AIAA
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Standard

Space Systems Verification Program and Management Process

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Abstract

This document enforces a systematic approach to planning and executing verification programs for manned and unmanned space systems based on a distributed approach that corrects fundamental deficiencies associated with the traditional centralized verification approach. Thus, this document corrects generic problems in conducting verification that existed even during post-Total System Program Responsibility or "Faster, Better, Cheaper" policy that prospered late 1990 through early 2000 for developing complex space systems. This standard is intended to help those in the space community develop reliable systems that meet requirements while ensuring proper accommodations of heritage and/or commercial systems in their developing systems. It also helps to facilitate the closely coordinated validation activities with those of verification, as the distributed systems engineering processes utilized in the latter can be easily adopted by the former activities.

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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 space program to successfully plan and execute verification of a space system based on a "distributed" verification program and associated processes. 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 these components.

Adhering to the requirements specified in this standard by each space program is important in order to prevent/minimize late changes and misuse of heritage/commercial systems that are typically very costly and in the worst case can cause post-launch mishaps.

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

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

At the time of approval, the members of the AIAA **SE Committee on Standards** who developed this standard were:

Satoshi Nagano, Chair	The Aerospace Corporation
John Hsu, Co-Chair	The Boeing Company
John C. Muehlbauer, Co-Chair	Lockheed Martin Aeronautics Company
Michelle Bailey	DAU South
Dexter Lee Blackstock	NASA Langley
Shirley Brandt	Jacobs Engineering
Edmund H. Conrow	Management and Technology Associates
John W. Dahlgren	MITRE
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Manantesh Hiremath	Space Systems Loral
Stephen Jensen	NASA Dryden Flight Research Center
Eric E. Nichols	Orbital Science Corporation
Brian Selvy	Paragon Space Development Corporation
William W. Vaughan	University of Alabama in Huntsville

The above SECoS consensus body approved this document in September 2010. The above consensus body submitted this document to the AIAA Standards Executive Council (SEC) for their review in October 2010. The AIAA Standards Executive Council (Wilson Felder, Vice President) accepted the document for publication in November 2010.

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Introduction

It is critical for each space system (SS) acquisition program to follow a standard set of management processes that enforce the "system is built right" verification approaches in order to develop reliable systems. This is based on survey evidence indicating that most 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 early development activities through delivery of the developed system to the launch site (see Reference 1).

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

- VM-Process 1: Requirement flow-down and establishment of specification process
- VM-Process 2: Verification cross-reference matrix (VCRM) process
- VM-Process 3: Integration and test (I&T) process
- VM-Process 4: Individual specification dedicated verification ledger (ISDVL) process
- VM-Process 5: Sell-Off/Consent-to-Ship process
- 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/or 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 at 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 these systems have been thoroughly verified by comparing them against the distributed verification program and its processes. If not, appropriate modifications for new applications 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 verification and validation. Frequently, material developed for verification is also applicable to validation efforts.

1 Scope

This standard establishes a set of requirements for planning and executing verification programs for both 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.

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.

The standard may, however, be adapted to the remaining two space systems: the user segment and the satellite control network segment. Other 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 management processes. This standard is applicable for the procurement of space systems, including space vehicles, launch vehicles, ground systems and associated equipment/subsystems.

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 organization. Any tailoring of this document, if included as a compliance 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