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# REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

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## REGULATORY GUIDE 1.171

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# SOFTWARE UNIT TESTING FOR DIGITAL COMPUTER SOFTWARE USED IN SAFETY SYSTEMS OF NUCLEAR POWER PLANTS

## A. INTRODUCTION

### Purpose

This regulatory guide (RG) describes a method that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for use in complying with NRC regulations with respect to the software unit testing of digital computer software used in the safety systems of nuclear power plants.

### Applicable Rules and Regulations

The regulatory framework that the NRC has established for nuclear power plants consists of a number of regulations and supporting guidelines applicable to the software unit testing of digital computer software. Title 10, of the *Code of Federal Regulations*, Part 50, “Domestic Licensing of Production and Utilization Facilities” (10 CFR Part 50) (Ref. 1), Appendix A, “General Design Criteria for Nuclear Power Plants,” General Design Criterion (GDC) 1, “Quality Standards and Records,” requires, in part, that quality standards be established and implemented to provide adequate assurance that systems and components important to safety will satisfactorily perform their safety functions. GDC 21, “Protection System Reliability and Testability,” requires, in part, that the protection system be designed for high functional reliability. Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50 describes criteria that a quality assurance program for systems and components that prevent or mitigate the consequences of postulated accidents must meet. In particular, in addition to the systems and components that directly prevent or mitigate the consequences of postulated accidents, Appendix B criteria also apply to all activities affecting the safety-related functions of those systems and components; these activities include designing, purchasing, installing, testing, operating, maintaining, repairing or modifying.

In 10 CFR 50.55a(a)(1) requires, in part, that systems and components be designed, fabricated, erected, tested, and inspected to quality standards commensurate with the safety function to be performed. The regulation in 10 CFR 50.55a(h) requires that reactor protection systems satisfy the criteria in Institute of Electrical and Electronics Engineers (IEEE) Standard (Std.) 603-1991, “IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations,” including a correction sheet dated January 30, 1995 (Ref. 2), or in IEEE Std. 279-1971, “Criteria for Protection Systems for Nuclear Power

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Written suggestions regarding this guide or development of new guides may be submitted through the NRC’s public Web site under the Regulatory Guides document collection of the NRC Library at <http://www.nrc.gov/reading-rm/doc-collections/reg-guides/contactus.html>.

Electronic copies of this guide and other recently issued guides are available through the NRC public Web site under the Regulatory Guides document collection of the NRC Library at <http://www.nrc.gov/reading-rm/doc-collections/> and through the NRC Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>, under Accession No. ML13004A375. The regulatory analysis may be found in ADAMS under Accession No. ML103120752 and the staff responses to the public comments on DG-1208 may be found in ADAMS under Accession No. ML13004A370.

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Generating Stations” (Ref. 3). These criteria shall be part of the evaluation of the recognized quality codes and standards selected for their applicability, adequacy, and sufficiency and shall be supplemented or modified as needed to assure a quality product and that it will perform the required safety function. The guidance on the safety systems equipment employing digital computers, and programs or firmware requires quality standards be used for testing software units.

This RG endorses American National Standards Institute (ANSI)/IEEE Std. 1008-1987, “IEEE Standard for Software Unit Testing” (Ref. 4), with the clarifications and exceptions as described in Section C, “Staff Regulatory Guidance.” ANSI/IEEE Std. 1008-1987, which was reaffirmed in 2002, describes a method acceptable to the NRC staff for complying with NRC regulations for promoting high functional reliability and design quality in the software used in safety systems.<sup>1</sup> In particular, the method is consistent with the previously cited GDC in Appendix A to 10 CFR Part 50 and the criteria for quality assurance programs in Appendix B to 10 CFR Part 50 as they apply to software unit testing. The criteria in Appendices A and B to 10 CFR Part 50 apply to systems and related quality assurance processes, and the requirements extend to the software elements if those systems include software.

