

“US Air Force Space Requirements for Launch Vehicles Specification SMC-S-011”

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March 1, 2016

Topics of the Presentation

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 - *Contributors - Aerospace*

Purpose of the Presentation

- Explain the Parts, Materials and Processes (PMP) requirements defined by the US Air Force for launch vehicles for satellites
- Understand the changing environment and rationale for evolving changes to requirements

Environment & Purpose for the Changes

- Original launch vehicle standard generated in June 2008 SMC-S-011
 - Prior to that timeframe, other documents were developed by launch vehicle organization
- Standard modified one time in July 2012 for minor changes
- The satellite PMP requirements (MIL-STD-1546/47) were modified in 2004, 2006, 2008 and 2013 bringing the requirements in line with government and industry approaches
 - These documents were released as Aerospace Technical Operating Reports

Environment & Purpose for the Changes (continued)

- Based on revised industry and government philosophy over the last few years, it was believed to be time to modernize the requirements for launch vehicles
- The basic changes will allow flexibility for alternative PMP management approaches while maintaining mission success
 - Recognize short mission life and redundancy impacts on PMP requirements
- Address affordability
- Leverage new technologies

Current PMP Requirements in SMC-S-011

- Parts selection from ELV Space PMP Baseline for all applications
 - *Required space level parts*
 - Part level 100% screening, Process Controls, & qualification
 - All non ELV Space Baseline parts would require equivalent technical info
- Program Plan to define Contractor PMP management approach
- PMPCB required with specific authority and Customer right of rejection
- Specific PAR and MAR forms for PMP approvals
- Specific Survivability testing at part level
- Part traceability to unit level
- Part DPA per MIL-STD-1580 for each lot of parts
- Procurement from OEM or authorized distribution
- PMP Lists (Selection; As Designed)
- Order of precedence of acceptable quality level
- Derating for reliability
- Prohibited PMP (items not to be used)
- Upscreening of lower quality levels defined

New SMC-S-011 Major Requirements/Changes

- Parts selection from ELV Space PMP Baseline for all Category I applications (Mission Critical & Single String or Mission Critical & Single Point Failures)
 - Part level 100% screening, Process Controls, & qualification
 - Detailed upsampling and sampling requirements
- Program PMP Baseline for Category II
 - Mission Critical and Redundant
 - Selection based on WCCA, Worst Case Derating, Redundancy, Mission Reliability and Survivability
 - Knowledge of manufacturer part (design & process) control, technology, & failure modes
 - Prescribed part screening and class selection no longer required
 - Baseline established by Contractor and approved by Parts, Materials, & Processes Control Authority (PMPCA) and customer
- Category III Non Mission Critical - Do no harm

Minimum PMP Requirements Defined

- Appendix B of document defines the minimum requirements imposed on parts and materials and includes the known failure mechanisms of all EEEE parts
- Summary of some requirements defined
 - All active EEEE parts selected for use shall have a minimum -40°C to $+85^{\circ}\text{C}$ operating temperature range unless exposed to other than -34°C to $+10^{\circ}\text{C}$ of margin (as defined by the manufacturer's operating temperature range) over the minimum and maximum unit qualification temperatures.
 - All passive EEEE parts selected for use shall have a minimum operating temperature range -55°C to $+125^{\circ}\text{C}$.
 - For plastic-encapsulated EEEE the parts selected shall have a minimum glass transition (T_g) temperature rating of 10°C above the maximum rated operating temperature value.
 - The contractor shall identify all special design application requirements for each part, material, and/or process, and shall verify they are met by the part, material, and/or process selected for the application.

Minimum PMP Requirements Defined (continued)

- Appendix B of document defines the minimum requirements imposed on parts and materials and includes the known failure mechanisms of all EEEE parts
- Summary of some requirements defined (continued)
 - All parts and materials critical parameters shall be verified to meet the established performance requirements as derived from the WCCA over the maximum temperature range established.
 - All EEEE parts operating under switching applications (e.g., current, voltage) shall be verified to have at least 100% margin over the expected current or voltage surge levels during operations.
 - All parts and materials selected for the application shall be verified to have 2x design fatigue margin with respect to expected operating environments (include all ground-level testing and launch/mission operating conditions) while meeting all the expected mission functional requirements.
 - The contractor shall verify that all potential parts, materials, and processes associated failure modes identified by the ELV FMECA are addressed.

