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BY ORDER OF THE COMMANDER

SMC Standard SMC-S-009
12 January 2009

Supersedes:
SMC-S-009 (2008)

Air Force Space Command

SPACE AND MISSILE SYSTEMS CENTER STANDARD

PARTS, MATERIALS, AND PROCESSES CONTROL PROGRAM FOR SPACE AND LAUNCH VEHICLES

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FOREWORD

1. This standard defines the Government's requirements and expectations for contractor performance in defense system acquisitions and technology developments.

2. This revised SMC standard comprises the text of The Aerospace Corporation report number TOR-2006(8583)-5235, dated 30 September 2008, and contains the following major changes:

- organized for more user-friendly "search and find"
- enhanced hybrid element evaluation,
- incorporates prime contractor suggested comments
- incorporates more flexible derating requirements to allow some NASA hardware

3. Beneficial comments (recommendations, changes, additions, deletions, etc.) and any pertinent data that may be of use in improving this standard should be forwarded to the following addressee using the Standardization Document Improvement Proposal appearing at the end of this document or by letter:

Division Chief, SMC/EAE
SPACE AND MISSILE SYSTEMS CENTER
Air Force Space Command
483 N. Aviation Blvd.
El Segundo, CA 90245

4. This standard has been approved for use on all Space and Missile Systems Center/Air Force Program Executive Office - Space development, acquisition, and sustainment contracts.

DAVID E. SWANSON, COL, USAF
SMC Chief Engineer

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1. Scope

1.1 Purpose

This document establishes the requirements (including those cited in the Appendices herein) for the preparation, implementation, and operation of a Parts, Materials, and Processes (PMP) control program for use during the design, development, manufacture, assembly, integration and test of space and launch vehicle systems. It is intended to be used in conjunction with Aerospace TOR-2006(8583)-5236, Technical Requirements for Electronic Parts, Materials, and Processes Used in Space and Launch Vehicles. The implementation of these requirements is intended to:

a. Assure integrated management of the selection, application, procurement, verification, control, and standardization of parts, materials, and processes (PMP).

b. Improve the reliability of program PMP

c. Improve procurement and test of small quantities of piece parts and materials that meet system requirements.

d. Reduce PMP failures at all levels of manufacturing, integration, assembly, and test.

e. Reduce program life cycle costs and enhance product performance during its life cycle.

1.2 Application

This document is intended for use in acquisition of all satellites, upper stages, launch vehicles, and experimental missions (as applicable when referenced in the contract) intended for spaceflight where repair is not possible. The document should be cited in the contract statement of work. This document may be tailored by the acquisition activity for the specific application or program prior to contract award.

1.3 Compliance with System Requirements

The requirements of this standard shall not relieve the contractor and subcontractors of the responsibility for complying with all the equipment, system performance, and reliability requirements as set forth in the applicable specifications and contract.

NOTE:
All reference in this document to Aerospace report number TOR2006(8583)-5236 shall refer to SMC standard number SMC-S-010 (2009).

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2. Applicable Documents

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue in effect on the date of invitation for bids or requests for proposal shall apply.

AEROSPACE TOR-2006(8583)-5236	Technical Requirements for Electronic Parts, Materials and Processes Used in Space and Launch Vehicles
MIL-STD-1580	Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts

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3. Definitions and Acronyms

3.1 Definitions

The following definitions describe terms used throughout this document, and shall form a part of the overall requirements of this document.

Acquisition Activity	The acquisition activity is the Government, contractor, or subcontractor acquiring the equipment, system, subsystem, part, or material for which this standard is being contractually applied.
As-Built Parts, Materials and Processes List (ABPMPL)	The ABPMPL shall identify all the PMP used in each deliverable end item. (See paragraph 4.6 and Appendix A herein for minimum required information.) All PMP contained "within, or internal to" a deliverable item shall also be listed in the ABPMPL (e.g. elements internal to a hybrid). A/R (as required) may be entered for materials where exact quantity is not available. (See paragraph 4.5 and Appendix A herein for minimum required information.)
As-Designed Parts Materials and Processes List (ADPMPL)	The ADPMPL shall consist of all the approved PMP items selected for use, and listed on the engineering drawing's parts and materials list and on the drawing notes. PMP "within, or internal to" an approved engineering drawing item shall also be listed in the ADPMPL. ADPMPL shall also include the expected quantity of each part and material listed. (See paragraph 4.5 and Appendix A herein for minimum required information.)
Categories of Contractor	The prime contractor is directly responsible to the acquisition activity for ensuring compliance with all the provisions of this document. Subcontractors and suppliers are subordinate contractors to the prime and are required to meet the provisions of this document. The prime is responsible for ensuring the flow down of requirements to all subcontractors, suppliers and sub-tier providers, and for managing the implementation of the entire program's PMP activity.
Contracting Officer	A contracting officer is a person with the authority to enter into, administer, or terminate contracts and make related determinations and findings. The term includes authorized representatives of the contracting officer, acting within the limits of delegated authority.
COTS Parts and Materials	Commercial-Off-The-Shelf (COTS) parts and materials are those that (a) have been developed and produced to commercial designs and specifications, (b) are readily available from a manufacturer as a catalog item and without additional testing, (c) are typically intended for consumer electronics, and (d) are controlled solely by the supplier of the item.

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Destructive Physical Analysis	A Destructive Physical Analysis (DPA) is a systematic, logical, detailed examination of parts and complex materials during various stages of disassembly, conducted on a sample of completed parts from a given manufacturing lot, wherein parts or materials are examined for design and workmanship characteristics, and processing problems that may not show up during normal screening tests. The purpose of this examination is to perform analysis of the item to compare it with the approved configuration baseline and to detect anomalies or defects that may be pervasive to the production lot such that they could, at some later date, cause the part or material to fail to meet its performance or reliability requirements.
Electronic Parts	The term "electronic" is used in a broad sense in this document and includes electrical, electromagnetic, electromechanical, and electro-optical (EEEE) parts. These parts are associated with electronic assemblies such as computers, communications equipment, control systems, electrical power, guidance, instruments, payloads, and space vehicles. Electronic parts also include connectors.
Electrostatic Discharge (ESD)	ESD is defined as the level of susceptibility of a device to damage by static electricity which is a transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field. The level of susceptibility of a device is found by ESD classification testing and is used as the basis for assigning an ESD class.
Government Industry Data Exchange Program (GIDEP)	GIDEP is a data-sharing program between government and industry, financed by the Armed Services and managed by the Navy. It is a repository of failure history, usage, and/or test reports on PMP and other commodities. The data is submitted by and distributed to member companies/agencies.
Government Right of Disapproval	The government retains the right of review and disapproval of all PMPCB activities and actions. The disapproval means the PMPCB decision or action is rejected, and the approval of the alternative approach is required by the government prior to implementation.
Long Lead PMP	Long lead parts and materials are items that take a long time (typically more than six months) to manufacture, test, qualify and deliver. Examples of such parts are hybrids, ASICs, new technology PMP, etc. These items require special attention in order to ensure that program schedules are met.
Manufacturing Baseline	The manufacturing baseline is a configuration managed description, normally in the form of a flow chart, providing the details necessary to ensure that product is produced in a consistent and controlled manner. It shall contain the details of required documentation, processes, materials, tooling, equipment, software, facilities, testing and inspections to ensure that any changes affecting the end product are understood and traceable to their date of implementation. Documents, custom software, and procedures listed in the manufacturing baseline shall be identified by the following as a minimum: Title, number, date of issue, applicable revision, and date of revision. When the item is produced and tested in a DSCC certified/approved military specification baseline, only the differences between the MIL spec baseline and the procuring activity requirements baseline shall be identified and documented.

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Material	Material is a metallic or nonmetallic element, alloy, mixture, or compound used in a manufacturing operation that becomes a permanent portion of the manufactured item, or which can leave a remnant, residue, coating, or other material that becomes or affects a permanent portion of a manufactured item. Environmental materials (e.g., moisture or oxygen in the air, etc.) and those used in tooling or equipment not intended to modify or leave residues are not meant to be covered by this definition.
Material Lot	A material lot refers to material produced as a single batch or in a single continuous operation or production cycle, come from the same production lots of raw materials, and offered for acceptance at any one time.
Mechanical Piece Parts	The term mechanical piece parts (non-electrical parts) is used in a broad sense in this document and includes such simple mechanical parts as nuts, bolts, washers, pins, and terminals, as well as more complex assemblies such as, clamps and glass-to-metal seals. Such mechanical parts have a single, non-electrical function (other than electrical grounding), and contain one or more necessary material items. Formed, shaped or otherwise processed portions of packages used by electronic assemblies, such as blank unmetallized substrates (i.e., with no electrical circuitry or ground plane functions) and lids, shall be considered as mechanical parts.
New PMP Technology	New technology is a part, material, or process (PMP) that has never been previously characterized or qualified by the contractor within the space environment intended for the application, or has limited or no space heritage, or commercial technology, and meets Appendix D herein. Class 1 changes (form, fit, function, reliability or radiation) to a previously qualified PMP shall result in the PMP being considered as new technology.
Part	A part is one piece, or two or more pieces joined together, which are not normally subjected to disassembly without destruction or impairment of its designed use.
Part / Material Approval Request	A traceable approval request form for parts (Parts Approval Request, PAR) and materials and processes (Material and Processes Approval Request, MAR). It provides technical justification, and supporting data/analysis, for adding parts (PAR), or materials and processes (MAR) to the PMPSL or ADPMPL, and shows how the PMP meets program technical requirements. The PAR/MAR shall also document any restrictions in the proposed use, the proposed technology, the sources of manufacturing and supply, and the proposed requirements for the manufacturing, test, and qualification.
Parts Derating	Derating is the reduction of operating and environmental stresses as applied to a part or material to reduce its degradation rate and prolong its expected service life. By derating, the margin of safety between operating stress levels is increased, while actual failure level for the part or material is reduced, providing added protection from system failures. The criteria have been limited to those parts and materials that have generally accepted direct correlation between thermal, voltage, or other stresses, and degradation or failure rates.

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Parts, Materials and Processes Control Board (PMPCB)	The PMPCB is a formal contractor organization established by contract to manage and control the selection, application, procurement, qualification, and inspection of parts, materials, and processes used in equipment, systems, or subsystems supplied to the Acquisition Activity in accordance with this document.
Parts, Materials and Processes Selection List (PMPSL)	The PMPSL is a list of all parts, materials and processes which are approved for design use in a specific contract. (See paragraph 4.4 and Appendix A herein for minimum required information.)
Process	A process is an operation, treatment, or procedure used during a step in the manufacturing or testing of a material, part, or assembly.
Production Lot	Unless otherwise specified in the applicable detail specification, a production lot of parts refers to a group of parts of a single part type; defined by a single design and part number; produced in a single production run by means of the same production processes, the same tools and machinery, same raw material, and the same manufacturing and quality controls. All parts in the same lot have the same lot date code, batch number, or equivalent identification.
Program Technical Requirements	These requirements are either stated directly, or derived from the system requirements document, technical requirements document, or listed as technical compliance documents in the contract. Examples of PMP requirements stated or derived from requirements documents are: natural space environments, radiation hardness performance levels, reliability requirements, parts screening requirements, etc.
Prohibited PMP Items	Prohibited PMP are those items that do not meet PMP technical requirements under any circumstances.
Registered or Reliability Suspect PMP	A registered or reliability suspect PMP is a part, material, or process that is listed in Aerospace TOR-2006(8583)-5236 to call attention to special reliability, quality, or other concerns, relating to its procurement, assembly or application.
Space Quality Baseline (SQB)	The space quality baseline defines available parts and materials that have been manufactured, tested and qualified by certified suppliers to a set of technical requirements based on typical satellite and launch system applications. The SQB also lists approved processes that have been successfully used in building space and launch systems.

3.2 Acronyms

ABPMPL	As-Built Parts, Materials and Processes List
ADPMPL	As-Designed Parts, Materials and Processes List
CDR	Critical Design Review

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CDRL	Contract Data Requirements List
CMOS	Complementary Metal Oxide Semiconductor
CONOPS	Concept of Operations
COTS	Commercial Off the Shelf
CSI	Customer Source Inspection
CVCM	Collected Volatile Condensable Mass
DPA	Destructive Physical Analysis
DID	Data Item Description
DOD	Department of Defense
DSCC	Defense Supply Center Columbus
EEEE	Electrical, Electronic, Electromagnetic and Electro-optical parts
ELDRS	Enhanced Low Dose Rate Sensitivity
ELV	Expendable Launch Vehicle
ESD	Electrostatic Discharge
FARS	Failure Analysis Report Summary
FMECA	Failure Mode Effects and Criticality Analysis
FRACAS	Failure Reporting and Corrective Action System
FRB	Failure Review Board
GFE	Government Furnished Equipment
GIDEP	Government Industry Data Exchange Program
HBT	Heterojunction Bipolar Transistor
IPT	Integrated Product (or Process) Team
MAR	Material and Process Approval Request
MRB	Material Review Board
OEM	Original Equipment Manufacturer
NASA	National Aeronautics and Space Administration

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PAR	Part Approval Request
PDR	Preliminary Design Review
PEDS	Plastic Encapsulated (Active) Devices
PEMS	Plastic Encapsulated Microcircuits
PIND	Particle Impact Noise Detection
PMP	Parts, Materials, and Processes
PMPSL	Parts, Materials, and Processes Selection List
PMPCB	Parts, Materials, and Processes Control Board
QCI	Quality Conformance Inspection
QML	Qualified Manufacturers List
QPL	Qualified Parts List
RCCR	Request for Change / Clarification to a Requirement
RGA	Residual Gas Analysis
RHA	Radiation Hardness Assurance
RLAT	Radiation Lot Acceptance Testing
SCD	Source Control Drawing
SEE	Single Event Effects
SMD	Standard Microcircuit Drawing
SPC	Statistical Process Control
SPWG	Space Parts Working Group
SQB	Space Quality Baseline
TML	Total Mass Loss
TRB	Technical Review Board
TRR	Test Readiness Review
WCA	Worst Case Analysis

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4. General Requirements

4.1 Parts, Materials and Processes (PMP) Control as part of the Overall Systems Acquisition Process

The contractor shall develop a PMP Control Program that meets the programmatic and technical requirements of the contract and statement of work. The contractor shall flow down and implement the PMP requirements to all subcontractors, sub-tiers and suppliers.

The contractor shall establish and implement practices, processes and procedures for the PMP technical requirements specified in the following paragraphs, and the contract.

The contractor shall prepare a PMP Program Plan that describes how the contractor's (and all subcontractor's) practices, processes, and procedures for the PMP management and technical requirements specified in this document are implemented.

At system design reviews, program management reviews and other reviews (as specified in the contract), the contractor shall present and/or provide objective evidence to the acquisition authority of the contractor's progress in complying with meeting the PMP requirements.

The contractor shall establish a Parts, Materials, and Processes Control Board (PMPCB) that includes all subcontractors to coordinate the program's PMP control program.

4.1.1 Existing Designs

Existing designs or the re-procurement of existing designs and their attendant PMP shall not be exempt from the PMP management, control, and requirements specified herein. However, previously performed reliability and worst-case analyses may be used to satisfy the requirements for re-procurement of existing designs except in cases where new parts are used to replace obsolete ones. Portions of the analyses may have to be re-done in these instances. The PMPCB can consider specific requests on a case-by-case basis and provide recommendations to the procurement activity. To support the PMPCB, the requestor shall provide sufficient justification demonstrating the detailed design and parts, material, and processes to be used to fabricate the end item will fully meet the technical, reliability, environmental, and survivability (if required) requirements of the program.

4.1.2 New Technology Insertion Requirements

A new technology insertion program shall be established (see Appendix D) for the identification, management, and tracking of new technology for each contract. The program shall include a plan that defines the new technology, and the criteria and methodology for characterization and qualification of new technology.

4.2 Parts, Materials, and Processes Control Board

The contractor shall establish a Parts, Materials, and Processes Control Board (PMPCB) to coordinate and manage the program's PMP control program. The Prime Contractor shall designate a PMPCB Chairperson responsible for the planning and execution of all PMPCB actions and decisions. The PMPCB decisions shall not change the contractual requirements of the program. The PMPCB shall include a government member or designated representative who shall: 1) be an active member of the PMPCB, 2) receive all meeting notifications, 3) receive all PMPCB agendas and all PMP data and

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material(s) with a sufficient amount of time for review, and 4) receive all PMPCB meeting minutes and records of action items. The government or designated representative retains the right of review and disapproval of PMPCB decisions while present at the PMPCB meeting or within a mutually agreed upon period. All PMP activities at subcontractors, major suppliers, and vendor selected, and all PMP items installed in flight, qualification and proto-qualification hardware shall be managed through the PMPCB. All program contractors and subcontractors shall support the PMPCB in performing and/or implementing the decisions, findings, and action items of the PMPCB. Subcontractor participation in routine PMPCB meetings may be left to the discretion of the PMPCB Chairman, who may only require such support on an as-needed basis.

The contractor shall implement procedures and processes that define PMPCB functions, roles, responsibilities, membership, (e.g., organizational chart, meeting procedures, data submittals, record keeping (agendas, meeting minutes, decisions, action items, etc.)), and interactions with other program functions; (e.g., failure review boards, material review boards, configuration control boards, survivability working groups, etc.). The PMPCB chairman shall hold regularly scheduled meetings as determined necessary to ensure program requirements are met.

