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DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-1132

QUALIFICATION OF SAFETY-RELATED CABLES AND FIELD SPLICES FOR NUCLEAR POWER PLANTS

A. INTRODUCTION

The regulations established by the U.S. Nuclear Regulatory Commission (NRC) in Title 10, Part 50, of the *Code of Federal Regulations* (10 CFR Part 50), "Domestic Licensing of Production and Utilization Facilities," require that structures, systems, and components that are important to safety in a nuclear power plant must be designed to accommodate the effects of environmental conditions [i.e., remain functional under postulated design-basis events (DBEs)]. Toward that end, the general requirements are contained in General Design Criteria 1, 2, 4, and 23 of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50. Augmenting those general requirements, the specific requirements pertaining to qualification of certain electrical equipment important to safety are contained in 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants." In addition, Criterion III, "Design Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants," to 10 CFR Part 50, requires that where a test program is used to verify the adequacy of a specific design feature, it must include suitable qualification testing of a prototype unit under the most severe DBE.

This regulatory guide describes a method that the staff of the NRC considers acceptable for complying with the Commission's regulations for qualification of safety-related cables and field splices for nuclear power plants.

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations, and compliance with regulatory guides is not required.

This regulatory guide contains information collections that are covered by the requirements of 10 CFR Part 50, and that the Office of Management and Budget (OMB) approved under OMB control number 3150-0011. 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

IEEE Std 383-2003, "IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations," published on June 10, 2004 (Ref.1), was developed by the Working Group on Cables (SC 2.4) of the Nuclear Power Engineering Committee of the Institute of Electrical and Electronics Engineers (IEEE) and was approved by the IEEE-SA Standards Board on December 12, 2003. That standard provides general requirements, direction, and methods for qualifying safety-related cables, field splices, factory splices, and factory rework for service in nuclear power plants. Categories of cables covered are those used for power, control, and instrumentation services, including signal and communication cables. Most importantly, IEEE Std 383-2003 requires that the safety-related cables and field splices must meet or exceed specified performance requirements throughout their installed life and be subjected to quality assurance programs that include, but are not limited to, design, qualification, and production quality control.

The objectives of qualification are to ensure that safety-related cables (single, multiconductor, and multiplex, as well as coaxial, triaxial, and twinaxial) and field splices can be demonstrated to perform their safety functions under postulated DBEs, and that no failure mechanism exists that could lead to common-cause failures under postulated service conditions. It is the degradation over time, followed by exposure to the environmental extremes of temperature, pressure, humidity, radiation, mechanical stress, or chemical spray (or a combination thereof) resulting from DBEs, which presents a potential for common-cause failures of safety-related cables and field splices. As a result, it is necessary to establish a qualified life for cables and splices that are installed in harsh environments and must perform a safety function during and following the DBEs.

These objectives should be accomplished using qualification methods (type testing, operating experience, analysis as a supplement to type testing and operating experience, ongoing qualification, or any combination thereof). However, qualification by analysis alone is not acceptable. Type testing of sample cables or field splices is the preferred qualification method. In addition, IEEE Std 383-2003 requires documentation, in an auditable form, to demonstrate that cables and field splices would adequately perform their safety functions.

Power cables that are routed underground should be capable of performing their function when subjected to anticipated environmental conditions such as moisture or flooding. Also, based on recent underground power cable failures, the staff has concluded that the field splices for medium-voltage cables in inaccessible locations should not be permitted. In addition, power and instrumentation and control cables for which failures could disable risk-significant equipment should have condition monitoring programs to demonstrate that the cables can perform their safety function when needed.

C. REGULATORY POSITION

Conformance with the requirements of IEEE Std 383-2003, "IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations," is a method that the

NRC staff considers acceptable for use in satisfying the Commission's regulations with respect to qualification of safety-related cables and field splices, subject to the following exceptions:

(1) Clause 3.3, "Representative Cable," of IEEE Std 383-2003 should be supplemented with a description of conductor type (material, strand, and strand type) and also differentiate between conductor shield, insulation shield, and overall static shield.

(2) Clause 4, "Principle qualification criteria," should be supplemented as follows:

   (a) The documentation should include the cable or field splice's specification and qualification plan.

   (b) The documentation should include manufacturer's inspection and maintenance requirements to maintain and demonstrate continued qualification throughout its qualified life.

   (c) A condition monitoring program should also be implemented.

(3) Clause 6.1.2, "Coaxial, triaxial, and twinaxial," should also include specimens of identical materials and construction, and the configuration should include connections.

(4) Clause 6.2.1.1, "Conductor," should include the stranding configuration.

(5) Clause 6.2.1.4, "Shielding," should include percent overlap and lay for tape shields.

(6) Clause 6.2.2.6, "Identification," should include the date of applicable manufacturing standards and the date of manufacture.

(7) Clause 6.3, "Age conditioning," should be supplemented to include aged cable specimen and new splice kits; and a new splice kit combining an aged cable with a new cable.