Minimum PMP Requirements Defined (continued)

- Appendix B of document defines the minimum requirements imposed on parts and materials and includes the known failure mechanisms of all EEEE parts
- Summary of some requirements defined (continued)
 - The contractor shall verify that the part and/or material manufacturer has identified and addressed the design of the part and/or material failure modes and the associated causes or mechanisms. The failure mechanisms and mitigation strategies shall be validated initially and for every subsequent major design change implemented.
 - The contractor shall verify that the part and/or material manufacturer-implemented mitigation strategies for the identified failure modes reduce infant mortality and operational failures consistent with the failure rates used in the reliability analysis.
 - The contractor shall implement additional mitigations where the manufacturer design and mitigation strategies are not satisfactory at the part level, including electrical testing over temperature, stress testing to validate maximum ratings, DPA, etc.

New SMC-S-011 Major Requirements/Changes

- Program Plan to define Contractor PMP management approach
 - Converted from prescriptive to performance based allowing for more flexibility in PMP management implementation
 - Retained the core requirements expected in the plan
 - Modified/Added requirements
- PMPCB required with specific activities and Customer right of rejection
 - Converted from prescriptive to performance based allowing for more flexibility in PMP management implementation
 - Retained the core requirements expected for PMPCB allowing for alternate approaches and authority

New SMC-S-011 Major Requirements/Changes

- Allowed contractor formats for PAR and MAR forms for PMP approvals
- Radiation testing
 - Limit requirements to Single Event Effects (SEE)
 - Requires risk assessment of any untested threats
 - Requires relevance of test data to flight units
- Part traceability to unit level (no change)
- Part DPA per MIL-STD-1580 for each lot of parts (no change)
- Procurement
 - Requires parts and materials to be procured directly from the manufacturer, whenever possible, or procured from the manufacturer's authorized distributor.
 - Requires selection and knowledge of suppliers based on criteria and factors to ensure that the required quality and reliability requirements can be met
 - Requires each procurement of parts and materials procured to be traceable to the original manufacturer and to be accompanied by a written certification of compliance to the specified requirements

New SMC-S-011 Major Requirements/Changes

- PMP Lists - added requirement for As-Built PMP Lists
- Order of precedence defined
- Derating modified to account for short missions and lessons learned
- Prohibited PMP defined based on lessons learned
- Upscreening
 - Deleted original and replaced with Program PMP Baseline Minimum Requirements

Revised SMC-S-011 Status

- Revised SMC-S-011 sent out to industry December 2014 for review and comments
- Comments sent to Aerospace by end of February 2015
- An Aerospace Team met every day for a few hours to compile and adjudicate comments and revise document as necessary
- Meetings held with industry representatives to discuss comments
- Document revised after adjudication discussions and published as a revision to SMC-S-011
- US Air Force Space and Missile Systems Center (SMC) plans to use this document in the next block buy for launch vehicles

Summary

- Provided background as to the reasons for revising the launch vehicle specification
- Provided a summary of current document requirements and changes to the modified document
- Provided document status
 - Provided industry with draft document
 - Reviewed comments and made applicable changes
 - Released modified document for SMC utilization

Back-Up

Acronyms

• DPA	Destructive Physical Analysis
• EEEE	Electrical, Electronic, Electromechanical & Electro-optical
• ELV	Expendable Launch Vehicle
• FMECA	Failure Modes and Effects Critical Analysis
• MAR	Material Approval Request
• OEM	Original Equipment Manufacturer
• PAR	Parts Approval Request
• PMP	Parts, Materials and Processes
• PMPCA	Parts, Materials and Processes Control Authority
• PMPCB	Parts, Materials and Processes Control Board
• SMC	Space and Missiles Systems Center
• WCCA	Worst Case Circuit Analysis

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