4.2.1 Delegation

The authority to conduct PMPCB meetings may be delegated by the prime contractor PMPCB chairman to major subcontractors, where the technical area is appropriate to the subcontractor. Each organization so delegated shall provide the higher acquisition activity PMPCB chairman (or delegate) and the government, and/or representative, the opportunity to participate in PMPCB meetings. All subcontractor PMPCB information and decisions shall be made available in a timely manner to the prime contractor and the government. The prime contractor and the government retain the right of review and disapproval, of delegated PMPCB decisions.

4.2.2 PMPCB Responsibilities

The PMPCB shall establish operating procedures in accordance with this document, including:

a. Establish and maintain under configuration control all Parts, Materials and Processes Lists (PMPSL, ADPMPL and ABPMPL) for the overall system. The PMPCB shall review and approve the initial versions and all subsequent revisions to the PMPSL, ADPMPL and ABPMPL.

b. Review and approve all Parts, Materials or Processes Approval Requests (PARs/MARs), with supporting details, to ensure all PMP program technical requirements (i.e. current version of Aerospace TOR-2006(8583)-5236) are met.

c. Interface with the design activity to ensure the design selection and use of PMP that meets the technical program requirements.

d. Ensure derating of all electronic, electromechanical, and electro-optical parts, and adequate design margins for mechanical parts used in deliverable end items.

e. Ensure the performance of lot screening, testing and/or qualification, Destructive Physical Analysis (DPA), and Prohibited Materials Analysis (PMA) of parts and materials, including the establishment of policies, procedures, and reporting formats. A summary list of all DPA and Lot testing (Qualification, Screening, QCI, Radiation Testing etc.) shall be presented to the PMPCB. This list shall include as a minimum: the Quantity accepted, Lot Pass/Fail for (DPA and lot

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testing), and final Disposition for each P/N, Manufacturer, Cage Code, Lot No/Lot Date Code. Problems and anomalies of concern shall be reviewed and dispositioned by the PMPCB.

f. Ensure re-procurement of all parts and materials meet all aspects of the technical requirements.

g. Ensure the review of Material Review Board (MRB) actions, Failure Analysis Reports, Failure Review Board actions, and any other actions pertaining to PMP.

h. Ensure the timely identification of long lead and other problem procurements.

i. Ensure the identification and configuration control of any changes to PMPCB approved documentation (e.g., EEEE part qualification or QCI tests, PARs/MARs, etc.), including the incorporation of special tests and associated criteria. The PMPCB shall also ascertain that appropriate systems are in place at all program supplier levels to identify and control such changes. All proposed changes to approved documents shall be communicated to the PMPCB for review and approval prior to implementation.

j. Ensure that laboratories and analysis facilities used for screening and/or evaluation of PMP are assessed for their capabilities (equipment and software, personnel and documented practices/procedures) in complying with the requirements of this document.

k. Establish and maintain a Prohibited PMP List.

l. Review all GIDEP, NASA, DOD, contractor, subcontractor, and other agency PMP alerts, advisories and reports for relevance to items used in the program/system and ensure appropriate mitigation is implemented.

m. Ensure that vendor facilities (including outside suppliers and internal contractor facilities), equipment and personnel that are used to manufacture parts and materials are audited for compliance to program requirements before actively engaging in producing products for the program. Government or other contractor independent resources may be used to accomplish the audit.

n. Manage the New Technology Insertion in accordance with the approved plan (see Appendix D herein). The PMPCB shall ensure that new technology PMP have been determined to be qualifiable by PDR, all long lead items have been released for procurement and all planned PARs/MARs have been submitted and approved by the PMPCB by CDR, or closure plans are in place.

o. Review and approve any revalidation plan and associated data for age-sensitive parts and materials.

All PMPCB decisions shall be documented in the meeting minutes. All supporting technical data or analyses shall be provided and attached to the minutes. Any additional analysis and/or test per the PMPCB direction shall be conducted and the results also attached to the minutes.

4.3 Parts, Materials and Processes Functions, Roles, and Responsibilities

The contractor shall define, plan, and implement the functions, roles, and responsibilities within the program's organization. This shall include both functional and programmatic reporting.

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4.3.1 Requirements Derivation and Flowdown Process

The contractor shall implement procedures and processes for the generation, analysis, flowdown, and verification of PMP requirements from the contract statement of work, top level system specification, the system environmental requirement specification(s), and other contractual documents as required, to lower level systems / segments / product specifications, subcontractor statement of work, and PMP specifications.

4.3.2 Parts, Materials and Processes Selection Process

The contractor shall implement procedures and processes for the selection and application of PMP items. All PMP selected and applied in the system shall meet the program technical PMP and system performance requirements. The PMPCB is responsible for ensuring that PMP used throughout the system meets the application, reliability, quality, and survivability requirements as derived from the system level requirements. The contractor shall develop a Parts, Materials, and Processes Selection List (PMPSL) to be used by all contractors and subcontractors on the program. Subcontractors may have their own PMPSL which meet all requirements of this document and is reviewed and approved by the prime contractor PMPCB. Changes to a previously approved PMPSL and ADPMPL shall be presented to the PMPCB for evaluation and approval. A PAR/MAR shall be prepared and submitted to the PMPCB for approval. One PAR/MAR may cover all the dash numbers in a Source Control Drawing, or slash sheet of the MIL spec, that will be used on the program (like in the case of capacitors or resistors, etc.).

4.3.2.1 PMP Procurement

The prime contractor is responsible for ensuring compliance of any PMP to all system and program requirements specified in the contract. Parts and materials shall be procured to the Space Quality Baseline (SQB) or to contractor prepared drawings (e.g. SCDs) that fulfill the program technical requirements (e.g. Aerospace TOR-2006(8583)-5236, Technical Requirements for Electronic Parts, Materials, and Processes Used in Space and Launch Vehicles), including the manufacturing baseline (see Section 3 definition), and ensure their equivalency to the SQB qualification, characterization, environmental stress capability, long-term reliability, and survivability (if applicable).

While either approach is technically and contractually acceptable, the government's preference is to maximize the use and procurement of military qualified products listed in the SQB. This will facilitate the continued, consistent and readily available sources of supply for high reliability PMP that meet space system requirements and applications.

The Space Quality Baseline (SQB), as defined in 5.1, represent those PMP items that are available within the industry and have a demonstrated heritage of high reliability, whose technology has been formally qualified to a military standard, and for which the suppliers have been formally certified by DSCC as having disciplined and documented practices and processes consistent with high reliability applications. SQB parts and materials shall not require additional approval when used for applications meeting all specification limits, derating and application conditions and restrictions. These parts, when applied in full compliance with the requirements of this document and TOR-2006(8583)-5236, shall be considered standard parts.

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4.3.3 Parts, Materials and Processes Characterization and Evaluation Process

The contractor shall implement procedures and processes for the characterization and evaluation of PMP items to verify they meet the program performance and PMP technical requirements. The procedures and processes shall include, but are not limited to:

a. Analytical methodologies used to select PMP components; e.g., functional, design margin

b. Electrical stress, derating, reliability, thermal, radiation hardness assurance analyses, etc.

c. Outgassing, contamination, and cleanliness

d. Corrosion control, stress corrosion cracking, dissimilar metals / materials analysis

e. Atomic Oxygen and micrometeoroid environmental analysis

f. Parts and materials obsolescence

g. Supplier selection and qualification, including counterfeit PMP prevention

h. Technology insertion and qualification

i. Prohibited and restricted PMP

4.3.3.1 Part & Circuit Stress Analysis

The contractor shall implement procedures and processes for performing part and circuit stress analysis. The contractor shall complete the part and circuit stress analysis prior to design release. The analysis shall take into account part parameters such as steady state and transient power loadings for analog circuits and power circuits, propagation delay compatibility for digital circuits and common mode protection for amplifiers. The analysis shall include temperature profiles for individual parts and thermal models that account for environmental factors, structural conduction, effects of power loading on junction temperatures or other applicable parameters where heat accelerates the wear-out mechanism of a given device. The analysis shall also include radiation effects degradation, and other end-of-life phenomenon.

The results of these analyses shall be used as inputs to the Failure Mode Effects and Criticality Analysis (FMECA), Worst Case Analysis (WCA) and other analytical analyses.

4.3.3.2 Parts Derating Criteria

The contractor shall establish a uniform derating policy that meets the system technical requirements and the derating requirements for flight conditions defined in Aerospace TOR-2006(8583)-5236 (Technical Requirements for Electronic Parts, Materials, and Processes Used in Space and Launch Vehicles). This policy shall be implemented on all parts and materials used by the contractor and subcontractors alike for all flight, qualification and/or proto-qualification hardware. The PMPCB shall review and approve the derating policy used on the program, and any exceptions requested thereafter. All electrical, electronic, electromechanical and electro-optical (EEEE) parts and materials shall be derated for power loading, temperature, duty cycle, service life, and radiation exposure, as applicable. The derating policy shall address degradation sensitive parameters and maximum expected variations over the program mission life. If a part or material selected for an application is not covered by the

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derating criteria defined in Aerospace TOR-2006(8583)-5236, the derating shall be determined on a case-by-case basis and approved by the PMPCB.

The contractor may offer its own equivalent internal derating plan for PMPCB review and approval, which shall be technically justified, as a minimum, with Part Stress and Worst-Case Analyses that support the required mission duration. MIL-STD-975 (CANCELED) derating requirements may be used to justify applications between the nominal and worst-case flight derating requirements of TOR-2006(8583)-5236.

4.3.3.3 Commercial Off the Shelf Components and Assemblies

The contractor shall implement procedures and processes ensuring that Commercial Off the Shelf (COTS) items meet the system performance, application and PMP technical requirements of this document and shall be approved by the PMPCB. All COTS items shall be treated as new technology. COTS that cannot be baselined and verified shall be prohibited.

4.3.4 Parts, Materials, and Processes Drawing Review

The contractor shall implement procedures and processes for review and approval of program engineering drawings and product specifications by the responsible PMP organization. As part of the drawing review process, the responsible PMP organization shall, as a minimum:

a. Ensure that the proper and correct PMP requirements are stated in program product specifications and in subcontractor procurement specifications.

b. Ensure that the PMP listed on the engineering drawings (parts list and drawing notes) are approved for use in the intended application (with its specific thermal, radiation, electrical, and mechanical stresses), and that they are correctly listed on the As-Designed PMP List.

c. Ensure that Prohibited PMP items are not used.

d. Ensure that Restricted usage PMP items (if used) are being used in the intended function with the correct controls, cautions, and application notes (including any additional screening/test for risk mitigation).

e. Ensure that the parts and materials are properly derated for thermal, radiation, electrical, and mechanical stresses.

f. Ensure that materials are not selected which may adversely interact with other parts or materials as a result of corrosion, stress corrosion, outgassing or other degrading mechanisms.

4.3.5 Parts, Materials, and Processes Prohibited and Restricted Usage Items

The contractor shall implement procedures and processes to publish, maintain, and conduct full configuration control of a prohibited PMP items list, and a restricted usage PMP list. The restricted usage PMP List shall include parts and materials meeting any of the following:

a. Restricted in temperature range capability due to performance limitations within a reduced temperature range

b. Exceed outgassing requirements

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c. Are registered/reliability suspect, or have known reliability hazards due to inherent design weaknesses, GIDEP recalls, internal purge/scrap actions, or any lot-related problem

d. Are COTS products

e. Are a risk for introducing contamination

f. Have restrictions that limit usability across all applications

g. GIDEP alert, GIDEP advisory with reliability/latent failure concerns, or other Alert issues

The prohibited PMP items list and the restricted usage PMP list shall be included in the flowdown of requirements to Program suppliers, and subcontractors. The contractor shall be responsible for ensuring that prohibited items are not used in the design and construction of flight, qualification, and proto-qualification hardware and that all uses of Restricted PMP are submitted to the PMPCB on a PAR/MAR for review and disposition.

4.3.5.1 Use of Plastic Encapsulated Microcircuits (PEMS) and Other Plastic Encapsulated (Active) Devices (PEDS)

A PEM or PED shall not be substituted for a form, fit, and functional equivalent, high reliability, hermetic device in flight, qualification or proto-qualification hardware. All usage of PEMS/PEDS in new applications, or usage of devices from a new lot, shall be submitted on a PAR for review and disposition by the PMPCB against the original application or lot data. If required by the PMPCB, an appropriate new technology insertion plan shall be developed for each new lot and/or application.

The contractor shall implement procedures and processes to ensure that the PEM, if used, meets the system performance and PMP technical requirements of the program, and shall have been approved by the PMPCB.

4.3.5.2 Prohibited Materials: Use of Lead-Free Solders, Tin and Other Prohibited Metal Finishes

The contractor shall prohibit the use of pure tin, or >97% tin by weight, internally or externally, as an underplate or final finish in the design and manufacture of parts and materials for use in the program, including (but is not limited to) EEEE parts and their packages/terminals/leads, mounting hardware, solder lugs, EMI shields, and spacecraft structures. Tin shall be alloyed with a minimum of 3% lead (Pb) by weight.

Lead-free tin alloy coatings or solders have not been approved for use on space hardware. The contractor shall demonstrate that the lead-free tin alloy soldering process used to manufacture the equipment meets the program's requirements for reliability, mission life, parts compatibility, rework and thermal, vibration and shock environments. The information provided shall include data from design of experiments, life test results, whiskering and /or tin pest susceptibility evaluation results, statistical process control monitor data, temperature / materials compatibility analyses, and mechanical test results. Customer program management shall review and approve this plan. Note that Sn96/Ag4 and Sn95/Sb5 are standard solder-attach materials used in high temperature soldering applications and are acceptable for those applications only. Tin plated wire may be used provided that for each lot of wire, all the tin has been converted to copper-tin intermetallic as demonstrated by chemical analysis. In addition, the solderability of the wire shall be verified.

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The contractor shall also prohibit the use of materials capable of emitting excessive vacuum condensables, noxious or toxic gases when exposed to low pressure or high temperature. Pure zinc, pure cadmium, selenium, or mercury shall not be used. The actual acceptable percentages of zinc and cadmium in alloys or brazes and the extent of overplating, when required, shall be technically substantiated with data for the intended applications and shall require PMPCB approval prior to use.

4.3.6 Parts, Materials, and Processes Risk Management

The contractor shall implement across the program procedures and processes for identifying, assessing, mitigating, tracking, and reporting PMP critical risk items. Such risks shall include both schedule (delivery) and technical risks (such as, qualification, temperature, radiation, reliability, single source, off-shore source, new technology, long lead procurement, etc). The PMP critical risk items shall be reported to the PMPCB and program management.

4.3.7 Parts, Materials, and Processes Subcontract and Procurement Management

The contractor shall implement procedures and processes for the oversight of subcontractors' and suppliers' PMP activities. The contractor shall validate that no prohibited part or material is procured by subcontractors or suppliers. The contractor shall also validate that each subcontractor and suppliers have established processes and procedures to prevent the procurement of counterfeit PMP items. The procedures and processes shall include descriptions for each of the following subparagraphs:

4.3.7.1 Review and Approval of Subcontractor PMP

The contractor shall implement procedures and processes for the review, approval (or disapproval) of subcontractor PMP. The review shall consist of assessing the subcontractor's internal PMP documentation, processes, and procedures to ensure compliance with all PMP technical requirements

4.3.7.2 Parts, Materials, and Processes Supplier Selection, Qualification and Monitoring

The contractor shall implement, and require all subcontractors to implement, procedures and processes for the selection, qualification, periodic re-qualification and monitoring of PMP suppliers, manufacturers, and laboratories. The process shall specify the selection criteria, control of software and hardware configurations, frequency of re-visits, problem resolution, and Customer Source Inspection (CSI) procedures. The findings / results of these audits and reviews shall be submitted to the PMPCB for review.

4.3.7.2.1 PMP Qualification

All PMP, including any processes developed to accomplish rework, repair or retrofit, shall be qualified for program use. Only qualified PMP shall be used on flight hardware. For each non-qualified PMP, the contractor, through the PMPCB, shall prepare a qualification plan and procedure based on the program technical requirements. The qualification plan shall identify all conditions and testing necessary to meet the program and mission reliability requirements. These plans and procedures shall be reviewed and approved by the PMPCB. A summary report of qualification test results shall be submitted to the PMPCB for review.

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4.3.7.2.1.1 Manufacturing Baseline

As part of the qualification plan for each non-SQB PMP, the contractor shall ensure the review and approval of the supplier manufacturing baseline (see Section 3 for definition) for compliance with all program requirements and the part procurement specification. Any subsequent change to the manufacturing baseline that results in a revision to the approved specification or validity of previous qualification data shall be submitted to the PMPCB for review and approval prior to implementation.

4.3.7.2.1.2 Extension of Qualification

Parts, materials, or processes may be qualified by extension when both of the following criteria are met:

a. The part, material, or process was successfully used in a prior but recent space application in which the application environment conditions of use and test were at least as severe as those required of the candidate PMP for qualification.

b. The part or material is of identical construction or contains constituents identical in composition and near identical in significant properties as the previously qualified part or material. The part or material is manufactured by the same manufacturing facility to the same manufacturing baseline as the previously qualified part or material, and the utilization of the part or material does not result in critical stresses or mechanical strain (such as due to thermal mismatch) greater than the previously qualified part or material. Qualification by extension shall be based on a review of supporting data by the PMPCB. Additionally, the previous qualification test was completed within two years of submittal of the request for qualification extension.

4.3.7.3 Authorized Sources of Supply

All parts and materials shall only be procured from the original qualified parts/materials equipment manufacturer (OEM), or its franchised/authorized distributor, and shall come with a Certificate of Conformance (C of C) and other required data in accordance with the applicable military specification, space-level-equivalent SCD, and other quality notes / requirements listed on the procurement / purchase order.

