Corrosive solder fluxes without the use of qualified and controlled cleaning processes
6. Dissimilar metals (with different galvanic potential) will not be used in conjunction with each other unless protected and separated by a finish
7. Silver or silver-plated surfaces that will be exposed to atomic oxygen
8. Teflon used in structural applications or where mechanical forces will be exerted on the material
9. Corrosive (acetic acid evolving) silicone resins, adhesives, and sealants
10. Polyvinyl chloride (PVC) as insulation for electrical hook-up wiring or used for packaging electronic components or within shipping containers.
11. Pressure-sensitive adhesive tapes are prohibited in critical areas, except where mechanically captured to prevent delamination during service
12. High-volatility compounds (e.g., lubricants, greases, functional fluids) that are free to migrate onto critical surfaces
13. Cotton, linen, or cellulose films used as insulation, paper, tapes, or lacing
14. Anaerobic thread locking compounds and varnishes for staking fasteners
15. Plated threaded fasteners, including connectors, where rotational engagement may generate metal debris
16. Metals and alloys used in structural applications, which have do not have high resistance to SCC as defined in the MSFC-STD-3029
17. Wire bundle sheathing such as that made with braided glass fibers that readily shed broken fiber ends
18. Conductive epoxy unless over-coated to mitigate conductive particle shedding and/or electrochemical migration concerns
19. Materials that are a nutrient for fungus
20. Non-reversion resistant polyurethane
21. Foams that may break apart during depressurization
22. Paints or other coatings that produce particulate contamination
23. Duct tape or Velcro

24. Dye penetrants
25. Split ring or tooth type lock washers
26. Parylene (paraxylylene-based) conformal coatings containing chlorine
27. Silver-plated copper wire with less than 40 µin of silver plating
28. Cyanoacrylate adhesives in structural applications
29. Elastomeric materials that contain hydrazine except for F-E-332 for diaphragms and AF-E-411 for soft valve seats
30. Silicone greases intended for thermal bonding
31. Kapton insulated wiring where voltage is greater than 18V and where flexure, tight bend radii, physical or chemical damage, or abrasion could crack insulation
32. PTFE, FEP, or PFA (Teflon) insulated wiring or tubing
33. Graphite used as a filler in lubricants
34. Butt splices
35. Solder sleeves, except for non-critical grounding of cable shields
36. Any non-vented honeycomb core structures
37. Pink poly packaging material in direct contact with hardware
38. Unannealed gold or silver ribbons
39. If solder attached, chip capacitor terminations without barrier plating layer
40. The use of chromium within MMICs
41. Surface mounted transistor outline (TO) case configurations with diameters of 0.35 inch or larger with three or less leads in which bonding or conformal coat completely fills the gap between the body and the case
42. TO case configurations where conductive bonding material for ESD bleed purposes bridges from the component body to the PCBs (refer to program processes)
43. Surface mounted dual-in-line packages (DIPs) lap soldered to surface mount pads

5.8.9 Reliability Suspect Parts

The following parts are considered reliability suspect and are not permitted in production hardware without prior approval from PMPCB:

1. Non-captivated connector contacts in coaxial or tri-axial connectors
2. Variable resistors
3. Variable capacitors

4. Filter pin connectors
5. Electromechanical Relays
6. Filters with tubular ceramic capacitor elements
7. Multi-pin coaxial connectors (multi-pin or rectangular connectors where the standard power contacts are replaced with coaxial contacts)
8. Stacked microvias
9. Microvias less than 5 mil in diameter
10. Target microvia design ratio exceeding 0.7:1

5.8.9.1 Prohibited Materials Screening

Supplier shall perform x-ray fluorescence (XRF) or energy dispersive x-ray (EDX) testing (or an equivalent means of quantitative material analysis) by way of verifying the absence of prohibited materials on all incoming flight hardware. CofCs are not acceptable for piece parts which contain metals (i.e. metallic pieces).

5.8.10 Retaining Parts and Materials

Supplier shall return surplus parts and materials that were procured as a part of SEAKR purchase orders. Supplier shall not dispose of any parts or materials related to SEAKR procurements unless written authorization has been provided by SEAKR.