### **Purpose of Regulatory Guides**

The NRC issues RGs to describe methods that the staff considers acceptable for use in implementing specific parts of NRC regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. However RGs are not substitutes for regulations and compliance with them is not required. The information provided by this RG is also in the Standard Review Plan, NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Chapter 7, “Instrumentation and Controls,” (Ref. 5). The NRC staff uses the NRC Standard Review Plan to review 10 CFR Part 50 and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” (Ref. 6) license applications.

### **Paperwork Reduction Act**

This RG contains information collection requirements covered by 10 CFR Part 50 and 10 CFR Part 52 that the Office of Management and Budget (OMB) approved under OMB control numbers 3150-0011 and 3150-0151, respectively. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

## **B. DISCUSSION**

### **Reason for Revision**

Both the original version of this RG and this revision endorse ANSI/IEEE Std. 1008-1987. Subsequently, associated software RGs and various related software standards have been developed or updated and this revision of RG 1.171 is being updated to be consistent with these standards and related guidance. The applicant or licensee should consider the hierarchy guidance of these different RGs and standards that relate to the software development process and unit testing. For example, RG 1.170,

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<sup>1</sup> The term “safety systems” is synonymous with “safety-related systems.” The scope of the GDC includes systems, structures, and components “important to safety.” However, the scope of this regulatory guide is limited to “safety systems,” which are a subset of “systems important to safety.” Although not specifically scoped to include non-safety-related but “important to safety systems” this regulatory guide provides methods that the staff finds appropriate for the design, development and implementation of all important to safety systems. The NRC may apply this guidance in licensing reviews of non-safety but important to safety digital software and may tailor it to account for the safety significance of the system software.

“Software Test Documentation for Digital Computer Software Used in Safety Systems of Nuclear Power Plants” (Ref. 7), endorses IEEE Std. 829-2008, “IEEE Standard for Software and System Test Documentation” (Ref. 8), and provides an approach that the NRC staff considers acceptable for meeting the requirements of 10 CFR Part 50 as they apply to the test documentation, including unit test documentation, of safety system software. The endorsed consensus standard, ANSI/IEEE Std. 1008-1987, defines a method for planning, preparing, conducting, and evaluating software unit testing that is consistent with the previously cited regulatory requirements as they apply to safety system software.

## **Background**

The use of industry consensus standards, such as IEEE standards, is part of an overall approach to meet the requirements of 10 CFR Part 50 when developing safety systems for nuclear power plants. Compliance with these standards does not guarantee that regulatory requirements will be met. However, compliance does ensure that practices accepted within various technical communities will be incorporated into the development and quality assurance processes used to design safety systems. These practices are based on past experience and represent industry consensus on approaches used for the development of such systems.

This RG refers to software incorporated into the instrumentation and control systems covered by Appendix B to 10 CFR Part 50 as “safety system software.” For safety system software, software testing is an important part of the effort to comply with NRC regulations. Software engineering practices rely, in part, on software testing to meet general quality and reliability requirements consistent with GDC 1 and 21 of Appendix A to 10 CFR Part 50, as well as Criteria I, II, III, V, VI, XI, and XVII of Appendix B.

Several criteria in Appendix B to 10 CFR Part 50 contain requirements closely related to testing activities. These listed criteria are only part of and not the entire requirement:

- Criterion I, “Organization,” requires, in part, the establishment and execution of a quality assurance program.
- Criterion II, “Quality Assurance Program,” requires, in part, that the program take into account the need for (1) special controls, processes, test equipment, tools, and skills necessary to attain the required quality and (2) the verification of quality through inspections and tests.
- Criterion III, “Design Control,” requires, in part, that measures be established for verifying and checking the adequacy of the design (e.g., through the performance of a suitable testing program) and that design control measures be applied to items such as the delineation of acceptance criteria for inspections and tests.
- Criterion V, “Instructions, Procedures, and Drawings,” requires, in part, activities affecting quality be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and that these activities be accomplished in accordance with these instructions, procedures, or drawings. Criterion V further requires that instructions, procedures, and drawings include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