4.3.7.4 Customer Source Inspection (CSI)

The contractor shall establish and implement processes and procedures for conducting CSI, including determining which products or parts are to be inspected, at what points in the process, and what CSI review activities are required. CSI points shall also be identified in the sub-tier procurement documents and flowcharts. The CSI review may include, but is not limited to, the following:

a. Review of the manufacturer's process documentation

b. Review of the documentation that accompanies each lot

c. In-process inspections that are not available non-destructively upon receipt, such as prior to plating, pre-cap visual, etc

d. Verification that manufacturing steps, tests, and inspections have been performed as specified for each part or item type

e. Verification that the required inspections by the manufacturer's Quality Control Department have been properly performed, and the travelers completed

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f. Verification of lot integrity and traceability of parts and materials as defined in the specifications

g. Review of test or inspection data, witnessing and/or performing the required inspections / tests in accordance with detailed instructions and procedures

h. Review of Statistical Process Control (SPC) and/or Technology Review Board (TRB) optimization data

i. Review of all Material Review Board (MRB) non-conformance dispositions and all failure data. These, along with all data required by the purchase order, shall be forwarded to the PMPCB for review and approval.

4.3.7.5 Fasteners, Bolts, Screws, Rivets, and other Mechanical Piece Parts

The contractor shall implement procedures and processes to ensure that fasteners, bolts, screws, rivets and other mechanical piece parts meet the structural, strength, torque, and plating requirements of their procurement specification. If fasteners, bolts, screws, rivets, nuts and other mechanical piece parts are procured using Industry Standards (such as ASTM, SAE, ANSI, NASM, AMS, etc), the contractor shall require the supplier to provide a lot qualification report showing that the delivered parts and materials meet the requirements of the procurement specification. A certificate of conformance shall not be substituted for the lot qualification report.

4.3.8 Parts, Materials, and Processes Traceability and Lot Control

The contractor shall implement across the program procedures and processes for establishing lot date/batch number control and two-way traceability for PMP manufactured into flight, qualification, and proto-qualification hardware. These procedures and processes shall be written into a traceability plan, which requires PMPCB approval. The contractor and subcontractors shall be able to determine by searching electronic records which part numbers, part manufacturers, lot date codes and individual device serial numbers (where applicable) are being used in which serial number of the next higher level assemblies / components or next lower level of assembly (e.g., elements internal to a hybrid), as the case may be.

4.3.9 Parts, Materials, and Processes Incoming Inspection

The contractor shall implement across the program procedures and processes for the incoming inspection of parts and materials, including the DPA of parts or materials to ensure that they meet the requirements of the procurement specification. Compositional analysis of all metal surfaces (both internal and external to the part or material) to verify the absence of prohibited materials shall be performed as part of incoming inspection. DPA shall be done in accordance with MIL-STD-1580 with the exceptions specified in Aerospace TOR-2006(8583)-5236 and/or as approved by PMPCB. Incoming inspection requirements shall be established consistent with any CSI requirements.

4.3.10 Parts, Materials and Processes Defective Material Control

The contractor shall implement across the program procedures and processes for the control and disposition of defective, discrepant and non-compliant PMP items. Non-conforming PMP items shall be reported to, reviewed and approved by the Material Review Board prior to being presented to the PMPCB for review and disposition. MRB actions that do not result in the use of discrepant material, such as scrap, Return-to-Vendor (RTV), etc., need not be presented to the PMPCB. Non-conforming PMP include any item that failed during manufacturing, assembly and testing of flight, qualification

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and proto-qualification hardware. The information shall be provided to the contractor's Failure Reporting and Corrective Action System (FRACAS) or equivalent.

4.3.10.1 Re-use of Parts and Materials

The contractor shall implement across the program procedures and processes to ensure that when parts or materials, once installed in an assembly (i.e., one terminal, lead or contact and/or device body has been permanently attached), and then removed from the assembly for any reason, are not re-installed in any flight, qualification, or proto-qualification hardware item without PMPCB approval if their installation and or removal require:

a. Deformation or environmental stresses beyond the limits allowed by the device specification.
b. Application of a force or elevated temperature by the operator to and from a bonding material.
c. Soldering, desoldering or debonding of a lead or electrical contact point.

Parts and materials shall likewise not be used again if, after removal, they cannot be physically or mechanically, and electrically (EEEE parts) inspected sufficiently to verify integrity and suitability for re-use

4.3.10.2 Failure Analysis

The contractor shall implement across the program procedures and processes for participation of a PMP representative on the program's failure review board (FRB). The contractor shall describe the procedures to be performed for failure analysis on PMP items.

Failure analysis shall be performed on confirmed part, material and process failures experienced during manufacturing, assembly and testing at all levels of integration up to system level, including pre-launch check-outs, and all catastrophic open and short circuit failures (i.e., non-parametric) during part qualification and testing, unless otherwise required by the governing MIL specification. This requirement does not apply to parts qualified/tested to military specifications, which have their own set of requirements for failure analysis, determination and disposition under DSCC oversight.

Failures shall be analyzed to the extent necessary to understand the failure mechanism and cause, to detect and correct out-of-control processes, to determine the necessary corrective actions, and to determine lot disposition. When required, a Failure Summary and Analysis Report (FSAR), reference: DI-RELI-80255 and Appendix C herein, shall be prepared and reviewed by the PMPCB. The PMPCB shall determine and implement appropriate corrective action for each PMP failure. All confirmed failures, and the results of final failure analysis, shall be reported to the PMPCB. Failure analysis reports shall be retrievable for the duration of the contract, and shall be available to the acquisition activity. When required, a Failed Item Analysis Report, reference: DI-RELI-80253 shall be prepared and reviewed by the PMPCB.

4.3.11 Handling, Storage, Packaging and Preservation Control

4.3.11.1 Handling and Storage Procedures and Processes

The contractor shall implement across the program handling and storage procedures and processes to prevent part and material degradation. The handling and storage procedures shall be maintained from

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receipt of parts and materials through inspection, kitting and assembly. These procedures shall include, but are not limited to:

a. Clearly identifiable containers/markings to identify space quality parts

b. Control measures to limit personnel access to parts and materials during receiving inspection and storage

c. Facilities/provisions for interim storage of parts and materials, as necessary

d. Provisions for protective cushioning, as required, on storage area shelves, and in storage and transportation containers

e. Protective features of transportation equipment design to prevent packages from being dropped or dislodged in transit

f. Protective bench surfaces on which parts and materials are handled during operations such as test, assembly, inspection, and organizing kits

g. Required use of gloves, finger cots, tweezers, or other means when handling parts to protect the parts from contact by bare hands

h. Provisions for protection of parts susceptible to damage by electrostatic discharge

4.3.11.2 Electrostatic Discharge Prevention and Control

The contractor shall implement, and require all subcontractors to implement, procedures and processes for prevention and protection of Electrostatic Discharge (ESD) sensitive parts and assemblies to the lowest voltage of the most sensitive part. The PMPCB shall review and approve all subcontractor ESD procedures and processes.

4.3.11.3 Preservation and Packaging

The contractor shall implement across the program processes and procedures for the preservation and packaging of parts and materials. All parts that are subject to degradation by electrostatic discharge shall be packaged in accordance with contractor approved ESD procedures.

4.3.12 Destructive Physical Analysis

The contractor shall implement, and require all subcontractors to implement, procedures and processes for performing Destructive Physical Analysis (DPA), consistent with program technical requirements and MIL-STD-1580. The procedures shall include provisions for: sample sizes/confidence levels, in-house facility versus an outside test laboratory, part types, and DPA methodology per MIL-STD-1580, or PMPCB approved equivalent. Unless otherwise specified in the contract statement of work or system specification, the contractor and all subcontractors shall perform a DPA on the parts types listed below including all devices procured to military specifications listed in the SQB. For small lots, the contractor can implement a small lot sampling plan approved by the PMPCB.

a. Capacitors, All types

b. Connectors, All types, including connectorized attenuators and filtered connectors

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c. Crystals, Quartz and Crystal Filters

d. Filters, EMI, Low-Pass, Feed-Thru, RFI, Metal Cased, RC Network (ARC Suppressor)

e. Fuses, solid body and hollow-core

f. Hybrid Modules, All classes

g. Magnetics (closed construction transformers, inductors/coils, RF coils, Motor / actuator windings)

h. Microcircuits, all classes including Plastic Encapsulated

i. Optically Coupled Isolators

j. Oscillators

k. Semiconductors, all classes including Plastic Encapsulated

l. Switches, all types

m. Thermistors (Disc and Bead) Encapsulated, Glass Bodied Hermetic

n. Relays (Electromechanical and solid state)

o. Resistors, for the types specified in Aerospace TOR-2006(8583)-5236

p. Optical/electro-optical devices

q. Passive RF devices

Unless otherwise required by the contract statement of work, the contractor shall maintain a record of all DPA reports and provide an electronic copy of the reports to the government program office, if requested. A summary list of all DPAs shall be presented to the PMPCB, which shall include as a minimum: the Quantity accepted, Lot Pass/Fail for (DPA and lot testing), and final Disposition for each P/N, Manufacturer, Cage Code, Lot No/Lot Date Code. Problems and anomalies of concern shall be reviewed and dispositioned by the PMPCB. Subcontractor DPA reports shall be maintained by the subcontractor and shall be made available upon request. Any Reject/Use-As-Is DPA report shall be dispositioned by PMPCB and an electronic copy maintained by the contractor.

4.3.13 Parts, Materials, and Processes Shelf Life Control

The contractor shall implement, and require all subcontractors to implement, shelf life control procedures and processes that identify the shelf life limitations for all parts and materials used on flight, qualification, and proto-qualification hardware. These procedures shall specify the storage conditions, length of time required, and minimum requirements for re-inspection, retest, or any other action required to ensure maintenance of space flight quality and reliability. The procedures shall be reviewed and approved by the PMPCB, and controls identified to ensure that they are followed before parts and materials are kitted and issued to assembly.

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4.3.13.1 Material and Mechanical Shelf Life Control

In addition to general age limitation considerations, the procedures shall identify any specific environmental requirements for storage (i.e., temperature, humidity, storage in dry nitrogen, etc.) and any associated limitations on shelf life of materials. Limitations shall be listed on the PMPSL and ADPMPL (see 4.4 and 4.5 herein). For organic materials, shelf life requirements (and extensions) shall be based on the original manufacturer's recommendation; otherwise, the extension process shall be reviewed and approved by the PMPCB.

For mechanical parts or assemblies, metallic and ceramic materials, when technical requirements are not provided in the appropriate sections of the Aerospace TOR-2006(8583)-5236, both the minimum shelf-life and the maximum period of time after procurement before retesting is required shall be seven (7) years unless otherwise approved by the PMPCB.

4.3.13.2 Parts Shelf Life Control

The plan or referenced procedures shall specify the length of time required and minimum requirements for re-inspection, retest, or any other action required to ensure the maintenance of space flight quality and reliability. The plan shall identify the part types considered to be potentially age sensitive, and the specific actions necessary to evaluate and/or re-validate these parts. As a minimum, the PMPCB shall review the flight worthiness of parts older than 7 years.

The plan shall define the specific age or shelf life limit for each part. The plan should consider a pedigree review and actions similar to that shown below for parts older than 7 calendar years (initially based on Date Code, then last validation date thereafter).

When parts exceed specified age limits in storage, the parts shall be revalidated, if permitted, per the requirements of the shelf life control plan. The actions taken shall be as specified in the control plan or the PMPCB shall provide direction based upon the following considerations:

a. Assess original part quality (Class S, SCD, Class B, etc.)

b. Assess lot and part history (supplier's percent defective, quantity used to date, number of failures, etc.).

c. Review of original lot screening/test data.

d. Review of problem/GIDEP Alerts.

e. Review of original DPA.

f. Part obsolescence

g. Availability of replacement parts

h. Review storage environment and controls (temperature, ESD protection, handling, etc.).

i. When possible, consider application criticality, redundancy, etc.

j. When retest/re-screening appears warranted, assess availability of retest equipment, outside re-screening facilities, potential for part damage during re-screening, etc.

k. Program technical requirements for screening shall be used as guidance for any planned re-screening of product due to shelf life limitations.

Problems found during re-screening and DPA shall be investigated in order that the rest of the lot may be dispositioned properly, whether scrapped or subjected to additional testing. Also after the pedigree

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review, any test that may be required to re-accept the lot for flight use or to address problems found during re-screening and DPA shall be presented to the PMPCB for review and approval prior to implementation.

4.3.14 Use of Alternate QCI and Small Lot Sampling Plans

The contractor may implement alternate Quality Conformance Inspection (QCI) procedures and processes and a small lot sampling plan for small lot quantities in accordance with the program's technical requirements. The PMPCB shall review and approve these procedures and processes.

4.3.15 Government Industry Data Exchange Program (GIDEP) Participation

The contractor shall implement procedures and processes for their participation, and their subcontractors' participation, in the GIDEP program, including the submission of alerts/advisories to GIDEP when warranted. The processes and procedures shall describe how the contractor (a) receives alerts and advisories from GIDEP and other agencies, or internal sources, (b) determines any impact to their product design and already manufactured hardware, (c) implements corrective action procedures when design and / or produced hardware are affected, and (d) how all of the above are flowed down to subcontractors. The results of all impact assessments for GIDEP and other agency alerts/advisories shall be reported and documented in the PMPCB meeting minutes.

4.3.16 Parts, Materials and Processes Corrosion Control

The contractor shall implement across the program procedures and processes for the analysis and prevention of corrosion. This includes dissimilar metals, launch integration environment(s), and on-orbit operation effects (including atomic oxygen effects, if applicable) on spacecraft surface materials. The total life cycle environment (i.e., manufacturing, test, storage, transportation, satellite integration, launch vehicle integration, launch site preparations, launch pad, ascent, and on-orbit) shall be used in the corrosion control analysis.

4.3.17 Contamination Control Program

The contractor shall develop and implement across the program a Contamination Control Plan (a typical example is shown in Figure 4.3-1) for the development, analysis and implementation of contamination control processes and procedures, including the outgassing of polymeric and organic materials.

4.3.17.1 Contamination Control Requirements Analysis

The contractor shall implement processes and procedures for the generation, analysis, flowdown and verification of contamination control requirements. The generation of contamination control requirements shall be based on the System's Concept of Operations (CONOPS) document, the system environmental specification, manufacturing, assembly, test, integration, launch site integration and on-orbit environments.

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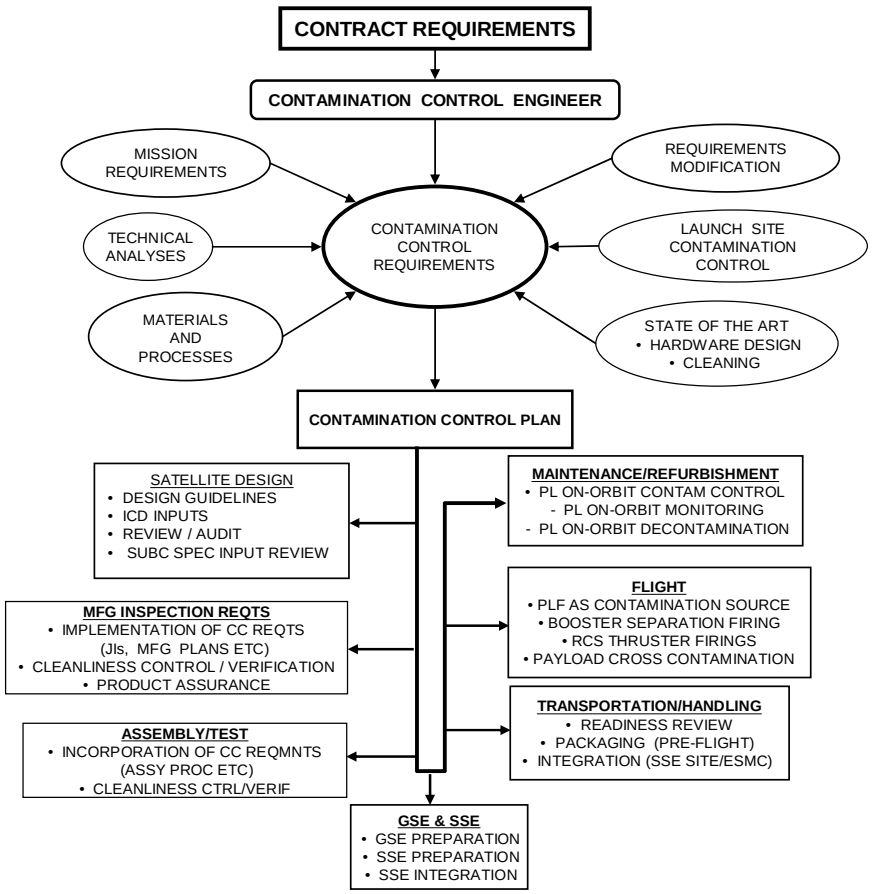

Figure 4.3-1. Typical interactions of contamination control with program elements.

4.3.17.2 Cleanliness Requirements and Clean Room Environmental Controls

The contractor's processes and procedures shall define materials selection criteria; design techniques for avoiding contamination; cleaning or conditioning methods to be employed; and environmental cleanliness controls for the manufacture, assembly, test, integration, storage and operations of all flight, qualification, and proto-qualification hardware and special test equipment that will be located and/or operated in clean rooms, and, if required, launch site operations.

4.3.17.3 Outgassing of Materials

When required by the Contamination Control plan, all polymeric and organic materials shall be tested for outgassing in accordance with ASTM E 595, and the results documented on the ADPMPL and ABPMPL. As a guideline, materials should exhibit a total mass loss (TML) of not more than 1.0 percent and a collected volatile condensable material (CVCM) of not more than 0.1 percent. Data listed in the NASA Reference Publication 1124 (see http://outgassing.nasa.gov/ for most current data) for applicable materials may be used in lieu of actual testing provided that the contractor determines that no chemical formulation changes have been made to the material between the time the material was tested by NASA and the procurement of the current batch of material.