(8) Clause 6.4.5, "Retained flexibility," should be supplemented to include the following: "The acceptance criteria for instrument cables should specify the minimum acceptable insulation resistance and signal attenuation limits."

(9) Clause 9.1, "General," should be supplemented to include the following: "Identification of the applicable date of manufacturing standards used in specification, manufacture, and selection of the factory acceptance criteria for test specimens. Documentation should also include manufacturer's inspection and maintenance requirements."

(10) Power and instrumentation and control cables for which failures could disable risk-significant equipment should have condition monitoring programs to demonstrate that the cables can perform their safety function when needed.

IEEE Std 383-2003 references several industry codes and standards. If a referenced standard has been separately incorporated into the regulations, licensees and applicants must comply with the standard *as set forth in the regulations*. By contrast, if the NRC staff has endorsed a referenced standard in a regulatory guide, that standard constitutes an acceptable method of meeting a regulatory requirement as described in the regulatory guide.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this draft regulatory guide. No backfit is intended or approved in connection with the issuance of this guide.

The NRC has issued this draft guide to encourage public participation in its development. Except in cases in which an applicant or licensee proposes or has previously established an acceptable alternative method for complying with the specified portions of the regulations, the methods to be described in the active guide will reflect public comments and will be used in evaluating (1) submittals in connection with applications for construction permits, design certifications, operating licenses, and combined licenses, and (2) submittals from operating reactor licensees who voluntarily propose to initiate system modifications involving cables and field splices.

REGULATORY ANALYSIS

1. Background

Since its issuance in February 1974, IEEE Std 383-1974, "Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations," has been used by the nuclear industry for qualification of safety-related cables. At that time, the NRC staff had reservations regarding IEEE Std 383-1974 and never endorsed its use. However, since that time, the staff has been working with IEEE in revising this standard, and a revised version, IEEE Std 383-2003, "Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations," was issued in June 2004. The significant changes to IEEE Std 383-1974 include (1) removing the vertical flame test procedure of IEEE Std 383-1974, (2) substituting a reference to IEEE Std. 1202-1991 (Ref. 2), and (3) removing the word "connections" from the title and scope of the standard because IEEE Std 572-1985 (Ref. 3) is specific to the qualification of connections.

2. Problem

Since its issuance in February 1974, nuclear power plant licensees have typically used IEEE Std 383-1974 for qualification of cables, subject to NRC staff review on a case-by-case basis. However, this has been inefficient.

3. Objective

The objective of this document is to provide clear guidance on qualification of safety-related cables and field splices. Issuing a regulatory guide is consistent with the NRC policy of evaluating the latest versions of consensus safety standards in terms of their suitability for endorsement by regulatory guides. This approach would also comply with the NRC's directive to use standards developed by consensus bodies in accordance with Public Law 104-113, "National Technology and Transfer Act of 1995" (Ref. 4).

4. Technical Approach

IEEE Std 383-1974 requires type testing as the only method of qualifying safety-related cables. By contrast, 10 CFR 50.49 allows alternative methods, such as qualification by past operating experience, analysis in combination with partial type test data, and so forth. These alternative qualification methods

are specifically included in IEEE Std 383-2003, and the vertical flame test procedure from IEEE Std 383-1974 has been removed.

The purposes of IEEE Std 383-2003 are to provide improved guidance for cable and field splice qualification and to clarify the existing qualification principles. In addition, this revised standard addresses qualification of both field splices and factory-made splices, and includes the following significant changes:

- generic and specific qualification guidance
- detailed discussion of qualification methods
- specific test sample selection criteria
- treatment of jacketed single-conductor cables
- need for overall aging program for all critical cable components
- specific requirements for thermal and radiation exposure
- detailed guidance on documentation requirements
- specific reference to high-energy line break testing
- special guidance for coaxial, twinaxial, and triaxial cables (jacket integrity, voltage, and performance testing)

5. Conclusion

The NRC intends to issue this regulatory guide to enhance the licensing process. The staff has concluded that the proposed action will reduce unnecessary burden on both the NRC and its licensees, and will result in an improved and more uniform process for qualifying safety-related cables and field splices. Moreover, the staff sees no adverse effects associated with issuing this regulatory guide.

REFERENCES

1. IEEE Std. 383-2003, "IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations," Piscataway, NJ, 1994.[1]

2. IEEE Std. 1202-1991, "IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies," Institute of Electrical and Electronics Engineers, Piscataway, NJ, 1991.

3. IEEE Std 572-1985, "IEEE Standard for Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, Piscataway, NJ, 1985.

4. National Technology and Transfer Act of 1995 (Public Law 104-113), 104th Congress of the United States of America, Washington, DC, March 7, 1996.[2]

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[1] The IEEE standards are available for purchase from the IEEE Web site at http://shop.ieee.org/ieeestore/Product.aspx?product_no=SS10041.

[2] The National Technology and Transfer Act of 1995 is available electronically through the Standards.gov Web site administered by the National Institute of Standards and Technology, http://standards.gov/standards_gov/index.cfm?do=documents.NTTAA.