American Nuclear Society

WITHDRAWN
August 12, 2008
ANSI/ANS-10.4-1987;R1998;W2008

guidelines for the verification and validation of scientific and engineering computer programs for the nuclear industry

an American National Standard

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published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

ANSI/ANS-10.4-1987 (R1998)

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American National Standard Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-10.4

Published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

Approved May 13, 1987; Reaffirmed August 12, 1998
by the
American National Standards Institute, Inc.

American National Standard

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Published by

American Nuclear Society
555 North Kensington Avenue, La Grange Park, Illinois 60526 USA

Printed in the United States of America

Foreword

(This Foreword is not a part of American National Standard Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry, ANSI/ANS-10.4-1987.)

The purpose of this standard is to provide guidelines for the verification and validation of scientific and engineering computer programs developed for nuclear industry applications. The standard does not recommend a specific approach to program development, but does recommend that verification and validation activities be carried out in parallel with program development. For a specific project, the project sponsor should determine the level of the verification and validation effort to be applied. The standard complements the following ANS-10 standards relating to computer program development:

American National Standard Guidelines for the Documentation of Digital Computer Programs, ANSI/ANS-10.3-1986.

American National Standard Guidelines for Considering User Needs in Computer Program Development, ANSI/ANS-10.5-1986.

American National Standard for Recommended Programming Practices to Facilitate the Portability of Scientific Computer Programs, ANSI/ANS-10.2-1982.

In addition, an effort has been made to maintain consistency in terminology and concepts with various software standards being developed under the sponsorship of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) and to identify areas of disagreement.

This standard has been written by Working Group ANS-10.4 of the American Nuclear Society's Standards Committee. The membership of this group during the preparation of the final drafts consisted of:

O. Ozer, Chairman, *Electric Power Research Institute*
M. K. Butler, *Argonne National Laboratory*
L. I. Kopp, *U.S. Nuclear Regulatory Commission*
S. Hartzell, *Power Computing Company*
G. C. Main, *BCS-Richland, Inc.*
G. W. Main, *JMJ Associates*
S. J. Nathan, *NUS Corporation*
J. E. Olhoeft, *Westinghouse Electric Corporation*
G. R. Poetschat, *GRP Consulting, a Division of SWUCO, Inc.*
J. W. Radatz, *Logicon, Inc.*
D. R. Vondy, *Oak Ridge National Laboratory*

Substantial contributions toward the development of the earlier drafts of this standard have also been received from:

P. W. Dagget, *Babcock & Wilcox Company*
H. R. Downs, *Science Applications, Inc.*
T. Dunn, *Westinghouse Hanford Company*
A. J. Elliott, *Quadrex Corporation*
M. H. L. Jester, *Bechtel Corporation*
N. M. Marshall, *EG&G Idaho, Inc.*
H. Richter, *Bechtel Corporation*
E. A. Straker, *Science Applications, Inc.*

The publication of R. L. Merilott, "Computer Software Validation and Verification, A Generic Guideline," BCS40342 June 1981, was used as a general reference.

Subcommittee ANS-10, Mathematics and Computation, had the following membership at the time of its approval of this standard:

L. I. Kopp, Chairman, *U.S. Nuclear Regulatory Commission*
M. K. Butler, *Argonne National Laboratory*
L. E. Dodd, *Battelle Pacific Northwest Laboratories*
S. Hartzell, *University Computing Company*
N. Hassan, *Babcock & Wilcox Company*
G. C. Main, *BCS-Richland, Inc.*
G. W. Main, *JMJ Associates*
N. H. Marshall, *EG&G Idaho, Inc.*
B. F. Maskewitz, *Oak Ridge National Laboratory*
S. J. Nathan, *NUS Corporation*
J. E. Olhoeft, *Westinghouse Electric Corporation*
O. Ozer, *Electric Power Research Institute*
G. R. Poetschat, *G.R.P. Consulting, Inc.*
A. O. Smetana, *Savannah River Laboratory*
D. R. Vondy, *Oak Ridge National Laboratory*