The analysis performed as part of the Contamination Control Plan shall demonstrate that outgassing from all materials used in the space vehicle, their mass and locations, including water vapor residue

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(WVR), do not degrade the performance of payload and bus systems, subsystems and units, such that they cannot meet the end-of-life requirements with adequate margin.

4.3.17.4 Training and Certification

The contractor shall implement processes and procedures for the training and certification of all personnel including representatives of the acquisition activity and subcontractors who have access to clean rooms. The training and certification procedures shall include prevention of contamination, foreign object damage prevention, clean room operating procedures, handling and operating of equipment in the clean room, and notification of a contamination event.

4.3.18 Parts and Materials Radiation Hardness Assurance Control

The contractor shall implement procedures and processes for the participation of the PMP engineering group on the program's survivability working group.

4.3.18.1 Radiation Hardness Assurance Control Program

The contractor shall develop and implement a Radiation Hardness Assurance (RHA) Program for the design, development and production of all qualification, proto-qualification, and flight hardware in accordance with Appendix B. The PMPCB shall be responsible for ensuring that all parts and materials hardness assurance parametric requirements have been established. An example of a typical Radiation Hardness Assessment is shown in Figure 4.3-2.

4.3.18.2 Integrating Subcontractor RHA Requirements

The contractor shall flowdown to all subcontractors the applicable RHA requirements to ensure parts and materials hardening requirements are met.

4.3.18.3 Radiation Hardness Assurance Processes and Procedures

The contractor shall implement radiation hardness assurance procedures and processes for:

a. Hardness assurance requirements derivation/ flowdown to the piece part level considering spacecraft surface materials, space radiation environmental effects analysis on system / circuit performance (natural space, and if applicable, man-made environments), for the worst case circuit conditions.

b. Circuit schematic, functional description, pin-out, operation conditions, and application of each critical circuit.

c. End-of-life radiation environment for each critical material and for piece parts in each critical circuit.

d. Design margin analysis.

e. List of piece parts for each critical circuit showing the radiation design margin between worst-case circuit requirements and the degradation of piece parts due to radiation.

f. List of materials subject to radiation degradation showing the radiation design margin between the worst-case requirements and the anticipated degradation of the material over its design life.

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g. Selection, characterization, and assessment of parts and materials.

h. Hardness assurance control requirements imposed on subcontractors and suppliers.

i. Determination of parts requiring radiation lot acceptance testing (RLAT).

j. RLAT procedures.

k. Hardness assurance data collecting and reporting.

l. Testability requirements and description of hardness assurance test items/test structures and process monitors.

m. Special controls, lot formation control, sample confidence level, screening and testing specified for parts with inadequate design margin.

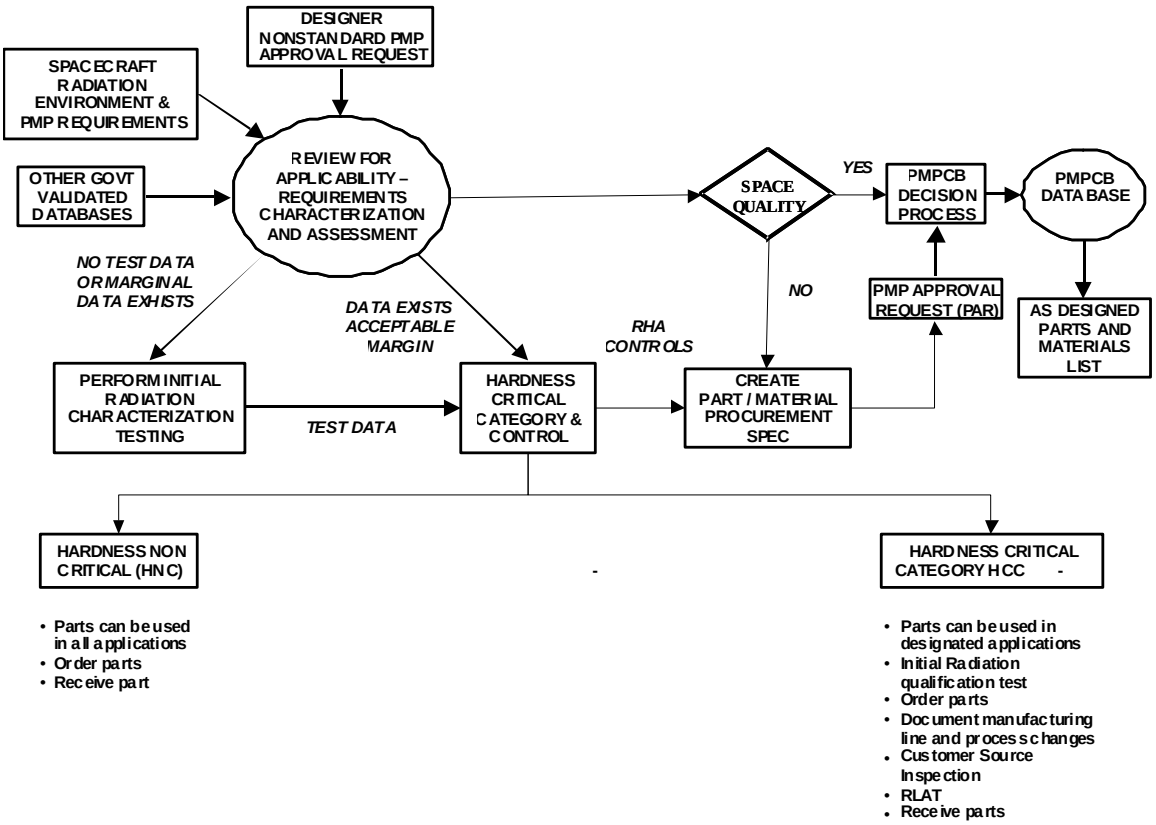

Figure 4.3-2. Typical radiation hardness assessment for selection of EEEE parts process flow.

4.3.18.4 Survivability / Radiation Hardness Assurance Design Guideline Document

The contractor shall prepare a RHA Design Guidelines, which details or references all radiation analysis procedures, test procedures, data formatting and reporting requirements for parts and materials.

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4.3.19 Survivability / Radiation Hardness Assurance Test Plan

The contractor shall prepare a system / component survivability test plan. The plan shall specify the test objectives, traceability to originating requirements, and the following:

a. Radiation test methods and test circuits.

b. Sample size/confidence level, and sampling method.

c. Radiation types and specification level.

d. Pre- and post-radiation response parameters and failure criteria.

e. Data reporting and analysis.

f. Radiation test facility and set-up

g. Dosimetry requirements.

h. Special radiation tests such as electrical or radiation screening tests.

4.3.20 Government Furnished Equipment

Parts and materials contained in unmodified government furnished equipment (GFE) used in qualification, proto-qualification, and/or flight hardware shall not be subject to the contractor's PMP control, except for storage, handling, integration and testing.

4.3.21 USAF Space Parts Working Group (SPWG)

The contractor is encouraged to provide representation to the United States Air Force (USAF) Space Parts Working Group meetings. These meetings are held every year at or near the USAF Space and Missile Systems Center (SMC) facility. The purpose of the meeting is to provide a forum for the exchange of information relating to technical, procurement, application and status issues of interest involving space programs and space quality parts, materials and processes.

4.3.22 Data Retention

The contractor shall establish procedures for the retention of data and records to include as a minimum incoming inspection test data, lot qualification and acceptance test data, DPA samples, radiation hardness assurance test data, traceability data and other data as determined by the PMPCB for the life of the program or a period of time specified by the acquisition activity.

4.4 Parts, Materials, and Processes Selection List.

The contractor shall document, maintain and configuration-control a Parts, Materials, and Processes Selection List (PMPSL). As a minimum, unless defined in the contract and statement of work, the contractor shall make available to the acquisition activity the preliminary anticipated PMPSL at contract award and SDR. This list shall contain a complete listing of all the electrical, electronic, electro-mechanical, electro-optical (EEEE), and mechanical parts, metallic and non-metallic materials, and processes that are available for use in the design of all flight, qualification, and proto-qualification hardware. The list may be in the contractor's format, but shall contain, as a minimum, the information

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described in the following subparagraphs and in the data formats shown in Appendix A. If identical parts from more than one manufacturer are approved for use, the PMPSL shall have a separate entry for each manufacturer. The subcontractors' PMP shall be included in the appropriate section of the PMPSL and be identified by their cage code number (if applicable) and subcontractor name. Limited application and registered PMP shall include (in the PMPSL) information on applicable restrictions and accompanying rationale.

4.4.1 Electrical, Electronic, Electromechanical, and Electro-Optical Parts List

The EEEE parts list shall contain the following data:

a. MIL-Spec / SMD / DSCC part number (if applicable)

b. Class / Level (K, V, S, etc.)

c. Manufacturer's Part Number

d. Contractor's Source Control Drawing (SCD) or internal part number

e. Part description, nomenclature, including technology (e.g., CMOS, HBT, etc.)

f. Additional Screening/Test Requirements (DPA, PIND, RGA, X-ray, RLAT (SEE and TID/ELDRS), Groups B, C and/or D screenings, etc.)

g. Approved / recommended supplier(s)

h. Application note and/or restriction information

4.4.2 Mechanical Parts List

The mechanical parts shall contain the following data:

a. MIL-Spec / ANSI / AMS / NAS Part number

b. Manufacturer's part number

c. Contractor's SCD or internal part number

d. Part description, Nomenclature

e. Additional Screening/Test and/or Preparation Requirements (hardness, tensile, surface finish verification testing, etc.)

f. Approved / recommended supplier(s)

g. Application note and/or restriction information

4.4.3 Metallic Materials List

The metallic materials list shall contain the following data:

a. MIL-Spec / ANSI / AMS / NAS Part number

b. Manufacturer's part number

c. Contractor's SCD or internal part number

d. Material description, Nomenclature

e. Stress Corrosion Cracking (SCC) Rating

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f. Form (Bar, Sheet, Plate, etc.)

g. Additional Screening/Test or Handling Requirements (hardness, tensile, surface finish verification testing, etc.)

h. Approved / recommended supplier(s)

i. Application note and/or restriction information

4.4.4 Non-Metallic Materials List

The non-metallic materials list shall contain the following data:

a. MIL-Spec / SAE number

b. Manufacturer's part number

c. Contractor's Source Control Drawing or Material Specification Part number

d. Material type / description / Nomenclature (e.g., polyurethane/potting compound/Arathane 5753, etc.)

e. Additional Screening/Test or Handling Requirements (hardness, tensile, adhesion verification testing, etc.)

f. Outgassing data and characteristics

g. Shelf Life Control requirements

h. Approved / recommended supplier(s)

i. Application note and/or restriction information

4.4.5 Processes List

The processes list shall contain the following data:

a. MIL-Spec / ANSI / AMS / NAS number (if applicable)

b. Manufacturer's process number

c. Contractor's internal process number

d. Type process (Bonding, Coating, Machining, Plating, Soldering, etc.)

e. Special Handling / Process Characteristics

f. Approved / recommended supplier(s)

g. Application note and/or restriction information

4.5 As-Designed Parts, Materials and Processes List

The contractor shall document and maintain under configuration control an As-Designed Parts, Materials and Processes List (ADPMPL). Unless defined in the contract and statement of work, the contractor shall make available to the acquisition activity the ADPMPL at PDR and CDR with clearly highlighted updates after CDR on an as required basis. This list shall contain a complete listing of all contractor and subcontractor electrical, electronic, electro-mechanical, electro-optical (EEEE), and mechanical parts, metallic and non-metallic materials, and processes used in the design of all flight, qualification, and proto-qualification hardware. The list may be in the contractor's format, but shall

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contain, as a minimum, the information described in the following subparagraphs and in the data formats shown in Appendix A. If identical parts from more than one manufacturer are used, the ADMPSL shall have a separate entry for each manufacturer. If the same parts are used in more than one location, each location (next higher level of assembly) shall have a separate entry. The subcontractors' PMP shall be included in the appropriate section of the ADPMPL and be identified by their cage code number (if applicable) and subcontractor name.

4.5.1 Electrical, Electronic, Electromechanical, and Electro-Optical Parts List

The EEEE parts list shall contain the following data:

a. MIL-Spec / SMD / DSCC part number (if applicable)

b. Class / Level (K, V, S, etc.)

c. Manufacturer's Part Number

d. Contractor's Source Control Drawing (SCD) or internal part number

e. Part description, nomenclature, including technology (e.g., CMOS, HBT, etc.)

f. Additional Screening/Test Requirements [DPA, PIND, RGA, X-ray, RLAT (SEE and TID/ELDRS), Groups B, C and/or D tests, etc.] placed in individual columns

g. Where used (assembly number and name of next higher assembly)

h. Manufacturer/Supplier/Cage Code (if known)

i. PAR number (if applicable)

4.5.2 Mechanical Parts List

The mechanical parts shall contain the following data:

a. MIL-Spec / ANSI / AMS / NAS Part number

b. Manufacturer's part number

c. Contractor's SCD or internal part number

d. Part description, Nomenclature

e. Additional Screening/Test and/or Preparation Requirements (hardness, tensile, surface finish verification testing, etc.) placed in individual columns

f. Where used (assembly number and name of next higher assembly)

g. Manufacturer/Supplier/Cage Code (if known)

h. PAR number (if applicable)

4.5.3 Metallic Materials List

The metallic materials list shall contain the following data:

a. MIL-Spec / ANSI / AMS / NAS Part number

b. Manufacturer's part number

c. Contractor's SCD or internal part number

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d. Material description, Nomenclature

e. Stress Corrosion Cracking (SCC) Rating

f. Form (Bar, Sheet, Plate, etc.)

g. Additional Screening/Test or Handling Requirements (hardness, tensile, surface finish verification testing, etc.) placed in individual columns

h. Where used (assembly number and name of next higher assembly)

i. Manufacturer/Supplier/Cage Code (if known)

j. MAR number (if applicable)

4.5.4 Non-Metallic Materials List

The non-metallic materials list shall contain the following data:

a. MIL-Spec / SAE number

b. Manufacturer's part number

c. Contractor's Source Control Drawing or Material Specification Part number

d. Material type / description / Nomenclature (e.g., polyurethane/potting compound/Arathane 5753, etc.)

e. Additional Screening/Test or Handling Requirements (hardness, tensile, adhesion verification testing, etc.) placed in individual columns

f. Outgassing data and characteristics

g. Shelf Life Control requirements

h. Where used (assembly number and name of next higher assembly)

i. Manufacturer/Supplier/Cage Code (if known)

j. MAR number (if applicable)

4.5.5 Processes List

The processes list shall contain the following data:

a. MIL-Spec / ANSI / AMS / NAS number (if applicable)

b. Manufacturer's process number

c. Contractor's internal process number

d. Type process (Bonding, Coating, Machining, Plating, Soldering, etc.)

e. Special Handling / Process Characteristics

f. Where used (assembly number and name of next higher assembly)

4.6 As-Built Parts, Materials and Processes List

The contractor shall document and maintain under configuration-control an As-Built Parts, Materials and Processes List (ABPMPL) for each end-item being delivered to the acquisition authority. Maintenance of the "As-built" data in each subcontractor's system shall be the responsibility of the sub,

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in order to maintain the integrity of the data. The contractor's final "as-built" hardware configuration shall include all EEEE parts, mechanical parts, metallic and non-metallic materials and processes used in manufacturing and assembling of the item being delivered to the acquisition authority. Any difference between the "As-Designed" and "As-Built" configuration PMP shall be clearly evident and reconciled. The information described below shall be readily accessible upon request of the acquisition authority. The contractor shall have a system that can retrieve and make available the information.

The final list may be in the contractor's format, but shall contain, as a minimum, the information described in the following subparagraphs and in the data formats shown in Appendix A. If identical parts from more than one manufacturer are used, the ABPMPL shall have a separate entry for each manufacturer. The subcontractors' PMP shall be included in the appropriate section of the ABPMPL and be identified by their cage code number (if applicable) and subcontractor name.

