AIAA
S-102.2.5-2009

Standard

Performance-Based Sneak Circuit Analysis (SCA) Requirements

AIAA
S-102.2.5-2009

Performance-Based Sneak Circuit Analysis (SCA) Requirements

Sponsored by

American Institute of Aeronautics and Astronautics

Approved 17 November 2008

Abstract

This standard provides the basis for developing the analysis of sneak conditions. The sneak conditions may consist of hardware, software, operator actions, or combinations of these elements. The requirements for contractors, planning and reporting needs, and analytical tools are established. The linkage of this standard to the other standards in the new family of performance-based reliability and maintainability standards is described, and all of the keywords for use in automating the SCA process are provided.

Library of Congress cataloging-in-publication data on file

Published by
American Institute of Aeronautics and Astronautics
1801 Alexander Bell Drive, Reston, VA 20191

Printed in the United States of America

Contents

Figures

Tables

AIAA S-102.2.5-2009

Foreword

A performance-based Sneak Circuit Analysis (SCA) standard has been developed to aid organizations in assuring that their SCA tasking presents a "value-added" contribution to the product-development effort. The need for such a standard arises from the absence of an accepted methodology for assessing the capability of reliability and maintainability (R&M) programs. The ISO 9000 series standards presently guide organizations in establishing practices for consistently producing superior products, but only within the discipline of quality assurance. The ISO 9000 series of standards does not define processes and practices for achieving high-reliability products. Because the criteria for quality and reliability differ, an organization that conforms to stringent workmanship specifications and produces high-quality products through participation in the ISO 9000 certification process may still lack the capability to consistently deliver high-reliability products. Hence, this SCA standard was developed as part of a suite of AIAA S-102 performance-based R&M standards for quantifying the results of, and improving the performance of, R&M programs.

The AIAA S-102 performance-based R&M standards document tree (Annex A) includes 35 standards that provide criteria for rating the capability of R&M practices. They represent proven approaches for planning and implementing the product life-cycle R&M program. The S-102 R&M capability-rating criteria allow organizations to:

— specify a level of R&M program performance;

— plan the activities necessary to achieve a level of R&M program performance;

— appraise the performance of an R&M program or individual practice; and

— identify the activities necessary to improve the performance of an R&M program or individual practice.

The S-102 R&M capability-rating criteria (Annex B in all S-102 standards) are intended to aid organizations in assuring their R&M programs are a "value-added" contribution to the product development effort. There is no intent to prescribe a universal methodology for quantifying the evaluation or improvement of R&M programs or individual practices. The S-102 R&M capability-rating criteria reflect the collective body of knowledge of the S-102 Working Group, which was chartered by the AIAA Standards Executive Council to develop and approve the S-102 standards. The S-102 Working Group comprises R&M experts that represent the government and industry sectors affected by the S-102 standards.

This standard establishes uniform requirements for a performance-based SCA. The principles of the SCA as promoted in a performance-based approach can be learned from this standard alone, but its proper use requires careful planning, for which the prerequisite is understanding associated S-102 documents and identifying the desired R&M data products in the systems engineering process. What distinguishes this standard from all past and present SCA standards is the following.

— It provides consistent criteria for rating the capability of the SCA process.

— It provides consistent criteria for rating the maturity of the SCA data.

— It calls for the use of knowledge-based approaches to identify, analyze, and manage sneak conditions that pose unacceptable risk.

— For a Capability Level 3 or above SCA process, it calls for the collection and review of existing lessons learned, and the generation and formal approval of new lessons learned.

— For a Capability Level 4 or above SCA process, it calls for the use of predefined R&M data parameters to facilitate the exchange of SCA data among computer-aided analysis tools and other project databases.

This standard includes three annexes, all of which are normative.