- Criterion VI, “Document Control,” requires, in part, that all documents that prescribe activities affecting quality, such as instructions, procedures, and drawings, be subject to controls that ensure that documents, including changes, are reviewed for adequacy and approved for release by authorized personnel.
- Criterion XI, “Test Control,” requires, in part, establishment of a test program to assure that all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service is identified and performed in accordance with written test procedures that incorporate the requirements and acceptance limits contained in applicable design documents. Test procedures must include provisions for ensuring that all prerequisites for the given test have been met, that adequate test instrumentation is available and used, and that the test is performed under suitable environmental conditions. Criterion XI also requires that test results be documented and evaluated to ensure that test requirements have been satisfied.
- Criterion XVII, “Quality Assurance Records,” requires, in part, that sufficient records be maintained so that data that are closely associated with the qualifications of personnel, procedures, and equipment are identifiable and retrievable. Test records must identify the inspector or data recorder, the type of observation made, the results, the acceptability of the results, and the action taken in connection with any noted deficiencies.

## **Related Guidance**

Current practice for the development of software for safety-related applications includes the use of a software life-cycle process that incorporates software testing activities (e.g., IEEE Std. 1074-2006, “IEEE Standard for Developing a Software Life Cycle Process” (Ref. 9), as endorsed by RG 1.173, “Developing Software Life Cycle Processes for Digital Computer Software Used in Safety Systems of Nuclear Power Plants” (Ref. 10)). Software testing, including software unit testing, is a key element in software verification and validation (V&V) activities, as indicated by IEEE Std. 1012-2004, “IEEE Standard for Software Verification and Validation” (Ref. 11), and IEEE Std. 7-4.3.2-2003, “IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations” (Ref. 12). Software testing consists of several levels. NUREG/CR-6101, “Software Reliability and Safety in Nuclear Reactor Protection Systems,” issued November 1993 (Ref. 13), and NUREG/CR-6263, “High Integrity Software for Nuclear Power Plants: Candidate Guidelines, Technical Basis, and Research Needs,” issued June 1995 (Ref. 14), provide a common approach to software testing. This approach includes a three-level test program to help ensure quality in a complex software product or a complex set of cooperating software products (i.e., unit-level testing, integration-level testing and system-level testing such as system validation tests or acceptance tests). ANSI/IEEE Std. 1008-1987 delineates an approach to the unit testing of software that assumes a larger context established by V&V planning and general planning for the application of the full range of testing activities. This context may be defined, for example, in IEEE Std. 1012-2004, as endorsed by RG 1.168, “Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants” (Ref. 15). Therefore, software unit testing that licensees perform in accordance with ANSI/IEEE Std. 1008-1987 should be consistent with the planning information established in V&V plans and higher level software test plans, although that planning information is not within the scope of ANSI/IEEE Std. 1008-1987.

This RG is based on standards and describes methods acceptable for any safety system software, and discusses the required V&V activities. The applicant or licensee determines how the required activities will be implemented.

## **Harmonization with International Standards**

The International Atomic Energy Agency (IAEA) has established a series of safety guides and standards constituting a high level of safety for protecting people and the environment. IAEA safety guides are international standards to help users striving to achieve high levels of safety. Pertinent to this RG, IAEA Safety Guide NS-G-1.1, “Software for Computer Based Systems Important to Safety in Nuclear Power Plants” issued September 2000 (Ref. 16) discusses the importance of unit testing for computer software used in safety related systems. This RG incorporates similar unit testing recommendations and is consistent with the basic principles provided in IAEA Safety Guide NS-G-1.1.

## **Documents Discussed in Staff Regulatory Guidance**

This RG endorses, in part, the use of one or more codes or standards developed by external organizations, and other third party guidance documents. These codes, standards and third party guidance documents may contain references to other codes, standards or third party guidance documents (“secondary references”). If a secondary reference has itself been incorporated by reference into NRC regulations as a requirement, then licensees and applicants must comply with that standard as set forth in the regulation. If the secondary reference has been endorsed in a RG as an acceptable approach for meeting an NRC requirement, then the standard constitutes a method acceptable to the NRC staff for meeting that regulatory requirement as described in the specific RG. If the secondary reference has neither been incorporated by reference into NRC regulations nor endorsed in a RG, then the secondary reference is neither a legally-binding requirement nor a “generic” NRC approval as an acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified and consistent with current regulatory practice, consistent with applicable NRC requirements.