4.6.1 Electrical, Electronic, Electromechanical, and Electro-Optical Parts List

The EEEE parts list shall contain the following data:

a. MIL-Spec / SMD / DSCC part number (if applicable)
b. Class / Level (K, V, S, etc.)
c. Manufacturer's Part Number
d. Contractor's Source Control Drawing (SCD) or internal part number
e. Part description, nomenclature
f. Where used (assembly number and name of next higher assembly)
g. Quantity used in each assembly
h. Supplier's name and CAGE code
i. Lot-Date-Code
j. Additional Screening/Test Report Number(s) (if applicable)
k. PAR number (if applicable)

4.6.2 Mechanical Parts List

For mechanical parts used in critical applications, the list shall contain all the data listed below. For items issued in bulk, such as NAS hardware, data provided shall be limited to 4.6.2a through 4.6.2e.

a. MIL-Spec / ANSI / AMS / NAS Part number
b. Manufacturer's part number
c. Contractor's SCD or internal part number
d. Part description, Nomenclature
e. Where used
f. Quantity used in next higher assembly
g. Supplier's name and CAGE code
h. Lot-Date-Code/Batch Number

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i. PAR number (if applicable)

4.6.3 Metallic Materials List

For metallic materials used in critical applications, the list shall contain all the data listed below. For items issued in bulk, such as solder, data provided shall be limited to 4.6.3a through 4.6.3g.

a. MIL-Spec / ANSI / AMS / NAS Part number

b. Manufacturer's part number

c. Contractor's SCD or internal part number

d. Material description, Nomenclature

e. Stress Corrosion Cracking (SCC) Rating

f. Form (Bar, Sheet, Plate, etc.)

g. Where used

h. Quantity used in next higher assembly

i. Supplier's name and CAGE code

j. Lot-Date-Code/Batch Number

k. MAR number (if applicable)

4.6.4 Non-Metallic Materials List

For non-metallic materials used in critical applications, the list shall contain all the data listed below. For items issued in bulk, such as epoxy, data provided shall be limited to 4.6.4a through 4.6.4e.

a. Material type (Adhesive, coating, epoxy, gasket, insulator, sleeving, wire, etc.)

b. Material description, Nomenclature

c. Outgassing data and test report number

d. Shelf Life Control

e. Where used

f. Quantity used in next higher assembly [A/R (as required) may be entered for materials where exact quantity is not available.]

g. Supplier's name and CAGE code

h. Lot-Date-Code/Batch Number

i. MAR number (if applicable)

4.6.5 Processes List

The processes list shall contain the following data:

a. MIL-Spec / ANSI / AMS / NAS number (if applicable)

b. Manufacturer's process number

c. Contractor's internal process number

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d. Type process (Bonding, Coating, Plating, Soldering, etc.)

e. Where used (assembly number and name of next higher assembly)

4.7 Parts, Materials or Processes Approval Request

All EEEE parts and materials not included in the Space Quality Baseline shall require a PAR/MAR to be submitted to the PMPCB for review and disposition. Also requiring a PAR/MAR are military specification items to be evaluated for exceeding their specification temperature limits, derating requirements and/or non-compliances to other application restrictions/limitations.

The requesting organization shall submit a PAR/MAR form (see Figure 4.7-3 for a sample form) to the contractor's PMPCB. The PAR/MAR shall be completed to the extent of available information, but must include the following entries as a minimum:

a. Initiating contractor or subcontractor

b. Serialization (PAR/MAR identification number)

c. Part designation (source and generic)

d. Part description

e. Specification(s) number with revision

f. Justification for usage (description of how the item meets the Program requirements within the intended application, and why no existing PMP on the SQB is satisfactory)

g. Critical part designation, when available

h. System/subsystem/equipment application (where used), when available

i. Supplier/manufacturer

j. Lot Date Code (if applicable)

k. Qualification status and basis

l. DPA history

m. Failure history

n. GIDEP (If applicable)

o. Radiation sensitivity (total dose, neutron, gamma, and latch-up)

p. Package outline

q. Quantity available and quantity required per unit, when known

The PAR/MAR form may be in the contractor's format as long as all the minimum required information is documented. A copy of the PMP item's procurement specification (Source Control Drawing, Specification, etc.) and all relevant analyses and data necessary for the review and approval of the item shall be submitted to the PMPCB along with the completed PAR/MAR form.

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(PROGRAM NAME) PARTS (MATERIALS / PROCESSES) APPROVAL REQUEST	PMPCB LOG NO:	DATE SUBMITTED
SUBMITTED BY	DATE DISPOSITIONED	
SUBSYSTEM/EQUIPMENT USED ON:		
PART PROCUREMENT DOCUMENT NO:		
POTENTIAL SUPPLIERS:	SUPPLIER PART NUMBER	
REASON FOR USE		
REPLY NEEDED BY:	SUBMITTED BY:	

EVALUATOR RECOMMENDATION							
	APPROVAL		DISAPPROVAL		NO RECOMMENDATION		DOCUMENT EVALUATION
	WITHOUT LIMITATION		REPLACE WITH MIL-SPEC PART		INSUFFICIENT INFO		ADEQUATE
	LIMITED APPLICATION		SPEC BEING PREPARED		PART PROBLEM		INADEQUATE
	OTHER LIMITATION		OTHER		OTHER		OTHER

REPLACE WITH MIL/FED OR DOD ADOPTED INDUSTRY STANDARD							
SPEC/STD NUMBER:				MIL-SPEC PART NUMBER:			
SUPPLIER:				SUPPLIER PART NUMBER:			
PART RECOMMENDED ABOVE IS:		INTERCHANGEABLE			SUBSTITUTE		REPLACEMENT
REVIEWER COMMENTS:							
EVALUATOR:		ORGANIZATION:				DATE:	
PROCURING / BUYER AGENCY DECISION							
	IMPLEMENT RECOMMENDATION		APPROVED SUBMITTED PART				DISAPPROVE SUBMITTED PART
PROCURING AGENCY AND/OR BUYING ACTIVITY COMMENTS:							
PRINTED NAME:		SIGNATURE:				DATE:	

Figure 4.7-3. Parts (Material/Process) Approval Request (PAR/MAR)

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5. Space Quality Baseline for the Selection of Parts and Materials

5.1 Space Quality Baseline (SQB)

The Space Quality Baseline defined within this paragraph is for all types of space systems where repair is impossible, and success is critical. The requirements are to ensure that quality and reliability of products meet the technical requirements of a space mission:

a. Satellite systems with on-orbit mission life greater than 1 year

b. Launch vehicle systems

c. Satellite systems with on-orbit missions less than 1 year (experimental programs) when called out in the contract Statement of Work (SOW)

Generally, these parts / materials are:

a. Documented on government specifications (Mil-Spec slash sheets and/or Standard Military Drawings (SMDs)), AEROSPACE TOR-2006(8583)-5236 compliant Source Control Drawing (SCD), DoD Adopted industry specifications, with designators indicating space grade requirements (Classes V, S, K for actives, and Class S/T-level for passives).

b. Manufactured on government certified / qualified lines with periodic DSCC audits

c. Tested on government certified / qualified facilities with periodic DSCC audits

NOTE: The SQB items listed here shall not be exempt from the other requirements specified in the general and detailed sections of Aerospace TOR-2006(8583)-5236 (e.g., plating thickness, conductor finish, application requirements, outgassing, etc.).

5.2 Approved EEEE Parts

5.2.1 Capacitors

MIL-PRF-123	Capacitor, Fixed, Ceramic Dielectric, Temperature Stable and General Purpose, High Reliability
MIL-PRF-23269	Capacitor, Fixed, Glass Dielectric, Established Reliability, Styles CYR 10, 15, 20 and 30, failure rate “S” minimum
MIL-PRF-39003/10	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polarized, Sintered Slug, Styles CSS13 and CSS33, High Reliability, Weibull grade C minimum with compliance to the application requirements of Section 270 in Aerospace TOR-2006(8583)-5236.
MIL-PRF- M39003/1	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polarized, Sintered Slug, Established Reliability, Style CSR13, Weibull grade C minimum with pre-Weibull surge current test option (C or F), and with compliance to the production lot definition of M39003/10 and the application requirements of Section 270 in Aerospace TOR-2006(8583)-5236.

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MIL-PRF-M39003/6	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polarized, Sintered Slug, Established Reliability, Style CSR33, Weibull grade C minimum with pre-Weibull surge current test option (C or F), and with compliance to the production lot definition of M39003/10 and the application requirements of Section 270 in Aerospace TOR-2006(8583)-5236.
MIL-PRF-M39003/9	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Polarized, Sintered Slug, Established Reliability, Style CSR21, Weibull grade C minimum with pre-Weibull surge current test option (C or F), and with compliance to the production lot definition of M39003/10 and the application requirements of Section 270 in Aerospace TOR-2006(8583)-5236.
MIL-PRF-49470	Capacitor, Fixed, Ceramic Dielectric, Switch Mode Power Supply, General Purpose and Temperature Stable, High Reliability T-level and procured from QPL-49470 T-level suppliers
MIL-PRF-55365	Capacitor, Fixed, Electrolytic (Tantalum), Chip, CWR Styles, T-level with compliance to the application requirements of Section 275 in Aerospace TOR-2006(8583)-5236
MIL-PRF-87164A	Capacitors, Fixed, Mica Dielectric, High Reliability (Obsolete for New Designs)
MIL-PRF-87217A	Capacitors, Fixed, Supermetallized Plastic Film Dielectric, Direct Current for Low Energy, High Impedance Application, Hermetically Sealed in Metal Cases, High Reliability (Obsolete for New Designs)

DSCC Drawings 06013, 06014, 06015, 06016 for Wet Slug Tantalum Capacitors

DSCC Drawings 06019, 06022 for Ceramic Chip Capacitors in High Frequency Applications

5.2.2 Connectors with compliance to Sections 300 and 310 of Aerospace TOR 2006(8583)-5236

MIL-DTL-5015	Connectors, Electrical, Circular Threaded, Series MS345X, Class L, rear release types
MIL-DTL-24308	Connectors, Electrical, Rectangular, Nonenvironmental, Miniature, Polarized Shell, Rack and Panel, Class D, K, or M
MIL-DTL-26482G(6)	Connectors, Electrical (circular, miniature, quick disconnect, environment resisting) Receptacles and Plugs, Class L, Series 2
MIL-DTL-38999	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded and Breech Coupling), Environment Resistant, Removeable Crimp and Hermetic Solder Contacts, Class G, H or F (with processing for outgassing)
MIL-PRF-39012	Connectors, Coaxial, Radio, Frequency
MIL-DTL-55302	Connectors, Printed Circuit Subassembly and Accessories
MIL-DTL-83513	Connectors, Electrical, (rectangular microminiature), Polarized Shell, Class M, Finish N (See Section 300 paragraph 5.k of TOR 2006(8583)-5236)

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MIL-DTL-83723	Connectors, Electrical, Circular, Environment Resisting, Receptacle, and Plugs, Series III only, Class R
MIL-DTL-83733	Connectors, Electrical, Miniature, Rectangular Type, Rack to Panel, Environment Resisting, 200ºC Total Continuous Operating Temperature, Class S
MIL-C-28754D	Connectors, Electrical, Modular, and Component Parts, Types IV and V (Backplane)
MIL-PRF-31031	Connectors, Electrical, Plugs and Receptacles, Coaxial, Radio Frequency, High Reliability, for Flexible and Semirigid Cables, Class B, G, or H
MIL-PRF-49142	Connector, Triaxial, Radio Frequency
MIL-PRF-55339	Adapters, Connectors, Coaxial, Radio Frequency, (Between Series and within Series)
MSFC-SPEC-40M38277	NASA Marshall Space Flight Center Connectors (NLS Series)
MSFC-SPEC-40M38298	NASA Marshall Space Flight Center Connectors (NBS Series)
MSFC-SPEC-40M39569	NASA Marshall Space Flight Center Connectors and Hardware (NB Series)
GSFC S-311-P-4	NASA Goddard Space Flight Center Connectors , Rectangular, D-Sub
SSQ 21635	NASA Marshal Space Flight Center Connectors (NATC Series)
DSCC 94007	Connector, Electrical, Coaxial, Radio Frequency, Shroud 2 Hole Pin and Adapter, Electrical, Coaxial, RF, Socket Contact, Series SMP to SMP
DSCC 94008	Connector, Electrical, Coaxial, Radio Frequency, Socket Contact, Series SMP for 0.047 and 0.086 Semirigid cables
SAE-AS85049	Connector Accessories (Backshells and Hardware), Electrical, Finish N
SAE-AS39029	Contacts, Electrical Connectors
SAE-AS81703	Connectors, Electric, Circular, Miniature, Rack and Panel or Push-Pull Coupling, Environment Resisting, Series 3, Class L
MIL-DTL-32139	Connectors, Electrical, Rectangular, Nanominiature, Polarized Shell, for Space Class S (See Section 300 paragraph 5.k of TOR 2006(8583)-5236)
GSFC S-311-P-822	Connectors, PWB, 2 mm cPCI Style (Compact PCI), High Reliability, for Space

5.2.3 Crystals and Crystal Oscillators

MIL-PRF-55310	Oscillator, Crystal Controlled, Product level S with compliance to Section 400 of Aerospace TOR-2006(8583)-5236, or compliance to Sections 410 and 960 of Aerospace TOR-2006(8583)-5236 for hybridized oscillators

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5.2.4 Discrete Semiconductors

MIL-PRF-19500	Semiconductor Devices, JANS, with compliance to Section 510 and 1400 of Aerospace TOR-2006(8583)-5236

5.2.5 Filters

MIL-PRF-28861	Filter and Capacitor, Radio Frequency/Electromagnetic Interference Suppression, Class S and procured from QPL-28861 suppliers

5.2.6 Fuses

MIL-PRF-23419/12	Fuses, Cartridge, Instrument Type, Style FM12 (Subminiature-High Performance)

5.2.7 Hybrid Microcircuits

MIL-PRF-38534	Hybrid Microcircuits, Class K with compliance to Section 960 of Aerospace TOR-2006(8583)-5236

5.2.8 Magnetics (Inductors, Coils and Transformers)

MIL-STD-981	Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications, Class S, and procured from QPL suppliers of MIL spec transformers, inductors and coils covered in MIL-STD-981 (including MIL-PRF-39010 when procured to MIL-STD-981 requirements)

5.2.9 Monolithic Microcircuits

MIL-PRF-38535	Class V Integrated Circuits (Microcircuits), and active MIL-M-38510 Class S Slash Sheets

5.2.10 Relays

MIL-PRF-39016	Relays, Electromagnetic, Established Reliability, with compliance to Section 1000 of Aerospace TOR-2006(8583)-5236

5.2.11 Resistors

MIL-PRF-39007	Resistors, Fixed, Wire-wound (Power Type), Established Reliability, failure rate “S” minimum
MIL-PRF-39009	Resistor, Fixed, Wirewound (Power Type, Chassis Mounted), Established Reliability, failure rate “R” minimum
MIL-PRF-39005	Resistor, Fixed, Wirewound, (Accurate), Established Reliability, failure rate “R” minimum
MIL-PRF-32159	Resistors, Chip, Fixed, Film, Zero Ohm, Industrial, High Reliability, T-level
MIL-PRF-55182	Resistors, Fixed, Film, Established Reliability, failure rate “S” minimum, except failure rate “R” for RNC90

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MIL-PRF-39017	Resistor, Fixed Film, (Insulated), Established Reliability, failure rate "S" minimum, except failure rate "R" for RLR05 (3.02KΩ to 1.0 MΩ) and RLR07 (3.02 MΩ to 10.0 MΩ)
MIL-PRF-55342	Resistor, Chip, Fixed, Film, High Reliability, T-level
DSCC drawing 04007B	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 0302
DSCC drawing 04008B	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 0402
DSCC drawing 04009B	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 0603
DSCC drawing 94012F	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 0505
DSCC drawing 94013F	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 1005
DSCC drawing 94015H	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 0705
DSCC drawing 94016G	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 1206
DSCC drawing 94017F	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 2010
DSCC drawing 94018F	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 2512
DSCC drawing 94019F	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 1010
DSCC drawing 94025G	Resistor, Chip, Fixed, Film, Moisture Resistant, Space Level (T-level), Style 0502

5.2.12 Thermistors

S-311-P-18-**A***	Precision Thermistors, (Thermally Sensitive Resistors), Insulated and Uninsulated, Negative Temperature Coefficient, Non-hermetic
S-311-P-18-**S***	Precision Thermistors, (Thermally Sensitive Resistors), Insulated and Uninsulated, Negative Temperature Coefficient, Non-hermetic

5.2.13 Wire and Cable with compliance to Section 1500 of Aerospace TOR 2006(8583)-5236

MIL-DTL-17	Cable, Radio Frequency, Flexible and Semi-rigid, Coax
NEMA-WC27500	Cable, Power, Electrical and Cable Special Purpose, Electrical Shielded and Unshielded, Types SC, SR, SS, ST, SP (Multiconductor)
SAE-AS22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy, Slash Sheets 33, 43, 44, 45 and 46 (Insulated Hook-up)

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5.3 Mechanical Piece Parts

5.3.1 Fasteners

ASME-FAP-1	Quality Assurance Program Requirements for Fastener Manufactures, Distributors, and Testing Laboratories

5.3.2 Screws

NASM1312	Fastener Test Methods
NASM1515	Fastener Systems for Aerospace Applications

5.3.3 Terminals

A-A-59126	Terminals, Feed thru Insulated and Terminals, Stud (insulated and non-insulated)

5.4 Metallic Materials

5.4.1 Aluminum Alloys

ASTM-B26/B26M-03	Aluminum-Alloy Sand Castings
ASTM-B85-03	Aluminum Alloy Die Castings
ASTM-B108-03a	Aluminum Alloy Permanent Mold Castings
ASTM-B209-04	Aluminum and Aluminum Alloy Sheet and Plate
ASTM-B211-03	Aluminum and Aluminum Alloy Bar, Rod and Wire
ASTM-B221-04a	Aluminum and Aluminum Alloy Extruded Bar, Rod, Wire, Profiles and Tubes
ASTM-B241/B241M-02	Aluminum and Aluminum Alloy Seamless Pipe and Seamless Extruded Tube
ASTM-B308/B308M-02	Aluminum-Alloy 6061-T6 Standard Structural Profiles
MIL-A-21180D(1)	Aluminum Alloy Castings, High Strength
SAE AMS-QQ-A-200B	Aluminum Alloy, Bar, Rod, Shapes, Structural Shapes, Tube, and Wire, Extruded
SAE AMS-QQ-A-250A	Aluminum and Aluminum Alloy Plate and Sheet
SAE AMS-QQ-A-367	Aluminum Alloy Forgings
SAE AMS 4290J	Aluminum Alloy, Die Castings 9.5Si - 0.50Mg (360.0-F)
SAE AMS 4291F	Aluminum Alloy, Die Castings 8.53 - 3.5Cu (A380.0-F)

5.4.2 Copper

ASTM B152	Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B272-02	Copper Flat Products with Finished (Rolled or Drawn) Edges (Flat Wire and Strip)