5.9 COUNTERFEIT DETECTION AND AVOIDANCE

There are two major concerns with respect to supply chain integrity: counterfeit parts and nefarious modified electronic components. Supplier shall have adequate process controls in place to ensure the reliability and authenticity of all parts and materials that form the production hardware. This supply chain management plan shall be delivered to the PMPCB for review, and PMPCB shall be apprised of any major revisions or changes at Supplier's PDR and CDR.

Supplier shall procure components or subsystems only from authorized distributors or the Original Equipment Manufacturer (OEM). Additionally, Supplier shall adopt a risk-based policy for the detection and avoidance of counterfeit parts, that meets the criteria established by AS5553, Counterfeit Electronic Parts: Avoidance, Detection, Mitigation, and Disposition and AS6462, Fraudulent/Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition Verification Criteria, including the following:

- Maximize the availability of authentic parts
- Procure parts from reliable sources
- Assure authenticity and conformance of procured parts
- Control suspect or confirmed fraudulent/ counterfeit parts
- Report suspect or confirmed fraudulent or counterfeit parts to other potential users and Authority having jurisdiction
- Assess, mitigate, control and report parts which have been used, refurbished, or reclaimed, but represented as new product

Any part or component found to be counterfeit, either from a Supplier or sub-tier Supplier, shall be reported to SEAKR within 48 hours of discovery.

6 ASSEMBLY, INTEGRATION AND TEST REQUIREMENTS

6.1.1 Workmanship Standards

Supplier 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. IPC-J-STD-001, Joint Industry Standard, Space Applications Electronic Hardware Addendum to J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies (Class 3 Requirements)
b. IPC-J-STD-004, Requirements for Soldering Fluxes
c. IPC-J-STD-005, Requirements for Soldering Pastes,
d. IPC-J-STD-006, Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications,
e. MIL-STD-883, Test Method Standard Microcircuits
f. NASA-STD-8739.1, Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies
g. NASA-STD-8739.4, Crimping, Interconnecting Cables, Harnesses, and Wiring or IPC/WHMA-A-620, Requirements and Acceptance for Cable and Wire Harness Assemblies, Space Addendum

6.1.2 Operator Training and Certification

Supplier shall maintain a Training and Certification program for all of its employees. All personnel (operators) involved in manufacture, handling, or testing of deliverable hardware should be certified to perform the task.

6.1.3 Assembly Instructions and Build History Records

Manufacture, build and assembly operations shall be documented using planning/assembly instructions.

A Build History Record (BHR) shall be used to assemble (or correlate) the following elements of the product build, test and quality inspection history for each configured end-item including:

- assembly and rework/repair instructions
- trace/kit records
- test procedures, reports, and data logs (connector mate/demate, open liens, ovens, etc.)
- photos at component, subassembly, and top level assembly including hardware part number, revision, serial number, and date taken
- quality inspection results
- nonconformance and test event/failure records
- as-built configuration

6.1.4 Electronic Hardware Rework and Repair Restrictions

Alternate wiring using jumper wires and/or rework and repair of printed wiring boards (PWBs) and circuit card assemblies (CCAs) shall conform to the following:

- EEE parts that have been installed and removed may not be reused without MRB approval.
- Devices sensitive to heat and thermal shock (e.g. ceramic capacitors, glass-body diodes, planer packs or solder joint rework) may not be reused without MRB approval.
- Multi-Layer Ceramic Capacitors (MLCC) are limited to a maximum of 3 solder reflows.
- Cumulative area of all PWB or CCA repair/rework ≥ 33 percent of the total board or card surface area require approval from the SEAKR.
- PWBs or CCAs that require jumper wires in excess of the limits below require SEAKR approval prior to addition.
    - A maximum of 18 jumpers wires are permitted for a board size <100 in^2
    - A maximum of 24 jumpers wires are permitted for a board size ≥100 in^2
    - The use of jumper wires is only permitted if the circuit card assembly is both producible and inspectable.

6.1.5 Internal Inspection and Test

Suppliers are to perform sufficient inspections and tests to ensure, prior to delivery, all articles conform to applicable drawings and specifications. Suppliers shall maintain inspection records on file for a 5-year period and made available for SEAKR review upon request.