## **C. STAFF REGULATORY GUIDANCE**

The requirements in ANSI/IEEE Std. 1008-1987 provide an acceptable approach for meeting NRC regulatory requirements on the unit testing of safety system software with the exceptions and additions listed in these regulatory positions. In this section of the guide, the cited criterion refers to Appendix B to 10 CFR Part 50 unless otherwise noted. This RG does not endorse the appendices to ANSI/IEEE Std. 1008-1987, except as noted below.

### **1. Software Testing Documentation**

Section 1.1 of ANSI/IEEE Std. 1008-1987 mandates the use of the test design specifications and the test summary report documents, which can be found in IEEE Std. 829-2008, Clauses 10, “Level Test Design” and 17, “Master Test Report” respectively. In addition, ANSI/IEEE Std. 1008-1987 either incorporates additional information into these two documents or indicates the need for additional documentation. Regardless of whether the licensee uses these two documentation formats, its documentation to support software unit testing (either documentation used directly in the software unit testing activity or documentation of the overall testing effort) should include information necessary to meet regulatory requirements as applied to software test documentation. As a minimum, this information should include the following:

- a. qualifications, duties, responsibilities, and skills required of persons and organizations assigned to testing activities;

- b. special conditions and controls, equipment, tools, and instrumentation needed for the accomplishment of testing;
- c. test instructions and procedures that incorporate the requirements and acceptance limits in applicable design documents;
- d. test prerequisites and the criteria for meeting these requirements and acceptance limits;
- e. test items and the approach taken by the testing program;
- f. test logs, test data, and test results;
- g. acceptance criteria; and
- h. test records that indicate the identity of the tester, the type of observation made, the results and acceptability, and the action taken in connection with any deficiencies.

The licensee should incorporate any information regarding the items listed above that are not in the documentation selected to support software unit testing as additional items.

## **2. Test Program**

The coverage of requirements and the internal structure of the code are two particularly important aspects of test coverage necessary for the unit testing of safety system software, as follows:

- a. Coverage of Requirements. The testing should include all features and associated procedures, states, state transitions, and associated data characteristics essential to the safety determination.
- b. Coverage of Module Structure. Section 3.1.2(2) of ANSI/IEEE Std. 1008-1987 specifies statement coverage (covering each source language statement with a test case) as a criterion for measuring the completeness of software unit testing. The staff believes that statement coverage is an insufficient criterion for measuring test completeness (Ref. 14 and Ref. 17). Therefore, the staff does not endorse statement coverage as a sufficient criterion for software unit testing. For safety system software, the licensee should identify and justify the unit testing coverage criteria that it will use.

## **3. Test Program Records**

Criteria VI and XVII and 10 CFR 21.51, "Maintenance and Inspection of Records" (Ref. 18), require the control and retention of documents and records that affect quality. In addition, Criterion III requires the licensee to subject design changes to design control measures commensurate with those that it applied to the original design. Section 3.8.2(4) of ANSI/IEEE Std. 1008-1987 discusses the preservation of testing products. Included with the testing products preservation are the test iterations caused by any task, procedure and design criteria variations or deviations from the original IEEE Std. 829-2008, Clauses 8 and 9, "Master Test Plan" and "Level Test Plans." Since the design control measures are required for testing acceptance criteria and because some software testing materials are frequently reused and evolve during the course of software development and software maintenance (e.g., regression test materials), such materials should be configuration items under the change control of a software configuration management system.

#### **4. Independence Software Verification**

Criterion III imposes an independence requirement for the verification and checking of the adequacy of the design. IEEE Std. 1008-1987 does not include a requirement for independent software verification. The RG 1.168 provides additional guidance on testing independence.