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5.4.3 Corrosion Resistant Steels

ASTM-A240/A240M-05	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications
ASTM-A666-03	Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM-A693-03	Precipitation-Hardening Stainless and Heat Resisting Steel Plate, Sheet and Strip
SAE-AMS5513	Steel, Corrosion-Resistant, Sheet, Strip, and Plate 19Cr-9.2Ni (SAE 30304), Solution Heat Treated
SAE-AMS5516-5519	Steel, Corrosion-Resistant, Sheet, Strip, and Plate 18Cr-9.0Ni (SAE 30302), Solution Heat Treated (UNS S30200)
SAE-AMS5901-5907	Steel, Corrosion-Resistant, Sheet, Strip, and Plate 18Cr-8.0Ni (SAE 30301), Solution Heat Treated (Composition similar to UNS S30100)
SAE-AMS5910-5913	Steel, Corrosion-Resistant, Sheet, Strip, and Plate 19Cr-9.2Ni (SAE 30304), Cold Rolled, 125 ksi (862 MPa) Tensile Strength (UNS S30400)

5.4.4 Magnesium

ASTM-B107	Magnesium-Alloy Extruded Bars, Rods, Profiles, Tubes and Wire
SAE-AMS4375	Sheet and Plate, Magnesium Alloy 3.0Al-1.0Zn-020Mn (AZ31B-0), Annealed and Recrystallized (UNS M11311)
SAE-AMS4376	Sheet and Plate, Magnesium Alloy 3.0Al-1.0Zn-020Mn (AZ31B-H26), Cold Rolled, Partially Annealed (UNS M11311)
SAE-AMS4377	Sheet and Plate, Magnesium Alloy 3.0Al-1.0Zn-020Mn (AZ31B-H24), Cold Rolled, Partially Annealed (UNS M11311)

5.4.5 Nickels Alloys

QQ-N-286	Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500)

5.4.6 Steels

SAE-AMS6257	Steel Bars, Forgings and Tubing 1.6Si-0.82Cr-1.8Ni-0.40Mo-0.08V (0.40-0.44C), Consumable Electrode Vacuum Remelted, Normalized and Tempered
SAE-AMS6345	Steel, Sheet, Strip and Plate, 0.95Cr-0.20Mo (0.28-0.33C) (SAE 4130), Normalized or Otherwise Heat Treated (Composition similar to UNS G41300)
SAE-AMS6349C	Steel, Bars 0.95Cr-0.20Mo (0.38-0.43C) (SAE 4140), Normalized (Composition similar to UNS G41400)
SAE-AMS6350	Steel, Sheet, Strip and Plate 0.95Cr-0.20Mo (0.28-0.33C) (SAE 4130) UNS G41300

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SAE-AMS6351	Steel, Sheet, Strip and Plate 0.95Cr-0.20Mo (0.28-0.33C) (SAE 4130), Spheroidized (Composition similar to G41300)
SAE-AMS6382M	Steel, Bars, Forgings and Rings 0.95Cr-0.20Mo (0.38-0.43C) (SAE 4140), Annealed (Composition similar to G41400)
SAE-AMS6414J	Steel, Bars, Forgings and Tubing 0.80Cr-1.8Ni-0.25Mo (0.38-0.43C) (SAE 4340), Vacuum Consumable Electrode Remelted (Composition similar to G43400)
SAE-AMS-S-5000	Steel, Chrome-Nickel-Molybdenum (E4340) Bars and Reforging Stock
SAE-AMS-T-6736A	Tubing, Chrome-Molybdenum (4130 – 8630) Steel, Seamless and Welded
SAE-AMS-6758	Steel, Chrome-molybdenum (4130), Bars and Reforging Stock (Aircraft Quality)

5.4.7 Tungsten

MIL-T-21014D(1)	Tungsten Base Metal, High Density

5.5 Non-Metallic Materials

5.5.1 Adhesives

MIL-A-46146	Adhesives-Sealants, Silicone, RTV, Non-Corrosive, (For Use with Sensitive Metals and Equipment), with compliance to the outgassing requirements of Section 4 in Aerospace TOR-2006(8583)-5236
SAE AMS-A-25463	Adhesive, Film Form, Metallic Structural Sandwich Construction

5.5.2 Coatings, Foaming Molding and Potting Compounds

MIL-I-16923	Insulating Compound, Electrical, Embedding, Epoxy, with compliance to the outgassing requirements of Section 4 in Aerospace TOR-2006(8583)-5236
MIL-I-46058C(7)	Insulating Compound, Electrical (for Coating Printed Assemblies), with compliance to the outgassing requirements of Section 4 in Aerospace TOR-2006(8583)-5236

5.5.3 Core

MIL-C-7438	Core Material, Aluminum, for Sandwich Construction

5.5.4 Elastomers

SAE-AMS3216F	Fluorocarbon (FKM) Rubber, High Temperature – Fluid Resistant, Low Compression Set 70 to 80
SAE-AMS3218B	Fluorocarbon (FKM) Rubber, High Temperature – Fluid Resistant, Low Compression Set 85 to 95
SAE-AMS7259D	Rings, Sealing, Fluorocarbon (FKM) Rubber, High Temperature – Fluid Resistant, Low Compression Set 70 to 80

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SAE-AMS7276G	Rings, Sealing, Fluorocarbon (FKM) Rubber, High Temperature – Fluid Resistant, Low Compression Set 70 to 80

5.5.5 Fluids, Gas and Liquids

MIL-A-18455	Argon, Technical
MIL-PRF-27401	Propellant, Pressurizing Agent, Nitrogen
MIL-PRF-27404	Propellant, Monomethylhydrazine
MIL-PRF-27407	Propellant Pressurizing Agent, Helium

5.5.6 Insulations

MIL-I-3190	Insulating Sleeving, Electrical, Flexible, Coated
MIL-I-24768	Insulation, Plastic, Laminated, Thermosetting

5.5.7 Lubricants

SAE-AMS-M-7866	Molybdenum Disulfide, Technical, Lubrication Grade
SAE-AS8660	Silicone Compound NATO Code Number S-736

5.5.8 Marking, Primers Paints

MIL-PRF-23377	Primer Coatings: Epoxy, High-Solids
MIL-PRF-85285	Coating: Polyurethane, Aircraft and Support Equipment
A-A-56032	Ink, Marking, Epoxy Base

5.5.9 Plastics, Laminates and Fabrics Rubbers

MIL-I-24768/2	Insulation, Plastic Laminated, Thermosetting, Glass-Cloth, Epoxy-Resin (GEE)
MIL-I-24768/3	Insulation, Plastic Laminated, Thermosetting, Glass-Cloth, Epoxy-Resin (GEB)
MIL-P-22241B	Plastic Sheet (and Film) Polytetrafluoroethylene
MIL-P-24074	Polytetrafluoroethylene Parts and Coatings and Polyamide Parts
MIL-P-46036B	Plastic Sheet, Rods, Tubes, and Discs, Polychlorotrifluoroethylene
MIL-P-46112B	Plastic Sheet and Strip, Polyimide
MIL-P-81390(1)	Plastic, Molding Material, Polycarbonate, Glass Fiber Reinforced
MIL-R-83248C	Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant
ASTM D2400	Standard Specification for Varnished Glass-Polyester Cloth Used for Electrical Insulation
ASTM D2754	Standard Specification for High-Temperature Glass Cloth Pressure-Sensitive Electrical Insulating Tape

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ASTM-D5948	Standard Specification for Molding Compounds, Thermosettings
ASTM-D3294	Standard Specification for PTFE Resin Molded Sheet and Molded Basic Shapes
ASTM-D3308	Standard Specification for PTFE Resin Skived Tape
ASTM-D3369	Standard Specification for PTFE Resin Cast Film
ASTM-D5213	Standard Specification for Polymeric Resin Film for Electrical Insulation and Dielectric Applications
IPC4101B	Base Materials for Rigid and Multilayer Boards
SAE-AMS7276	Rings, Sealing, Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression, Set 70 – 80
SAE-AMS7259	Rings, Sealing, Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression, Set 85 – 95
SAE-AMS3216	Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression Set 70 – 80
SAE-AMS3218	Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression, Set 85 – 95

5.5.10 Tapes

A-A-59770A	Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting Adhesive
A-A-59474	Insulation Tape, Electrical, High Temperature, Polytetrafluoroethylene, Pressure-Sensitive
A-A-52080	Tape, Lacing and Tying, Nylon
A-A-52081	Tape, Lacing and Tying, Polyester
A-A-52082	Tape, Lacing and Tying, TFE-Fluorocarbon
A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid

5.5.11 Thermal Control Materials

MIL-I-631	Insulation, Electrical, Synthetic-Resin Composition, Non-rigid
A-A-55126	Fastener Tapes, Hook and Loop, Synthetic
MIL-P-46112B	Plastic Sheet and Strip, Polyimide

5.5.12 Tubing

MIL-Y-1140	Yarn, Cord, Sleeving, Cloth, and Tape–Glass
MIL-S-85848	Sleeving, For Identification Marking, Heat Shrinkable
SAE-AMS-DTL-23053	Insulation Sleeving, Electrical, Heat Shrinkable, with compliance to the outgassing requirements of Section 4 in Aerospace TOR-2006(8583)-5236

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5.6 Approved Processes

5.6.1 Adhesive Bonding

MIL-A-83376A	Adhesive Bonded Metal Faced Structures, Acceptance Criteria
MIL-HDBK-83377B	Adhesive Bonding (Structural) for Aerospace and other Systems

5.6.2 Brazing, soldering (non-electrical), and welding

SAE-AMS-W6858	Welding, Resistance: Spot and Seam
MIL-W-6873C	Welding; Flash, Carbon and Alloy Steel
AWS-C3.4	Torch Brazing
AWS-C3.5	Induction Brazing
AWS-C3.6	Furnace Brazing
AWS-C3.7	Aluminum Brazing

5.6.3 Heat Treating and Surface Hardening

SAE-AMS-H-81200	Heat Treatment of Titanium and Titanium Alloys
SAE-AMS-H-6875	Heat Treatment of Steel Raw Materials
SAE-AMS-A-22771D	Aluminum Alloy Forgings, Heat Treated
SAE-AMS-H-7199	Heat Treatment of Wrought Copper-Beryllium Alloys, Process for
SAE-AMS-H-6088	Heat Treatment of Aluminum Alloys
MSFC-SPEC-469	Specification, Titanium and Titanium Alloys, Heat Treatment of

5.6.4 Metal Fabrication Assembly

SAE-AMS-S-13165	Shot Peening of Metal Parts
MIL-A-21180D	Aluminum-Alloy Coatings, High Strength

5.6.5 Metal Machining Chemical Milling

SAE-AMS-81769	Chemical Milling of Metals

5.6.6 Miscellaneous Processes

MIL-STD-889	Dissimilar Metals
NASA-STD-5009	Nondestructive Evaluation Requirements for Fracture Critical Metallic Components

5.6.7 Platings and coatings

SAE-AMS-P-81728	Plating, Tin Lead (Electrodeposited)
SAE-AMS-2418	Copper Plating

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SAE-AMS-C-26074	Coatings, Electroless Nickel
MIL-DTL-32119	Coatings, Electroless Nickel, Special Applications
MIL-DTL-45204	Gold Plating, Electrodeposited
MIL-R-46085B	Rhodium Plating, Electrodeposited
SAE-AMS-QQ-N-290A	Nickel Plating, Electrodeposited
SAE-AMS-QQ-C-320	Chromium Plating, Electrodeposited
ASTM-B700	Coatings, Silver, Electrodeposited

5.6.8 Printed Wiring Boards / Printed Circuit Cards

Additional requirements in Sections 100, 110 and 120 of Aerospace TOR 2006(1590)-5236 shall apply.

(Note: Equivalent IPC specs to the MIL-PRF-55110 and 31032 (such as IPC 6012, IPC 6013 and IPC 6018) that are referenced in Aerospace TOR 2006(8583)-5236, are commercial specs and have no independent certification process besides the manufacturer's own self certification. They require a PAR/MAR with Contractor verification that all the requirements of the program are met.)

MIL-PRF-55110	Performance Specification Printed Wiring Board, Rigid
MIL-PRF-31032	Performance Specification Printed Circuit Board/Printed Wiring Board

5.6.9 Soldering in accordance with the following:

NASA-STD-8739.3	Soldered Electrical Connections
NASA-STD-8739.2	Workmanship Standard for Surface Mount Technology
IPC-J-STD-001DS	Standard for Soldering Electrical and Electronic Assemblies with Additional Requirements for Space Applications

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APPENDIX A
DATA FORMATS

A.1 Scope

This appendix is a mandatory part of the document. The information contained herein is intended for compliance. This appendix provides the detailed requirements for common terminology for exchange of part experience summary information between contractors and the government. It is necessary to establish a standard reporting convention for parts and pedigree information. Among the standardization objectives to be achieved by these templates are the establishment of a minimum set of reporting requirements, and an increase in the level of detail of reporting.

A.2 Data Entry Templates and Term Definitions

The template for data entry is given in this section. Table A-1 through A-4 list the data required only for electronic parts; Table A-5 lists the data required only for mechanical parts; Table A-6 lists data only for materials; and Table A-7 lists data only for processes. "RIA" indicates "Required If Available". Table A-8 lists the data required for all items. A/R (as required) may be entered for materials where exact quantity is not available.

A.2.1 Electronic Parts Term Definitions

Table A-1. Template for Electronic Parts Data Entry

Data Field	Data Type	Requirement
Type	string (40)	Required
Family	string (40)	Required
Description	string (255)	Required
Number Quantity	integer	Required
Contractor Specification Number	string (40)	Required
Generic part number	string (40)	Required
Military part number	string (40)	Required
Manufacturer part number	string (40)	Required
Lot date code / Batch number	string(40)	Required
Part Manufacturer Cage Code	string (5)	Required
Supplier / Manufacturer name	string (60)	Required
Part Class	string (40)	Required
Total Ionizing Dose Hardness	float	RIA
Dose Rate Upset Hardness	float	RIA
Dose Rate Survivability Hardness	float	RIA
Singe Event Upset Hardness	float	RIA
Neutron Fluence Hardness	float	RIA
Outgassing TML	float	RIA
Outgassing CVCM	float	RIA
Outgassing WVR	Float	RIA
Body / Case Finish	string (40)	Optional
Lead / Contact Finish	string (40)	Optional

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Type

The most generic description of the item. Table A-2 contains examples of allowed values for electronic part type.

Table A-2. Examples of Allowed Values for Electronic Part "Type"

ASIC	Crystal	EEPROM	Hybrid/MCM	Microcircuit Die	PROM	SRAM	Transformer
Assembly	Delay Line	Filter	Inductor	MMIC	Relay	Switch	Transistor
Capacitor	Diode	FPGA	Integrated Circuit	Optoelectronic	Resistor	Thermistor	Other*
Connector	DRAM	Fuse	Isolator	Oscillator	Solar Cell	Thermostat	

* Requires description in Comments

Family

A more detailed description of the item related to its technology. Examples of allowed values for electronic part family are in Table A-3.

Table A-3. Examples of Allowed Values for Electronic Part "Family"

BiCMOS	CMOS	GaAs/InP	MOS	Resistor Network	Tantalum Solid Leaded
Bipolar	ECL	HBT	MOSFET	Si	Tantalum Non-Solid Leaded
Capacitor Axial Leaded	FET	HEMT	NMOS	SiGe	Wirewound
Capacitor Radial Leaded	Film Chip	InGaP	PHEMT	SOI	N/A
Ceramic Chip	Film Leaded	InP	PMOS	SOS	Other*
Ceramic Stacked	GaAs	MESFET	Resistor Chip	Tantalum Chip	Multiple*

* Requires description in Comments

Description

Provides specific information about the item (e.g., dual flip/flop; 1/8 W 0-115 K; 1/16 W 5K; 50V 0.1 MF, etc.)

Number Quantity

Number of this item used next higher assembly.

Contractor Specification Number

Enter the Contractor Specification Number.

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Generic, Military, and Manufacturer Part Number:

Generic

The standard generic number that exists for most parts. This number may or may not include code letters indicating package type, etc.

Military

The military equivalent part number associated with the particular part in question.

Manufacturer

This field refers to any part number, other than generic or military. Note: if Military part number is not available, use Generic part number.

Lot Date Code / Batch Number

Lot date code or batch number as supplied by manufacturer for this item.

Part Manufacturer Cage Code

Use Federal H4/H8 Cage Code Dictionary.

Supplier / Manufacturer Name

Name of company that supplies or manufactures the item if a Cage Code for the company is not available.

Part Class

This describes the part reliability level or classification (e.g., PEMs, COTs, JANS, etc.) Allowed values for electronic part classification are in Table A-3a.

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Table A-3a. Allowed Values for Electronic Part Classifications (Continued)

Entry	Description
JANS	JAN Class S
JANTX	JAN Class TX
JANTXV	JAN Class TXV
QML D	QML Class D
QML E	QML Class E
QML G	QML Class G
QML H	QML Class H
QML K	QML Class K
QML Q	QML Class Q/B
QML T	QML Class T
QML V	QML Class V/S

Entry	Description
C-SCD	Contractor SCD requirements
COTS	Commercial-Off-the-shelf (COTS)
MIL-SCD	Source Control Drawing Imposing Aerospace TOR-2006(8583)-5236 Requirements
PEMS N	Plastic encapsulated microcircuits (PEMS), Class N
PPFL L	Passive Parts Failure Level L (2 percent per 1000 hours)
PPFL M	Passive Parts Failure Level M (1 percent per 1000 hours)
PPFL B	Passive Parts Failure Level P or Weibull-grade B (0.1 percent per 1000 hours)
PPFL C	Passive Parts Failure Level R or Weibull-grade C (0.01 percent per 1000 hours)
PPFL S	Passive Parts Failure Level S or Weibull-grade D (0.001 percent per 1000 hours)
PPFL T	Passive Parts Class T or Class S (0.0001 percent per 1000 hours)
QML M	QML M/883-compliant

Total Ionizing Dose Hardness

The specific value to which the item has been approved, in Krad (Si).