6.1.6 Equipment Calibration

Suppliers shall maintain documented procedures to control, calibrate and maintain inspection, measurement and test equipment (including software and tooling), that is used to demonstrate the conformance of product or service requirements and traceable to NIST Standards (ANSI/NCSL Z540-1 General Requirements for the Competence of Testing and Calibration Laboratories or ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories).

Supplier will maintain a calibration system that demonstrates the traceability between calibrated instruments or equipment found to be out-of-tolerance and the hardware that has been accepted using such equipment.

6.2 ACCEPTANCE

6.2.1 Assembly Inspection

The assembly shall be visually inspected for quality per IPC-A-610 Acceptability of Electronics Assemblies IPC J-STD-001 to verify that the design, construction, physical dimensions, markings and workmanship are in accordance with the requirements of the PO, the drawing, and this specification.

6.2.2 Component Substitutions

Where component substitutions are required, a SEAKR representative (SEAKR) shall be contacted to authorize the change. SEAKR will provide written authorization via email or PO notes for any changes.

6.3 TEST AND EVALUATION PROGRAM

Supplier shall plan and execute an environmental test and evaluation program to validate that the product design is compatible with pre-launch, launch, and on-orbit environments (e.g. transportation, acceleration, pressure, vibration, shock, thermal, Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC), radiation and meteoroids) defined in the product specification. The environmental test and evaluation program shall be responsible for specification requirements analysis/flow-down and process execution for environmental testing, and oversight and compliance of Supplier-performed environmental testing.

Testing shall be performed for verification of safety compliance and interface compatibility.

7 RADIATION MITIGATION

Supplier shall plan and execute a Radiation mitigation program to achieve the end-item performance requirements in accordance with mission life. Supplier shall complete a detailed review and assess the need for additional radiation testing and analysis for all proposed susceptible parts. Supplier may propose a radiation qualification approach for the EEE parts used in this program that leverages existing radiation data, heritage designs, and analysis addressing radiation requirements in specified orbit. Analysis should include SEE rate analysis and mitigation techniques which minimize the impact of the SEEs occurring in orbit.

8 RELIABILITY

Supplier shall plan and execute a Reliability program to achieve the end-item performance requirements in accordance with mission life.

8.1.1 Failure Modes, Effects, and Criticality Analysis (FMECA)

Suppliers should complete a FMECA, at the electrical interfaces, for all components. Supplier's analysis shall consider circuit design as well as physical layout and operation. Suppliers shall maintain the FMECA on file and available for review by SEAKR upon request.

8.1.2 Power Supply Transient Analysis

Suppliers should perform power supply transient analysis to identify all transient conditions presented to the spacecraft power bus, including turn-on/off transients, in-rush current, component state changes, etc. Suppliers shall maintain the transient analysis on file and available for review by SEAKR upon request.

8.1.3 Stress Analysis

Suppliers should perform stress analyses to verify that the applied stress on each component does not exceed the specified ratings. Suppliers shall take appropriate steps to correct any overstressed condition unless specifically approved in writing by SEAKR. Suppliers shall maintain the stress analyses on file and available for review by SEAKR upon request.

8.1.4 EEE Part Stress Analysis

Suppliers should perform an EEE part stress analysis to verify that parts do not exceed their specified maximum voltage, current, or temperature ratings. The junction temperature of active parts shall be calculated based upon the expected component base plate temperature and are not to exceed the specified maximum temperature rating. EEE parts shall be derated in accordance with MIL-STD-975 Electrical, Electronic and Electromechanical Parts List. Suppliers shall maintain the EEE part stress analyses on file and available for review by SEAKR upon request.

8.1.5 Structural Stress Analysis

Suppliers should perform a structural stress analysis to determine the dynamic environment effects expected to be applied to the structure. The analysis shall demonstrate the structural design adequacy (including margins) for mission requirements. Suppliers shall maintain the structural stress analyses on file and available for review by SEAKR upon request.