#### **5. References to ANSI/IEEE Std. 829-1983**

ANSI/IEEE Std. 1008-1987 includes references to ANSI/IEEE Std. 829-1983; however, ANSI/IEEE Std. 829-1983 has been revised since the publication of ANSI/IEEE Std. 1008-1987. With the new ANSI/IEEE Std. 829-2008 revision there are added levels of test documentation for the licensee and applicant to consider, which also includes unit test documentation. Thus IEEE Std. 829-2008, which is endorsed by RG 1.170, should be used.

#### **6. Annexes**

ANSI/IEEE Std. 1008-1987 contains the following informative appendixes listed below. These appendixes are listed here as sources of information; they have not received regulatory endorsement unless otherwise noted:

- Appendix A, “Implementation and Usage Guidelines,” provides some additional guidance on using the standard. Although this is a useful introduction to several topics, the NRC does not endorse the appendix because it does not provide sufficient guidance on how to perform specific activities.
- Appendix B, “Concepts and Assumptions,” contains a variety of topics that relate unit testing to software engineering in general and that discuss testing assumptions. This appendix is helpful but out of date; therefore, the NRC does not endorse it.
- Appendix C, “Sources for Techniques and Tools,” lists documents that relate to unit testing. This list is out of date; therefore, the NRC does not endorse it.
- Appendix D, “General References,” lists a basic set of references on software testing. This list is out of date; therefore, the NRC does not endorse it.

### **D. IMPLEMENTATION**

The purpose of this section is to provide information on how applicants and licensees<sup>2</sup> may use this guide and information about NRC plans for using this RG. In addition, it describes how the staff complies with 10 CFR 50.109, “Backfitting” and any applicable finality provisions in 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants.”

#### **Use by Applicants and Licensees**

Applicants and licensees may voluntarily<sup>3</sup> use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described

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2 In this section, “licensees” refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term “applicants” refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

in this RG may be deemed acceptable if they provide sufficient basis and information for the staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable in the past to comply with the identified regulations, as long as their current licensing basis remains unchanged.

Licensees may use the information in this RG for actions which do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59, “Changes, Tests, and Experiments.” Licensees may use the information in this RG or applicable parts to resolve regulatory or inspection issues.

Additionally, an existing applicant may be required to adhere to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

If a licensee believes that the NRC either is using this RG or requesting or requiring the licensee to implement the methods or processes in this RG in a manner inconsistent with the discussion in this implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409, “Backfitting Guidelines,” (Ref. 19) and the NRC Management Directive 8.4, “Management of Facility-Specific Backfitting and Information Collection” (Ref. 20).

### **Use by NRC Staff**

During regulatory discussions on plant-specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this RG, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting, even if prior versions of this RG are part of the licensing basis of the facility. However, unless this RG is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee’s failure to comply with the positions in this RG constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the staff’s consideration of the request involves a regulatory issue directly relevant to this new or revised RG, and (2) the specific subject matter of this RG is an essential consideration in the staff’s determination of the acceptability of the licensee’s request, then the staff may request that the licensee either follow the guidance in this RG or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This action is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this RG. The staff does not expect any existing licensee to use or commit to using the guidance in this RG, unless the licensee makes a change to its licensing basis. The staff does not expect or plan to request licensees to voluntarily adopt this RG to resolve a generic regulatory issue. The staff does not expect or plan to initiate NRC regulatory action that would require the use of this RG. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the RG, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this RG, generic communication, or promulgation of a rule requiring the use of this RG without further backfit consideration.