At the time of approval the members of the AIAA Performance-Based Reliability and Maintainability Standards Working Group were:

Tyrone Jackson (Chair)	SRS Technologies
Lily Lau	The Aerospace Corporation
David Oberhettinger	NASA Jet Propulsion Laboratory
Walt Willing	Northrop Grumman Electronic Systems
Steve Harbater	Northrop Grumman Integrated Systems
Alazel Jackson	Raytheon Space and Airborne Systems
Jan Swider	Pratt & Whitney Rocketdyne, Inc.
Dev Raheja	Design for Competitiveness
Jeff Merrick	Merrick Consulting
Ken Gibson	Boeing Space and Intelligence Systems
James French	RMS Partnership
Ari Jain	Reliability Consultant
Dawson Coblin	Lockheed Martin Space Systems
Terry Hardy	Federal Aviation Administration

The above consensus body approved this document in June 2006.

The AIAA Standards Executive Council Mr. Amr ElSawy, Chairman) accepted the document for publication in July 2008.

The AIAA Standards Procedures dictate that all approved Standards, Recommended Practices, and Guides are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any AIAA standards publication and no commitment to conform to or be guided by standards reports. In formulating, revising, and approving standards publications, the committees on standards will not consider patents that may apply to the subject matter. Prospective users of the publications are responsible for protecting themselves against liability for infringement of patents or copyright or both.

1 Scope

This standard establishes uniform requirements and criteria for a performance-based sneak circuit analysis (SCA). This performance-based aspect of this standard requires that the organization's SCA capability be rated according to predetermined criteria for process capability and data maturity. Although it is a common industry practice for SCA to be performed using computerized tools, this standard does not mandate that any particular computerized methodology be used.

1.1 Purpose

Sneak circuit analysis may be performed on high-criticality systems to uncover inherent design flaws that may cause occurrence of an unwanted function or the inhibition of a desired function. The primary purpose of the SCA process is to identify and eliminate or control all sneak conditions that may lead to such unplanned modes of operation. In this regard, SCA is an important analysis technique because it uncovers latent system faults that otherwise may have gone undetected. SCA should be considered for application on high criticality systems, where undetected design flaws may cause catastrophic events such as loss of life, critical system failure, or loss of mission. To assure maximum analysis benefit while controlling cost, the SCA effort should be scoped to those specific high-criticality areas where sneak conditions are most likely to occur. The early identification and control of such conditions improves system safety and reliability, while enabling design changes to be made in a more cost-effective manner.

The defining cause and effect characteristics of a sneak condition are as follows:

— It is caused by an unintended system path (e.g., wiring, tubing, software interfaces, operator actions, instrumentation, mechanical interlocks, or some combination thereof) or condition (e.g., timing incompatibility) that was inadvertently introduced into the system.

— It leads to unintended system effects that range from an intermittent nuisance to complete system loss or loss of life.

Regardless of whether the SCA is performed using manual, semi-automated, or automated methods, a prerequisite is the collection, processing, and evaluation of detailed system design information. The SCA results may be used to support the activities of a variety of Systems Engineering functions, but its most important use is to aid in the improvement of design reliability prior to product manufacture and test. For this standard, there are four types of sneak conditions:

— sneak paths - Unexpected paths along which current, energy, or logical sequence flows in an unintended direction;

— sneak timing - Events occurring in an unexpected or conflicting sequence;

— sneak indications - Ambiguous or false displays of system operating conditions that may cause the system or operator to take an undesired action[1];

— sneak labels - Incorrect or imprecise labeling of system functions (e.g., system inputs, controls, displays, and buses) that may cause an operator to apply an incorrect stimulus to the system.

The SCA process assures that the likelihood of unwanted functions or inhibition of desired functions is minimized for all designed-for operating modes. In this context, an unwanted function is a system response that violates a design requirement, and designed-for operating modes include all known states of system success.

The analysis of sneak conditions can be considered static in nature because it does not involve stepping through all the possible combinations of inputs and system states. Instead, the analysis applies a rule

---

[1] An example of a potential sneak indication is when two identical failure indications (i.e., fault signatures) can be generated by different system functions.