8.1.6 Thermal Stress Analysis

Suppliers should perform a thermal stress analysis to determine the thermal environment effects expected to be applied to the structure. The analysis shall demonstrate the design adequacy (including margins) for the mission requirements. Suppliers shall maintain the thermal stress analyses on file and available for review by SEAKR upon request.

8.2 SAFETY

Suppliers shall maintain a safe and healthy work environment and have a safety program to establish internal procedures and reporting systems for hazard identification, investigation, and mishap, and safety incident disposition.

Supplier shall present and address safety issues during design reviews.

8.2.1 Hazard Identification

Suppliers shall assess hazardous operations to determine the risk to program personnel and use the assessment to establish guidelines, procedures for hazard resolution, and safe operations conduct.

All identified hazards and hazardous operations that could pose any serious health or safety risk to personnel shall be reported to SEAKR. Hazardous materials delivered to SEAKR shall be accompanied by a (Material) Safety Data Sheet (SDS).

8.2.2 Records and Reports

Suppliers shall maintain hazard assessments and analyses performed records, and mishap reports on file and available to review by SEAKR upon request.

8.2.3 Mishap Reporting

Any mishap involving Supplier or deliverable hardware shall be reported to the SEAKR as soon as possible but no later than 24 hours after occurrence. A mishap is defined as an incident or series of incidents that result in death, injury, occupational illness, or damage/loss to equipment or property. Any mishaps shall be investigated to determine the cause and corrective action to prevent recurrence.

9 CERTIFICATE OF CONFORMANCE

A CofC shall be supplied for any assembly built by Supplier. SEAKR reserves the right to require a manufacturer's CofC for all federal, standard, military-specified, and DLA controlled parts as well as any other high reliability parts.

The CofC document provides traceability of parts and conformance and must include the following:

a) Manufacturer name with location or CAGE code

b) A manufacturer's or SEAKR part number (PN) that matches the PO including the drawing revision if called out per the PO. CofC PN must match part markings. Part markings may be directly labeled on the part itself or on the bag/container containing the part.

c) Full traceability to the serial number, lot and/or date code for all parts, assemblies, and subassemblies as required by engineering drawing/specification/BOM.

d) If multiple lots or lot date codes are delivered simultaneously, the paperwork must show this, and the parts shall be segregated or marked per lot.

e) Serial numbers (if applicable) of all parts delivered.

f) Manufacturer with location or Commercial and Government Entity Code (CAGE) specified

g) Signature and date of an authorized representative (electronic signature is acceptable).

h) Title of authorized representative is optional but encouraged.

9.1.1 Sub-Tier Certificates of Conformance

Supplier shall require and retain a CofC for all procured parts and materials from its sub-tier Suppliers.

10 END ITEM DATA PACKAGE (EIDP)

Supplier shall submit a EIDP with each completed assembly. Supplier's standard format for documentation and data package is acceptable. All assembly documentation shall be available for SEAKR review. The EIDP shall contain the following, at a minimum:

A) A parts and materials identification list for each unit built, that specifies all manufacturer-supplied parts and materials used in the manufacturing and assembly of the module. This list will include at a minimum:
   - Material manufacturer and manufacturer part number
   - Material type (e.g., Tape, Adhesive, Epoxy, Sleeving, etc.)
   - Estimated mass, volume, or quantity (each) of the material used

B) Certifications for all Supplier-provided materials, components, and the top level assemblies

C) Documentation of all waivers, written approvals including nonconformances, or deviations from the engineering between SEAKR and Supplier

D) Build and close-out photos, appropriately labeled in accordance with **Section 6.1.3**

When specified on the SOW, the EIDP may contain the following:

A) Box-level and subsystem requirements verification/compliance matrix (RVCM): Documentation, test data, test results, and test reports, used to verify requirements,

B) The completed traveler/router for each assembly built, which includes all documentation for each build including clearly identified rework and repair documentation and signed manufacturing operation steps
C) End item mechanical and electrical interface control drawings
D) End item test electrical and environmental summary reports, including cumulative operating time and power levels for any life limited items
E) End item acceptance, proto-qualification, or qualification test data, including environmental test results.
F) An As-Built List identifying all EEE components, mechanical piece parts / hardware, polymeric materials, and manufacturing processes used on each box-level unit throughout the production program