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3 In this section, “voluntary” and “voluntarily” mean that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

## REFERENCES<sup>4</sup>

1. *U.S. Code of Federal Regulations (CFR)* “Domestic Licensing of Production and Utilization Facilities, Part 50, Chapter 1, Title 10, “Energy.”
2. Institute of Electrical and Electronic Engineers (IEEE), Std. 603-1991, “IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations,” Piscataway, NJ, 1991 (including a correction sheet dated January 30, 1995).<sup>5</sup>
3. IEEE, Std. 279-1971, “Criteria for Protection Systems for Nuclear Power Generating Stations,” Piscataway, NJ, 1971.
4. IEEE Std. 1008-1987, “IEEE Standard for Software Unit of Testing,” Piscataway, NJ, 1987.
5. U. S. Nuclear Regulatory Commission (NRC), NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” Chapter 7, “Instrumentation and Controls,” Washington, DC. (<http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/ch7/>)
6. CFR, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Part 52, Chapter 1, Title 10, “Energy.”
7. NRC, Regulatory Guide (RG) 1.170, “Software Test Documentation for Digital Computer Software Used in Safety Systems of Nuclear Power Plants,” Washington, DC.
8. IEEE Std. 829-2008, “IEEE Standard for Software Test Documentation,” Piscataway, NJ, 2008.
9. IEEE Std. 1074-2006, “IEEE Standard for Developing a Software Life Cycle Process,” Piscataway, NJ, 2006.
10. NRC, RG 1.173, “Developing Software Life Cycle Processes for Digital Computer Software Used in Safety Systems of Nuclear Power Plants,” Washington, DC.
11. IEEE Std. 1012-2004, “IEEE Standard for Software Verification and Validation,” Piscataway, NJ, 2004.
12. IEEE Std. 7-4.3.2-2003, “IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations,” Piscataway, NJ, 2003.
13. NRC, NUREG/CR-6101, “Software Reliability and Safety in Nuclear Reactor Protection Systems,” Washington, DC, November 1993. (ADAMS Accession No. ML072750055)
14. NRC, NUREG/CR-6263, “High Integrity Software for Nuclear Power Plants: Candidate Guidelines, Technical Basis, and Research Needs,” Washington, DC, June 1995. (ADAMS Accession Nos. ML063470590 and ML063470593)

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4 Publicly available NRC published documents are available electronically through the Electronic Reading Room on the NRC’s public Web site at: <http://www.nrc.gov/reading-rm/doc-collections/>. The documents can also be viewed online or printed for a fee in the NRC’s Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail [pdr.resource@nrc.gov](mailto:pdr.resource@nrc.gov).

5 Copies of Institute of Electrical and Electronics Engineers (IEEE) documents may be purchased from the Institute of Electrical and Electronics Engineers Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855 or through the IEEE’s public Web site at [http://www.ieee.org/publications\\_standards/index.html](http://www.ieee.org/publications_standards/index.html).

15. NRC, RG 1.168, "Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants," Washington, DC.
16. International Atomic Energy Agency (IAEA) Safety Guide NS-G-1.1, "Software for Computer Based Systems Important to Safety in Nuclear Power Plants" issued September 2000, Vienna, Austria, 2000.<sup>6</sup>
17. Beizer, B., *Software Testing Techniques*, Van Nostrand Reinhold, New York, NY, 1990.<sup>7</sup>
18. CFR, "Maintenance and Inspection of Records" Part 21.51, Chapter 1, Title 10, "Energy."
19. NRC, NUREG-1409, "Backfitting Guidelines," Washington, DC. (ADAMS Accession No. ML032230247)
20. NRC, Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection," Washington DC. (ADAMS Accession No. ML050110156)

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6 Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: [WWW.IAEA.Org/](http://WWW.IAEA.Org/) or by writing the International Atomic Energy Agency P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria. Telephone (+431) 2600-0, Fax (+431) 2600-7, or E-Mail at [Official.Mail@IAEA.Org](mailto:Official.Mail@IAEA.Org)

7 Boris Beizer, *Software Testing Techniques*, June 1990, ISBN-10: 1850328803, ISBN-13: 978-1850328803 can be purchased at many book stores and online locations, including the following Web site: [http://www.amazon.com/Software-Testing-Techniques-Boris-Beizer/dp/1850328803/ref=sr\\_1\\_1?s=books&ie=UTF8&qid=1288897895&sr=1-1](http://www.amazon.com/Software-Testing-Techniques-Boris-Beizer/dp/1850328803/ref=sr_1_1?s=books&ie=UTF8&qid=1288897895&sr=1-1).