Dose Rate Upset Hardness

The specific value to which the item has been approved, in rads (Si)/s.

Dose Rate Survivability Hardness

The specific value to which the item has been approved, in rads (Si)/s.

Single Event Upset Hardness

The specific value to which the item has been approved, in errors/bit-day.

Neutron Fluence Hardness

The specific value to which the item has been approved, in MeV-cm^2/mg.

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Outgassing Total Mass Loss (TML) of internal/external organic materials

If tested for outgassing, enter the results for percentage TML.

Outgassing Collected Volatile Condensable Materials (CVCM) of internal/external organic materials

If tested for outgassing, enter the results for percentage CVCM.

Body / Case Finish and Lead / Contact Finish

Table A-4 contains examples of the allowed values for electronic part finish. A "Prohibited" finish requires an explanation in "Comments".

Table A-4. Examples of Allowed Values for Electronic Part Finish

Anodized	Nickel	No Finish	Cadmium (Prohibited)
Gold	Passivated Stainless Steel	Other*	Silver (Prohibited) or Silver (Approved for this application. Ref. PAR/MAR# --) ***
Gold over Nickel	Solder	N/A	Tin > 97% (Prohibited)
Irridite	Tin < 97%		Zinc (Prohibited)

*** If there is no risk of silver migration, silver finishes may be used when the outer surface is covered with insulation materials or the atomic oxygen attack to the silver finish is negligible. However, silver-cased electrolytic (wet slug) tantulum capacitors are prohibited for space and launch vehicles. Silver shall not be used as a contact overplate finish or as an underplate for electrical connectors. PMPCB approved usages of silver shall be traceable to a PAR/MAR.

A.2.2 Mechanical Parts Term Definitions

Table A-5. Template for Mechanical Parts Data Entry

Data Field	Data Type	Requirement
Type	string (40)	Required
Family	string (40)	Required
Description	string (255)	Required
Contractor Specification Number	string (40)	Required
Generic part number	string (40)	Required
Military part number	string (40)	Required
Manufacturer part number	string (40)	Required
Lot date code / Batch number	string(40)	Required
Part Manufacturer Cage Code	string (5)	Required

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Data Field	Data Type	Requirement
Supplier / Manufacturer name	string (60)	Required
Number Quantity	integer	Required

Type

This provides the most generic description of the item (e.g., nut; valve; cable tie, etc.).

Family

A second level of description of the item; provide the material of which the part is composed. Examples are: CRES; brass; nylon 66.

Description

Specific information describing the item. Examples are: 10 x 32; 1: diameter; fuel; ¼ inch.

Contractor Specification Number

Enter the Contractor Specification Number.

Generic, Military, and Manufacturer Part Number

Generic: The standard generic number that exists for most parts. This number may or may not include code letters indicating package type, etc. Military: The military equivalent part number associated with the particular part in question. Manufacturer: This field refers to any part number, other than generic or military. Note: if Military part number is not available, use Generic part number.

Lot Date Code / Batch Number

Lot date code or batch number as supplied by manufacturer for this item.

Part Manufacturer Cage Code

Use Federal H4/H8 Cage Code Dictionary.

Supplier / Manufacturer Name

Name of company that supplies or manufactures the item if a Cage Code for the company is not available.

Number Quantity

Number of this item that is used in next-higher assembly.

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A.2.3 Materials Term Definitions

Table A-6. Template for Materials Data Entry

Data Field	Data Type	Materials
Type	string (40)	Required
Family	string (40)	Required
Form	string (255)	Required
Contractor Specification Number	string (40)	Required
Trade name	string (60)	Required
Supplier / Manufacturer name	string (60)	Required
Lot date code / Batch number	string(40)	Required
Outgassing TML	float	RIA
Outgassing CVCM	float	RIA
Outgassing WVR	Float	RIA
Bulk Quantity	float	RIA
Quantity Unit	string (20)	RIA
Shelf Life Requirements	string (1)	Required
Hazards	string (1)	Required

Type

The most generic description of the item. Examples are: adhesive coating; epoxy; metal; organic; composite.

Family

A second level of description of the item. Examples are: tin; gold; polymer.

Form

The physical shape of the item. Examples are: bar; rod; sheet; wire.

Contractor Specification Number

Enter the Contractor Specification Number.

Trade Name

Common industry usage name.

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Supplier / Manufacturer Name

Name of company that supplies or manufactures the item.

Lot Date Code / Batch Number

Lot date code or batch number as supplied by manufacturer for this item.

Outgassing Total Mass Loss (TML) of internal/external organic materials

If tested for outgassing, enter the results for percentage TML.

Outgassing Collected Volatile Condensable Materials (CVCM) of internal/external organic materials

If tested for outgassing, enter the results for percentage CVCM.

Bulk Quantity and Quantity Unit

Total amount of material used in next-higher assembly, and unit used to measure the amount of item (pounds, gallons, etc.). A/R (as required) may be entered for materials where exact quantity is not available.

Shelf Life Requirements

Has a limited shelf life age, or requires specific temperature or humidity conditions, or has other special environmental requirements (e.g., storage in dry nitrogen). Enter "L" and explain in comments.

Hazardous material

If material is hazardous, use the codes in Table A-6a to describe how it is hazardous:

Table A-6a. Template for Hazardous Material Data Entry

A	Creates health hazard if not handled properly.
B	Environmental hazard.
C	Fire/explosive hazard.
D	Other (explain in comment field).

A.2.4 Processes Term Definitions

Table A-7. Template for Processes Data Entry

Data Field	Data Type	Requirement
Type	string (40)	Required
Family	string (40)	Required
Description	string (255)	Required
Hazards	string (1)	Required

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Type

The most generic description of the process. Examples are: heat treatment; soldering.

Family

A second level of description of the process. Examples are: silver plating; quenching.

Description

Specific information describing the process, such as process number or other description.

Hazardous process

If the process is hazardous, use the Table A-6a codes (above) to describe how it is hazardous:

A.2.5 Global Term Definitions

The following term definitions are valid for all types of items.

Table A-8. Template for All Items Data Entry

Data Field	Data Type	Requirement
New Technology	string(1)	Required
Limited Application	string(1)	Required
Qualification status	string (20)	Required
End item part name	string(60)	Required
End item part number	string(60)	Required
End item serial number	string(60)	Required
Comments	string(4000)	Required

New Technology

"Y" or "N"; If "Y", explain in Comments. New Technology is defined as a part, material, or process that has never been previously characterized or qualified for space use; or has limited or no space heritage or commercial technology; or that has recently undergone major changes in the element selection process, assembly, manufacturing, or testing.

Limited Application

"Y" or "N"; If "Y", explain in Comments the way in which the application of the item is limited.

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Qualification Status

If item is qualified, use the following entries to describe how:

NAS-STD	MTL-STD	SIMILARITY
FED-STD	DESIGN & TEST	OTHER

End Item Part Name, Part Number, and Serial Number

The unit or black box where the part, material, or process is used in.

Comments

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APPENDIX B
HARDNESS ASSURANCE

B.1 Scope

This appendix is a mandatory part of the document. The information contained is intended for compliance. This appendix provides the detailed requirements for managing a PMP radiation hardness assurance program for space vehicles.

B.2 Radiation Hardness Assurance Program

Hardness Assurance of EEEE parts is an integral part of the overall system level survivability program. Accordingly, the contractor and all subcontractors shall develop and implement a Radiation Hardness Assurance (RHA) Program applicable to radiation sensitive EEEE parts. The parts hardness assurance program shall define the set of constraints, measures and disciplines that must be applied to design, selection, procurement, testing and application of radiation sensitive parts. Implementation of this RHA Program assures that parts and materials used in equipment are capable of surviving and operating within expected performance boundaries when exposed to the specified radiation environments. The contractor shall establish the necessary infrastructure that is needed for incorporation/implementation of the hardness assurance program tasks. As a minimum, the parts hardness assurance program shall include the following:

a. Performance of characterization testing of radiation sensitive parts and materials in each applicable radiation environment to verify operational/survival thresholds/margins; and also to establish radiation degradation limits used in design and radiation wafer lot acceptance. Characterization test requirements apply where there is no current radiation test data corresponding to the item in question.

b. Generation of parameter degradation limits at specified confidence level and percentile cut off value. These degradation limits are obtained from sampling data (characterization test), and are intended for dual purposes: 1) These degradation limits allow designers to incorporate end-of-life margin into circuits they design, and 2) these same degradation limits are used as pass/fail criteria for acceptance of flight wafer lots during radiation wafer lot acceptance test (RWLAT).

c. Timely dissemination of above degradation limits among equipment designers for their use in worst case design (margin) analyses.

d. Generation of SEE rates applicable to SEE sensitive parts and timely dissemination of these rates among equipment designers. SEE rates shall be based on actual test data, and are intended for box/system level SEE analyses to demonstrate compliance with allocated outage rates and system's availability/dependability requirements.

e. Performance of Radiation Wafer Lot Acceptance Test (RWLAT). This requirement applies to all wafer lots intended for use in flight equipment.

f. Generation of a Parts/Materials Hardness Assurance Plan specifying methodology for implementation of the Hardness Assurance Program, and allocation/ownership of hardness assurance tasks

g. Representation of Hardness Assurance activities (Hardness Assurance Responsible Engineer) in parts selection and parts application forums such as Parts Materials and Processes Control Board (PMPCB) meetings, IPT meetings, Design Review meetings, etc.

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h. Flow down of Hardness Assurance requirements to subcontractors to the extent necessary for the system to meet its operational and survival requirements in the specified radiation environment.

i. Surveillance of subcontractor's activities to verify compliance with specified hardness assurance requirements.

j. Provide validation of worst-case analyses at box/system level demonstrating compliance to system level survival and performance requirements at end-of life. Validation consist of verification that only those limits endorsed/sanctioned by cognizant hardness assurance engineer have been used for calculation of parameter's end-of-life values used in node equations.

k. Provide validation of SEE analyses at box/system level demonstrating compliance to allocated outages and system level availability/dependability requirements. Validation consists of verification that the SEE rates used in the analyses are those that had endorsement/sanction from the cognizant hardness assurance engineer.

l. Provide validation of box/system level upsettability/operate-thru analyses demonstrating compliance to specified operational, survival and recovery requirements in the specified prompt dose environment (if applicable). Validation consists of verification that upset/survival threshold data used in the analyses are traceable to actual values endorsed/sanctioned by the cognizant hardness assurance engineer.

The Contractor shall identify the organizational blocks and individuals that are responsible for observance and execution of particular hardness assurance tasks.

B.2.1 Radiation Hardness Assurance (RHA) Program Plan

The contractor shall generate a documented RHA Program Plan that defines methodology for implementation/execution of radiation hardness assurance tasks. The plan shall identify process flow and methodology for integration of the hardness assurance functions into design and manufacturing activities. The plan shall allocate responsibilities/ownership for each hardness assurance task and shall define a timeline for execution of each task. As a minimum, the RHA Program Plan shall include the following:

a. Detailed description of each hardness assurance task and allocation of ownership, responsibility and timeline for execution of each task

b. Block/Box diagram of the system (hardware).

c. List of subcontracted items as well as name of responsible subcontractor

d. Organizational structure of Program organizational blocks, including program management, systems engineering, design, manufacturing and subordinate specialty engineering functions, supply chain, subcontractor management, etc., depicting their allocated responsibilities and interfaces

e. Identification (directly or by reference) of the allocated radiation environments (hazard/threat) that apply to the particular orbit/mission, including prompt levels and Single Event Effect (SEE) rates for parts and materials, along with applicable dose/fluence dose depth curves.

f. Part selection criteria in terms of required attributes or minimum hardness levels that parts must have in order to be acceptable for use in equipment.

g. Prescription of methodology for radiation characterization testing.

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h. Prescription of methodology for generation of radiation degradation limits. Definition of minimum requirements for radiation design margin (R_{DM}), confidence level (C) and proportion of acceptable parts (P)

i. Prescription of methodology for radiation wafer lot acceptance test (RWLAT).

j. Conditions necessary for (on the basis of overtest/design margin) RWLAT exemption.

k. Methodology for ELDRS testing of linear bipolar circuits. Methodology for incorporation of ELDRS effects into parameter EOL limits used in worst-case design.

l. Methodology for flowdown and verification of hardness assurance requirements to subcontractors.

m. Methodology for performance of hardness assurance testing of hybrids and MCMs

n. Methodology for dissemination of radiation degradation limits to equipment designers

o. Methodology for resolving/dispositioning radiation lot acceptance test failures

p. Methodology for implementation of all other hardness assurance tasks within the parts hardness assurance program.

q. Matrix listing all radiation sensitive parts used in the system by generic part number and by the part number used for procurement. This matrix shall also identify the source of supply, radiation test requirements, including RWLAT, dose or exposure level and the AID, SID, or special test requirement document that specifies each applicable radiation test requirement as well as pass fail criteria.

B.2.2 Hardness Assurance Design Documentation

Radiation acceptance test is an integral part of the part acceptance process. For QML/RHA parts, radiation acceptance test is part of QCI. For non-QML/RHA parts, radiation acceptance test is also considered part of QCI. Accordingly, all radiation sensitive parts that are subjected to radiation testing shall have their radiation test requirements specified in a formally released drawing (SMD, SCD, SID, AID, Special Requirements Document, etc.). In general, the required hardness assurance documentation consists of:

a. Hardness Assurance Plan

b. Part procurement specification containing RWLAT requirements (SMD, SCD, AID, SID, etc), or contractor's special requirements document that calls out RLAT test requirements including test level and pass fail criteria

c. Derating sheet that calls out parameter's degradation limits. These degraded limits are used by designers to incorporate circuit design margin.

d. SEE performance sheet calling out survival and upset rates of parts. This data is used by designers for their SEE analyses

e. Prompt dose performance attributes sheet calling out upsettability and burnout thresholds, as well as recovery time. This data is used by designers for their prompt dose upset/survival analyses.

B.2.3 Representation of RHA Issues at Audits and Design Reviews

The contractor shall have an RHA representative at all applicable design reviews, including preliminary and critical design reviews. The contractor shall ensure that all system design decisions are evaluated

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for their effect upon the hardness assurance of the system and its components. In addition, the representative shall ensure that the RHA Program Plan, the RHA Design Document, and the detailed specification are updated to incorporate any hardness assurance critical decisions made at the design reviews.

B.2.4 Integrating Subcontractor RHA Capabilities

The contractor shall flow down to subcontractors the applicable RHA requirements to the extent necessary to assure that the system level survivability and operability requirements are met. As a condition for contract award, the contractor shall verify that a subcontractor has the processes and infrastructure necessary to assure compliance with the specified radiation requirements.

B.2.5 Part Procurement Documents

Parts and materials subject to hardness assurance requirements shall be procured in accordance with section 4.3.2.1. The contractor's drawings must include radiation requirements with the following as a minimum and must be approved by the PMPCB:

a. Radiation test methods and test circuits.

b. Except for SMD specified RHA parts, contractor's prepared drawings shall call out sample size and sampling and sampling statistics used in lot acceptance

c. Radiation type, source and dose/exposure level.

d. End point test, pre- and post-radiation test requirements and acceptance criteria.

e. Data reporting and analysis.

f. Special radiation tests such as electrical or radiation screening tests.

B.2.6 Hardness Assurance Verification Analyses

The contractor shall perform and document radiation analyses based on the part or material radiation characterization data to ensure that under worst-case conditions, critical circuits or materials are capable of meeting the RHA requirements.

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APPENDIX C
FAILURE SUMMARY AND ANALYSIS REPORT (FSAR)

C.1 Scope

This appendix provides the detail requirements for submitting the parts and materials Failure Summary and Analysis Report (FSAR) over the life of a program for a specific contract, including reports on catastrophic open and short circuit failures generated during EEEE qualification and testing. (See paragraph 4.3.10.2 for limitations to this requirement.) This appendix is used by the procuring activity to monitor/evaluate all program piece part failures.

C.2 Format

The FSAR as generated by the work task paragraph 4.3.10.2 shall contain the information of Tables C-l and C-2, but maybe in any format selected by the contractor.

C.2.1 Contents

The FSAR shall include all the items identified as being required in Table C-l.

a. Part type shall be per Federal Cataloging Handbook H6 and name modifiers.

b. Each part analyzed, shall be a separate record.

c. A separate FSAR record shall be required for each part or material number/type analyzed.

Note: the word pan refers to parts, materials or processes.

C.2.2 Revisions to the FSAR

When the contractor revises the FSAR, a new copy shall be in accordance to the same requirements as stated in Table C-2.