The Consensus Committee N17, Research Reactors, Reactor Physics, and Radiation Shielding, had the following membership at the time it reviewed and approved this standard:

R. S. Carter, Chairman
T. M. Raby, Secretary

J. D. Buchanan . . . . . Health Physics Society
A. D. Callihan (Subcommittee ANS-1) . . . . . Individual
R. E. Carter . . . . . U.S. Nuclear Regulatory Commission
C. Thomas (Alt.)
R. S. Carter . . . . . American Nuclear Society
A. B. Chilton . . . . . Individual
A. De La Paz (Subcommittee ANS-14) . . . . . Department of U.S. Army
D. Duffey . . . . . American Institute of Chemical Engineers
H. Goldstein . . . . . American Physical Society
P. B. Hemming . . . . . U.S. Department of Energy
J. W. Lewellen (Alt.)
W. A. Holt . . . . . American Public Health Association
L. I. Kopp (Subcommittee ANS-10) . . . . . U.S. Nuclear Regulatory Commission
J. E. Olhoeft . . . . . Individual
T. M. Raby . . . . . National Bureau of Standards
W. J. Richards (Subcommittee ANS-15) . . . . . Argonne National Laboratory
M. M. Ter Pogossian . . . . . American College of Radiology
D. K. Trubey (Subcommittee ANS-6) . . . . . Oak Ridge National Laboratory
A. Weitzberg (Subcommittee ANS-19) . . . . . NUS Corporation
W. L. Whittemore . . . . . Individual

Contents

Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry

1. Scope and Objective

1.1 Scope. This standard provides guidelines for the verification and validation (V&V) of scientific and engineering computer programs developed for use by the nuclear industry.

1.2 Objective. The objective of this standard is to identify activities which will improve the reliability of scientific and engineering computer programs and reduce the risk of incorrect application.

1.3 Guidelines for Applying This Standard. The intent of this standard is to present a comprehensive set of V&V activities. These activities may be performed in parallel with the program development process, or a posteriori. Sections 5 through 10 address the situation in which V&V is carried out in parallel with program development. Section 11 describes V&V activities that may be applied a posteriori to an existing program. Since for a specific project, performing the complete set of V&V activities may be impractical, the level of the V&V effort to be applied and whether it is to be carried out in parallel or a posteriori should be determined by the project sponsor.

Application of this standard is expected to provide material for use in a quality assurance program. The standard does not recommend a particular approach toward quality assurance. Questions about frequency of reviews or audits, resolution of discrepancies, or responsibility for configuration control are not within the scope of the standard. Quality Assurance Plans are addressed in American National Standard for Software Quality Assurance Plans, ANSI/IEEE 730-1984 [1].[1] In the case of parallel V&V, the standard presents an idealized case in which no software development phase is initiated until all discrepancies detected during verification of the previous phase have been resolved. In actuality, the developer may be authorized to proceed provided all discrepancies are resolved prior to the completion of the final phase.

[1]Numbers in brackets refer to corresponding numbers in Section 12, References.

2. Definitions

In the context of this standard the following definitions apply:*

validation. The process of testing a computer program and evaluating the results to ensure compliance with specified requirements.

verification. The process of evaluating the products of a software development phase to provide assurance that they meet the requirements defined for them by the previous phase.

Validation and verification is abbreviated throughout the standard as V&V. In addition, reference is made to the following software development, maintenance or V&V products:

Statement of Problem
Management Plan
Requirements Specification
Design Specification
Program Documentation
Source Code
Integrated Program
Installation Package
Test Plan
V&V Report.

These products are briefly described in Section 4, Overview of V&V in the Program Development Process and the following Sections 5 through 10.

*These definitions differ from those in American National Standard Glossary of Software Engineering Terminology, ANSI/IEEE 729-1983 [2].

3. Introduction and Overview

Computer programs are used extensively in scientific and engineering applications involving the design of facilities or the prediction of results of