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AIAA S-117A-2016

Standard

Space Systems Verification Program and Management Process

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Standard

Space System Verification Program and Management Process

Sponsored by

American Institute of Aeronautics and Astronautics

Approved 3 June 2016

Abstract

This standard is an AIAA mandatory 5 year review version of the original AIAA S-117-2010.

This updated version continues to be intended for commercial/noncommercial manned or unmanned space programs to achieve a key Mission Assurance goal of “Robust yet Cost Effective” systems by enforcing a “distributed” verification program for planning and executing “system is built right” verification activities

It provides a set of requirements that utilizes a standardized set of “six” verification management processes starting from the earliest phase and the lowest level of a program to develop a robust system since even a single overlooked deficiency could cause very costly late changes or catastrophic post-launch failures of any heritage/new space systems.

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As such, it corrects fundamental problems associated with the traditional “centralized” approach, those dictated by “Total System Program Responsibility (TSPR)”, or “Faster, Better, Cheaper” policy that often caused program failures due to overlooking deficiencies in their systems.

Finally, this verification standard facilitates the closely coordinated verification and validation (V&V) activities based on the similar “distributed” systems engineering processes from the earliest and the lowest system development.

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Foreword

This standard has been developed by the AIAA Systems Engineering Committee on Standards (SECoS) under the auspices of AIAA Standard Executive Council (SEC).

The standard delineates a specific set of requirements for each commercial/noncommercial space program to successfully achieve a key mission assurance goal of “Robust yet Cheaper” system developments based on a “distributed” verification program and associated processes. Namely, the “distributed” verification program requires all the participants, including the prime developer and associated subcontractors, and vendors, of a space program to implement the standardized set of “six” verification management processes described in this standard in developing each of their responsible part of a space system.

In particular, this standard uniformly applies to the verification of space and launch vehicles, ground systems and associated devices, units, subsystems, and internal/external interfaces regardless of builders that are engaged in the development of any of these components.

Adhering to the requirements specified in this standard by each space program is important to avoid overlooking of deficiencies associated with requirements, designs and analyses, or tests, etc., as earliest phase/lowest level of system development as possible in order to prevent/minimize typically very costly late changes and catastrophic post-launch mishaps, in the worst case.

The required “distributed” verification program and its processes also facilitate implementation of similar “distributed” validation program such as those conducted by third-party participants in the work breakdown structure—integrated product team (WBS-IPT) as well as Development Test and Evaluation (DT&E), Operational Test and Evaluation (OT&E), or Independent Readiness Review (IRR) teams.

In any regard, this standard can be tailored to be applicable to any space programs such as of lean acquiring groups as long as the tailoring will not jeopardized the prevention of any very costly/catastrophic post-launch mishap.

This AIAA standard was developed as the result of a series of reviews by the SECoS, SEC, and the general public.

At the time of approval, the members of the AIAA SECoS who participated in the 5yrs review of this standard are listed in the table below (See next page)

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The above SE CoS consensus body approved this document in May 2016. The above consensus body submitted this document to the AIAA Standards Executive Council (SEC) for their review in May 2016. The AIAA SEC (Allen Arrington, Chair) accepted the document for publication in June 2016.

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Introduction

It is critical for each commercial/noncommercial space system (SS) acquisition program to establish a standard set of management processes that enforce the “system is built right” verification approaches from the earliest phase and the lowest level of system development in order to achieve successful mission assurance. This is based on survey evidence indicating that very costly “late changes” or post-launch mishaps could have been avoided by implementing a thorough verification program. The findings show that such a program is needed throughout the system development phases/levels including those associated with system building facility and the launch site activities (see Reference 1).

This document outlines “distributed” verification program as a space system community standard that implements a set of six verification management processes in every level and phase of a system’s development as follows:

(1) VM-Process 1: Requirement flow-down and establishment of specification process
(2) VM-Process 2: Verification cross-reference matrix (VCRM) process
(3) VM-Process 3: Integration and test (I&T) process
(4) VM-Process 4: Individual specification dedicated verification ledger (ISDVL) process
(5) VM-Process 5: Sell-Off/Consent-to-Ship process
(6) VM-Process 6: Verification-related risk management process

When applied, these management processes enforce verification approaches that are consistent and uniform among all space system builders.

These processes also enable and encourage each system developer to conduct proactive and continual risk management. This includes the use of issue and watch lists to help identify and resolve concerns at the earliest phase and lowest level of the system being developed.

This “distributed” verification process, if applied from the start of a program, will also ensure thorough re-verification of any late changes that might occur.

Furthermore, this standard will also help each space program to properly apply any heritage/commercial systems to a new program by examining whether the applicability of these systems have been thoroughly verified based on the distributed verification program and its processes. Namely, appropriate modifications of any heritage systems for new/modified systems will be systematically accomplished by applying these six verification management processes.

Although this standard focuses on system verification, it includes some requirements for system validation because of the close relationship between these two activities, verification and validation (V&V), i.e., requirements developed for verification are frequently applicable to validation efforts.

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1 Scope

This standard establishes a set of requirements for planning and executing verification programs for commercial/noncommercial manned and unmanned space systems.

This standard enforces the “distributed” verification program among general space system builders that engage in the development of any components of a space system, starting at the lowest level (i.e., unit/piece part level) and the earliest phase (i.e., requirement phase) through to the sell-off and the consent-to-ship of a system’s development as well as the launch site activities.

Although space systems generally include all or combinations of five segments—Space Segment, Launch Segment, Ground Segment (GS), User Segment, and Satellite Control Network Segment—this standard primarily addresses verification associated with space segment, launch segment, and ground segment acquisitions. Launch segments including range safety, ground support equipment, and launch operation facilities, which are not otherwise addressed in this document, may also benefit from the described verification management processes.

The standard may be adapted to the remaining two space systems: the user segment and the satellite control network segment.

2 Tailoring

In order to better support a specific program or project, the processes defined in this standard may be tailored to match the actual requirements or needs of the particular program as long as any tailoring will not accidentally lead to overlooking of technical deficiencies that could cause very costly late changes or catastrophic post launch failures. Any tailoring of this document should be coordinated with/approved by the procuring authority or customer.

NOTE Tailoring is a process by which individual requirements or specifications, standards, and related documents are evaluated and made applicable to a specific program or project.

3 Applicable Documents and Reference Documents

3.1 Applicable Documents

These documents should support a specification by including additional guidance on the verification method, approach, and success criteria, and by promoting compliance through design, analysis, manufacturing, test, and system acceptance at each level of the system’s development.

3.2 Reference Documents

Reference documents are defined as documents that are not contractually binding but that may contain useful or supporting information. A list of references used for developing this standard is as follows:

Reference 1: AIAA 2007-6099 Solid Verification Program Enables Cost-Effective Acquisition of Complex yet Reliable Space Systems, September 2007

Reference 2: INCOSE Systems Engineering Handbook Version 3.2, February 15, 2010

Reference 3: NPR 7123.1 NASA Systems Engineering Processes and Requirements, March 26, 2007

Reference 4: ANSI/EIA-632 EIA Standard, Processes for Engineering a System, 1999