Table C-1. FSAR minimum database field requirements

Required fields and minimum field widths along with a recommended format and structure

FIELD NUM	FIELD DATA DESCRIPTION	DB NAME	FIELD WIDTH	REQ'D
1	Failure Analysis Report (FAR) number	FARNO	15	YES
2	Failed pan type (Resistor, Diode, Capacitor, etc.) (C2.5)	PANTYPE	10	YES
3	Pan characteristic (Film, Ceramic, Mica, etc.)	PANCHAR	15	YES
4	Pan description (Voltage, Current, etc.)	PANDESCR	40	OPT
5	Contractor specification number	SPECNO	20	YES
6	Pan supplier/manufacturer name/cage code	MFRNAME	20	YES
7	Generic, Military or Industry pan number	PANNUM	22	YES

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Table C-1. FSAR minimum database field requirements (continued)

FIELD NUM	FIELD DATA DESCRIPTION	DB NAME	FIELD WIDTH	REQ'D
8	Program name where pan failed	PROGNAME	8	YES
9	Lot dale code (LDC) Start (note 4)	LDCSTART	10	YES
9a	Lot Date Code (LDC End (note 4)	LDCEND	10	YES
10	Serial number of end item (black box)	SN	10	YES
11	NR: Report Number that caused FAR to be opened	NR	10	YES
12	Next assembly drawing (dwg) number of printed wiring board	PWBDWG	20	YES
13	End item usage (black box) dwg number	ENDITEMDWG	20	YES
14	End item usage name (Receiver)(name of black box)	ENDITEMNAME	20	YES
15	Vehicle dwg/identification where box installed	VEHNUM	10	YES
16	Date failure occurred	DATEFLR	8	YES
17	Date FAR closed	DATECLOSED	8	YES
18	Failure review board number that closed FAR	FRBNUM	6	YES
19	Cause of pan failure (summary in words)	CAUSE	160	YES
20	Corrective action summary	CA SUMMARY	60	YES
21*	Phase of manufacturing (mfg) when failure occurred (C.2.3.1)	PHASE	3	YES
22*	Test event when failure occurred (C.2.3.3)	TEST	5	YES
23*	Level of assembly when failure occurred (C.2.3.2)	LEVEL	3	YES
24*	Pan defect caused by (C.2.4)	DEFECT	5	YES
25	Sub Contractor Name (mfg of black box)	SUBCONT	20	YES
26	Comment (note 3)	COMMENTS	160	OPT

NOTES

1/ "OPT" found in the REQ'D (required) field column indicates that data need not be entered for that field, but shall be part of the database structure.

2/ "*" found in the Field Num column indicates that database field shall be filled with the failure/defect codes identified in the applicable para referenced in the data description field.

3/ The Comment field need only be used when appropriate.

4/ Use Symbol ">" after LDC to indicate all subsequent LDCs are suspect. Use Symbol "<" after LDC to indicate all prior LDCs are suspect Use symbol "S" after LCD to indicate a multiple of LDCs between LDCSTART and LDCEND are suspect.

C.2.3 Recommended code definitions for the applicable database fields

The contractor may use their own codes or add additional codes to describe when, where, and how the failure occurred. The contractor shall provide documentation to describe these codes.

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C.2.3.1 Phase of manufacturing when failure occurred (Table C-I #21)

NAME	CODE
Assembly and Integration (A/I)	AI
System	SYS
Post System	POS
Launch Preparations/OPS	OPS
Other	OTH

C.2.3.2 Level of assembly when failure occurred (Table C-I #23)

NAME	CODE
Destructive Physical Analysis	DPA
Receiving Inspection	REC
Lot Acceptance Test	LAT
Printed Wiring Board	PWB
Component (Black Box)	BOX
Subsystem	SUB
Vehicle	VEH
Other	OTH

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C.2.3.3 Testing event where failure occurred (Table C-I #22)

NAME	CODE
Pre Acceptance Test Procedure (ATP)	PRATP
1st Electrical	FSTEL
Thermal Cycle Test	TC
Thermal Vacuum Test	TV
Shock Test	SHOCK
Sine Vibration Test	VIBSI
Random Vibration Test	VIBRA
Acceleration Test	ACCEL
Acoustic	ACUST
Climatic (Humidity, Altitude, etc.)	CLIMA
Bum-In Test	BURIN
EMI Test	EMI
Special Test	SPEC
Leak Test	LEAK
Pressure Test	PRESS
Mechanical Test	MECH
Final Electrical	FINEL
Other	OTH

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C.2.4 Cause code of part failure (Table C-1#24)

PAN DEFECT CAUSED BY PART MANUFACTURER	CODE
Contamination	MC
Short	MS
Open	MO
Out of Tolerance	MT
Drift	MD
Mechanical Damage	MM
Friction	MF
Wrong Material/Defective Material	MD
Wrong Heat Treatment	MH
Pan Workmanship	MW
Pan anomaly could not be detected/duplicated	NP
Manufacturer Other (added to comments Table C-1 #26)	OTH

PAN DEFECT CAUSED BY CONTRACTOR	CODE
Misapplication/Design	CM
Mishandling	CH
Planning Paper Error	CP
Workmanship	CW
Contractor Others (added to comments Table C-1 #26)	COTH

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C.2.5 Sample inputs for pan types (see Table C-1, Field Num, 1,2 &3)

PAN TYPE	PAN CHAR	PAN DESCRIPTION	PAN USAGE
MICROCIRCUIT	DIGITAL CMOS	DUAL FLIP/FLOP	HIGH SPD CLOCK
RESISTOR	WIRE	VAR 1/8W 0-115K	PREC TIMING CKT
RESISTOR CHIP	FILM	1/16W 5K	HYBRID
CAPACITOR	TANTALUM SLUG	60V 32MF	FILTER
NUT	10x32, 1" DIAM	CRES	
VALVE	FUEL	BRASS	HYDROGEN
CABLE TIES	¼ INCH	NYLON 66	12-Lb RATING

Table C-2. FSAR database documentation requirements for each submittal

REQUIRED DATA TO BE SUPPLIED WITH EACH NEW OR REVISED FSAR SUBMITTED EACH ENTRY FOR INFORMATION TO BE ON A SEPARATE LINE

CONTRACTOR NAME _____

CONTRACTOR CAGE CODE _____

CONTRACTOR ADDRESS _____

CONTRACTOR CITY _____

CONTRACTOR STATE _____

CONTRACTOR ZIP _____

ADPMPL CONTROL # _____

ADPMPL REVISION # _____

CONTRACT# _____

USER (NASA, NAVY, SMC) _____

PROGRAM NAME (IUS, DSCS) _____

DATA ITEM TITLE _____

DATE OF LAST REVISION _____

RESPONSIBLE GROUP PHONE # _____

TOTAL NUMBER OF RECORDS _____

COMMENTS _____

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APPENDIX D

NEW TECHNOLOGY INSERTION PLAN REQUIREMENTS

D1.0 Introduction

In recent years, the Government has not required space systems manufacturers or their subcontractors to only use space-qualified parts in their systems. Systems manufacturers have evaluated the best part available and determined through a self-selected series of tests and analyses that a specific device is acceptable and meets the system performance and reliability requirements. However, based on a number of recent problems, which have had a critical impact upon launch schedules as well as on-orbit performance, it has been determined that a more stringent approach to the use of new technology parts, materials, and processes is required before they are actually used to build space flight hardware.

D2.0 Scope/Objective

This appendix provides a set of requirements and guidelines for the contractor development of a New Technology Insertion Plan (NTIP) to enable the insertion of new technologies into space flight hardware at the prime, subcontractor(s), and supplier levels. The plan shall insure that contractor(s) and the Government form an integrated effort to manage the new technology insertion into a seamless, efficient management process and identify the minimum set of requirements that a new technology must meet in order to be installed in space flight hardware. The plan, which is to be a living document, will define a generalized approach that shall be followed to determine, evaluate, gather and analyze the technical data for a new technology in order to demonstrate that it meets program and mission requirements. This portion of the plan will not define the specific tests for a new technology or how to perform the tests, but will identify generic issues that must be considered. As the plan matures, specific new technologies will be identified and specific, detailed evaluation plans included in the plan's appendix.

D3.0 New Technology Process

The plan shall define the methodology and process used for inserting new technology. The methodology and approach must include the following:

a. Roles and Responsibilities. The NTIP shall specify that the Parts, Materials, and Processes Control Board (PMPCB) will be responsible for the new technology insertion process. The PMPCB will ensure that the NTIP is initially prepared, submitted and maintained through subsequent updates for Government approval. The PMPCB shall provide oversight throughout the entire process. It shall; verify that the process is being properly implemented, and that it is seamlessly integrated with the contractor and subcontractors. It shall evaluate the data and analyses and ensure that the findings are disseminated to concerned parties. And finally it will approve the new technology for use on flight hardware. The plan shall delineate the roles and responsibilities for the contractor and subcontractors as related to new technology insertion. It shall describe the PMPCB responsibilities relative to supporting the Program's Risk Management Board.

b. Process Flow. The plan shall define the flow and specific requirements for approval of new technology including the evaluation of changes that may become necessary. This shall include how the PMPCB will interact with the overall program.

c. Definitions/Criteria/Description of New Technology. Specific criteria shall be delineated to determine if a specific item, part, material, process, etc. should be classified as new technology and therefore, must be evaluated in accordance with the approved plan. New technologies are defined as parts, materials, or processes that have not been qualified for application within the specific space environment, do not have an extensive space flight history or have undergone a change that may alter the performance and/or functionality or reliability of the part, material or process within the space environment. Examples include:

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(1) New technology PMP is a PMP that has never been previously characterized or qualified for applications within the specific space environment, has limited or no space heritage, or has undergone changes that may alter performance, functionality or reliability of the PMP within the space environment.

(2) Commercial technology, characterized by lack of compliance to established standards and a controlled product baseline assuring a uniformed and consistent product.

(3) Space technology that has undergone major changes within the last two years in the element selection, design, materials, processes, assembly, manufacturing, testing or application.

(4) PMP that is new within a heritage technology family.

(5) PMP or technology that is new to a particular supplier.

(6) PMP or technology that is below a NASA Technology Readiness Level of six (TRL).

d. New Technology Evaluation. The NTIP shall require the evaluation of new technology for insertion prior to the System Design Review (SDR). In developing the generalized evaluation approach, the following guidance is provided which separates the evaluation into two distinct phases: Characterization and Qualification Testing. As the associated evaluation periods could be significant, the NTIP should encourage the use of supplier/manufacturer data whenever possible after independently determining the relevance of that data. See the following discussion.

(1) Characterization Testing is needed to completely characterize the part, material or process and to ensure that the item's capabilities meet mission requirements. All aspects of the technology must be evaluated to ensure that the process is well controlled, that the long term reliability is established, that radiation characteristics are identified and that overall parametric performance is well defined in terms of margins and areas of concern. A detailed physics of failure (considers the mechanical, thermal, electrical and chemical properties that could contribute to root cause failures throughout the product life cycle) and failure modes effects analysis approach must be followed to ensure all failure mechanisms have been defined, understood and mitigation techniques either implemented or at least identified so that users understand the technology's limitations and can devise a potential mitigation screen or test program. When possible, the characterization program should be performed on sufficient quantities including multiple lots to account for variations in processing. Evaluations can utilize actual product and/or test structures designed specifically for that purpose. Two of them are: Technology Characterization Vehicle (TCV) and Standard Evaluation Circuits (SEC is used to demonstrate fabrication process reliability for the technology) or Process Control Monitor (PCM) circuits (used by the manufacturer to control key processing steps to insure yield, reliability and radiation hardness, if applicable). The monitoring system can utilize various test structures, coupons, methods and measurement techniques. The manufacturer based on their experience and knowledge of their processes should determine the critical operations that need to be monitored. The resulting data should be analyzed by appropriate statistical process control methods to determine effectiveness. Testing and analysis data collected from characterization must include methods of analysis, and must be well documented for subsequent review. Sufficient quantity of test articles as noted above must be manufactured and kept as control samples for further test and experimentation if necessary.

(2) The contractor/subcontractor must determine what characteristics of the new technology are critical. The contractor/subcontractor can utilize data gathered from the supplier or conduct testing on their own as necessary. This will require a detailed evaluation and analysis of the specific items being considered. It will also require an evaluation of the maturity and stability of the supplier's parts, materials and processes. In addition the following information shall be collected as applicable:

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i. Process and performance margins and their sensitivities.

ii. Process trending and the use of Standard Evaluation Circuits to evaluate changes to the process.

iii. Yield enhancement – how the supplier evaluates yield and implements corrective action on a continual basis.

iv. Statistical Process Controls (SPC) – approach and methodology used, establishment of control limits and data analysis (periodicity, out of control plan, corrective action).

v. Identification and understanding of all failure mechanisms – use of test structures, how the testing is accomplished, test to failure, activation energy (high and low).

vi. Reliability

(a) Standard tests such as electro-migration, time dependent dielectric breakdown (TDDB), hot carrier aging, ohmic contact degradation, etc.

(b) Accelerated testing such as step stress tests, constant stress life tests at various temperatures (hot, cold, etc) dependent upon the failure mechanism and acceleration factors.

(c) Highly accelerated stress test (HAST) – elevated temperature and high relative humidity.

(d) Highly accelerated life test (HALT) – a combination of thermal cycle life test and vibration test.

(e) 85% RH/85°C –life test at 85 ^{o}C and 85% relative humidity

(f) Thermal cycle test for creep/fatigue life and workmanship type defects.

(g) DC bias at various voltages and temperatures to characterize reliability of capacitors.

(h) Life test of circuit conductors under various current loads to test for electromigration mechanism.

(i) Autoclave test to accelerate failure by temperature and pressure

(j) Long term testing to provide FIT rates and ensure part, material or processes will meet mission duration.

(k) Failure Modes and Effect Analysis (FMEA): The FMEA concept should apply to new parts, devices, and materials to be inserted in space applications. The principle of FMEA is to consider each mode of failure to ascertain the effects on device operation and reliability of each failure mode.

(l) Special tests as deemed necessary by identification of issues/failure mechanisms.

vii. Radiation control and verification requirements are essential for space vehicle hardware, and are dependent on their mission environment and operational requirements. The parts, devices, and materials for new technologies must be tested for total ionizing dosage (high and low dose rates), displacement damage dosage, and single event effects. Standard industry test methods such as MIL-STD-883 must be used.

viii. Process/test optimization – what and how the supplier evaluates process and/or test optimizations

ix. In addition to understanding the aspects of the part, material or process, the contractor/subcontractor must also ensure the usability of the new technology within their system and application. They shall ensure that the item has sufficient or ample margin (the minimum allowable margin must be defined by the contractor within his plan)

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between the supplier's specifications and the operating conditions within the application. All derating criteria must be adequately evaluated. Electrical, mechanical and radiation test data shall be evaluated and testing performed as necessary to ensure the item meets all system and mission requirements. A thermal analysis shall be performed to ensure the item operates within system reliability requirements. A durability analysis and appropriate testing shall be required to ensure that the item meets the system and mission mechanical environmental requirements.

x. Electronic devices and materials generally fail based on two mechanisms, chemical reactions and physical processes. The chemical reaction is governed by thermodynamics and kinetics. If thermodynamics predicts that the reaction will occur, then the next question is how soon will it occur? If the reaction rate is very slow (> 100 years), then it will meet the mission life requirement. The rate of reaction, such as the corrosion processes or formation of undesirable compounds (e.g. brittle intermetallics), will determine the life of some part types. The physical process includes mechanical change (physical and thermal stress), mass transfer (e.g. diffusion, evaporation and or sublimation in a vacuum), and electrical stress (voltage and current). In each situation, the rate of change must be evaluated so that the lifetime can be determined.

xi. Additional evaluations and testing maybe required based on the new technology item and/or information determined from the supplier's data and/or system application requirements.

(3) Qualification is the validation that all the previous characterization testing and evaluations of failure mechanisms shows that the technology meets or exceeds the stringent requirements for space. Space qualification of materials and processes is generally bounded by certain limitations, such as application environments, operating conditions and requirements. Space qualification should consist of the following categories:

i. Manufacturing line qualification: qualify the line with standard processes and materials, equipment, tools, etc, based on each manufacturer's process requirements.

ii. Technology qualification: based on the technology and potential applications, new technology approaches must be defined.

iii. Product qualification: product must be qualified to specific design, application, performance and reliability requirements.

(4) Approach to qualification: Qualification methodology will vary depending on the technology and applications. A cookbook approach is not recommended unless the technology is similar to a technology already evaluated and qualified. The qualification testing should consist of the typical military standard tests (electrical, mechanical and environmental including radiation) defined in the specifications for that technology or the closest technology and a "Physics of Failure" philosophy in qualifying various parts, materials, processes and products. If no military specification exists or there is no technology similar to the new technology, the NTIP should define the tests required for qualification. Additional testing shall be included as determined by the NTIP based on the characterization data, system level testing and mission requirements.

D4.0 Documentation

The plan shall delineate the required documentation and formats to be used. Provisions should be made to accommodate an Automated Information System to enable its efficient distribution.

D5.0 Detailed Plans

The NTIP's appendix shall contain a detailed evaluation plan for each specific new technology part, material or process that has been identified including the methodology to be used in understanding the

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items physics of failure and how to determine its failure modes and effects. The appendices may be incrementally submitted after the initial plan has been approved.

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SMC Standard Improvement Proposal

INSTRUCTIONS

1. Complete blocks 1 through 7. All blocks must be completed.
2. Send to the Preparing Activity specified in block 8.

NOTE: Do not be used to request copies of documents, or to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Comments submitted on this form do not constitute a commitment by the Preparing Activity to implement the suggestion; the Preparing Authority will coordinate a review of the comment and provide disposition to the comment submitter specified in Block 6.

SMC STANDARD CHANGE RECOMMENDATION:	**1. Document Number**	**2. Document Date**

3. Document Title	

4. Nature of Change
(Identify paragraph number; include proposed revision language and supporting data. Attach extra sheets as needed.)

5. Reason for Recommendation

6. Submitter Information

a. Name	**b. Organization**
c. Address	**d. Telephone**
e. E-mail address	**7. Date Submitted**

8. Preparing Activity

Space and Missile Systems Center
AIR FORCE SPACE COMMAND
483 N. Aviation Blvd.
El Segundo, CA 91245
Attention: SMC/EAE

March 2008