

# Tailoring of SMC-S-016 (2014), Test Requirements for Launch, Upper-Stage, and Space Vehicles

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This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas until adopted or otherwise implemented by the government.

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## Change History

Rev No	Description of Change	Effective Date
-	Initial release  Stakeholder review was documented in TOR-2020-00566-Rev A, “Stakeholder Review: Tailoring of SMC-S-016 (2014), Test Requirements for Launch, Upper-Stage and Space Vehicles”	08-21-2020

## Foreword

This document is a tailoring of USAF Space and Missile Systems Center (SMC) standard number SMC-S-016 (2014), entitled *Test Requirements for Launch, Upper-Stage and Space Vehicles*, which focuses on design verification and the identification of latent defects to help ensure a high level of confidence in achieving successful space missions.

SMC-S-016 (2014) and this document, together, are intended for use in acquisition and study contracts as compliance documents. The tailoring detailed in this document pertains to heritage units.

### Tailoring Intent

This tailoring is based on a joint assessment by The Aerospace Corporation (Aerospace) and SMC of test requirements currently on, or required for near-term future, SMC contracts. The goal was to streamline those requirements that are either commonly tailored or can be restated to facilitate more effective implementation.

### Formatting of This Tailoring Document

The outline and organization in this tailoring document are consistent with SMC-S-016 (2014), originally published as The Aerospace Corporation report number TR-RS-2014-00016. To avoid ambiguity, the formatting, section title capitalization, and section numbering, including inconsistencies, have been preserved as originally published.

### Tailoring Definition

Tailoring is a process by which individual requirements from specifications, standards, or related documents are evaluated and applied to a specific program by deletion, modification, or addition of requirements. Tailoring of requirements must be undertaken with consultation and approval of the procuring authority and subject matter experts to align the standard with the acquisition authority's requirements and the mission needs. The diversity of missions, buses, payloads, environments, and unique approaches of contractors makes tailoring of standard requirements mandatory.

This tailored standard establishes a baseline for requirements, which in turn may be tailored or revised with rationale for specific project needs upon approval by the procuring authority.

### Summary of tailoring

The following is a comprehensive list of the changes that this document imposes on SMC-S-016 (2014).

Section	Title	Change Summary
	Foreword	Added background for this tailoring.
4.10.3	Electrical and electronic unit test reduction based on flight heritage and proven reliability	Added option for electrical and electronic unit acceptance and protoqualification testing reduction when significant flight heritage and proven reliability can be demonstrated.
6	Table 6.3-2 Unit Acceptance Test Summary, Table 6.3-3 Unit Test Level Margin and Duration, Section 6.3.8.3 Test Levels and Duration for Electrical and Electronic Units, and Section 6.3.9.3 Test Levels and Duration for Electrical and Electronic Units	References back to Section 4.10.3 are added with text to indicate that reductions below specified levels may be possible if the prescribed conditions are met.

## Contents

1.	Scope.....	1
2.	Reference Documents .....	1
3.	Definitions.....	1
4.	General Requirements.....	1
5.	Alternative Strategies.....	2
6.	Unit Test Requirements .....	2
7.	Subsystem Test Requirements .....	3
8.	Vehicle Test Requirements .....	3
9.	Prelaunch Validation and Operational Tests.....	3
Appendix A.	Thermal Test Considerations .....	3
Appendix B.	Dynamic Test Considerations .....	3

## **1. Scope**

Use SMC-S-016 (2014) verbatim.

## **2. Reference Documents**

Use SMC-S-016 (2014) verbatim.

## **3. Definitions**

Use SMC-S-016 (2014) verbatim.

## **4. General Requirements**

ADD THE FOLLOWING. Otherwise use SMC-S-016 (2014) verbatim.

### **4.10.3 Electrical and electronic unit test reduction based on flight heritage and proven reliability**

When it can be demonstrated that electrical and electronic unit design and manufacturing processes and techniques have significant test or flight heritage and proven reliability, the environmental test requirements can be reduced, as described below, while still meeting baseline test effectiveness goals.

Claims of heritage shall meet the following conditions:

- a) Each of the heritage units being used to demonstrate proven reliability were representative flight articles.
- b) The environments, both amplitude and duration, encountered by each of the heritage flight units being used to demonstrate proven reliability during their test history, and applicable flight history, are equal to, or more severe than, the environments intended for the unit design under consideration for environmental test requirement reduction.
- c) The unit design under consideration for environmental test requirement reduction and each of the heritage units being used to demonstrate proven reliability are produced by the same manufacturer in the same facility using identical tools, manufacturing processes, quality control procedures, and manufacturing staff training/certification levels, without gaps that impact production continuity.
- d) The unit design under consideration for environmental test requirement reduction and each of the heritage units being used to demonstrate proven reliability shall perform similar functions, and the heritage units shall have equivalent or greater operating life with variations only in terms of performance such as accuracy, sensitivity, formatting, and input-output characteristics.
- e) Supporting documentation for each of the heritage units being used to demonstrate proven reliability is available and includes specifications, drawings, qualification test procedures, qualification and acceptance test reports, ground and flight discrepancy reports with closure history, test waivers, and flight history summary.
- f) Modified unit designs under consideration for environmental test reduction may be a minor variation of the heritage units. Dissimilarities of safety, reliability, maintainability, weight, thermal effects, dynamic response, and structural, mechanical, and electrical configurations shall require that the characteristics of the unit design under consideration for environmental test

requirement reduction be enveloped by the characteristics of the heritage unit. Minor design changes involving substitution of piece parts and materials with equivalent reliability items can generally be accepted. Design dissimilarities resulting from addition or subtraction of piece parts and particularly moving parts, ceramic or glass parts, crystals, magnetic devices, and power conversion or distribution equipment shall void the consideration of reduced environmental test requirements unless the contractor's QBS analysis, as described in Section 4.10.1, includes technical rationale supporting the similarity claim.

There is no reduction for qualification testing because requalification denotes a change in design or processes. Given the change in unit design, environments, and/or process is significant enough to require requalifying the unit, any test history of prior related units could not be considered heritage per conditions a – f listed above. In general, protoqualification testing would also not be subject to reductions, although there may be exceptions where the unit conditions have changed enough to warrant protoqualification of the next unit, but the heritage reliability is still relevant.

- For electrical and electronic unit thermal cycle (TC) and thermal vacuum (TV) testing, the minimum number thermal cycles may be reduced to:
  - Protoqualification: 15 cycles (with at least 3 cycles in vacuum)
  - Acceptance: 10 cycles (with at least 3 cycles in vacuum)
- For electrical and electronic unit burn-in testing, the 200-hour test duration can be split:
  - 100 hours in thermal testing at hot acceptance temperature or cyclic over the acceptance temperature range and 100 hours at ambient temperature
- The noted "Evaluation Required (ER)" for shock for electrical and electronic units in Table 6.3-2 (Unit Acceptance Testing) is not mandatory unless an issue arose in qualification or protoqualification testing that indicates unit shock sensitivity. It is left to the qualification review board to determine whether an evaluation for acceptance test is appropriate given qualification or protoqualification shock test results. If no shock susceptibility issues were realized in qualification or protoqualification, shock acceptance testing is not required.

A typical approach for demonstrating unit reliability for a single unit or group of units with common parts and manufacturing processes involves aggregating unit failure data and out-of-specification events over testing of all preceding units to nominal environmental test requirements and demonstrating either that failure rates for the units under consideration are consistently low enough or have decreased over time to the point that they are low enough to meet program test effectiveness goals. In no circumstance shall the heritage data for units under consideration for test reductions show an increasing failure rate with time. Further, the aggregated failure data should cover higher integration level downstream testing and any flight anomalies to demonstrate that latent defects are not being propagated. Failures should be examined in sufficient detail to determine if they are potentially related to the tests under consideration for reduction or definitively unrelated.

## **5. Alternative Strategies**

Use SMC-S-016 (2014) verbatim.

## **6. Unit Test Requirements**

ADD THE FOLLOWING at the beginning:



“The environmental test requirements specified herein (particularly as per Table 6.3-2 and 6.3-3) may be reduced as described in Section 4.10.3 provided the prescribed conditions there are satisfied.”

ADD THE FOLLOWING as a prominent general note on Table 6.3-3 or as a repeated footnote on the individual affected requirements:

“Listed requirements may be reduced as described in Section 4.10.3, provided the prescribed conditions there are satisfied.”

ADD THE FOLLOWING to Section 6.3.8.3c:

“The acceptance and protoqualification durations for a unit may be further reduced, as described in Section 4.10.3, when the unit meets the prescribed conditions of that section.”

ADD THE FOLLOWING to Section 6.3.9.3c:

“The acceptance and protoqualification durations for a unit may be further reduced, as described in Section 4.10.3, when the unit meets the prescribed conditions of that section.”

Otherwise use SMC-S-016 (2014) verbatim.

## **7. Subsystem Test Requirements**

Use SMC-S-016 (2014) verbatim.

## **8. Vehicle Test Requirements**

Use SMC-S-016 (2014) verbatim.

## **9. Prelaunch Validation and Operational Tests**

Use SMC-S-016 (2014) verbatim.

## **Appendix A. Thermal Test Considerations**

Use SMC-S-016 (2014) verbatim.

## **Appendix B. Dynamic Test Considerations**

Use SMC-S-016 (2014) verbatim.

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