

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE 1.156 REVISION 2



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QUALIFICATION OF CONNECTION ASSEMBLIES FOR PRODUCTION AND UTILIZATION FACILITIES

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes an approach that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for complying with the Commission's regulations on the environmental qualification of connection assemblies and environmental seals in combination with cables or wires as assemblies for production and utilization facilities. It endorses Institute of Electrical and Electronics Engineers (IEEE) Standard (Std.) 572-2019, "IEEE Standard for Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations and Other Nuclear Facilities" (Ref. 1). The environmental qualification requirements in this standard, when followed, help applicants or licensees to demonstrate the ability of the connection assemblies to perform their safety functions under applicable service conditions.

Applicability

This RG applies to applicants and licensees subject to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 2), and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 3). With respect to 10 CFR Part 50, this RG applies to holders of, or applicants for construction permits and operating licenses. With respect to 10 CFR Part 52, this RG applies to applicants and holders of combined licenses, standard design certifications, standard design approvals, and manufacturing licenses.

Applicable Regulations

- 10 CFR Part 50 provides requirements for licensing production and utilization facilities, including, among other things, that structures, systems, and components (SSCs) 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).
 - 10 CFR 50.34, "Contents of applications; technical information," requires evaluation of the design and performance of facility SSCs with the objective of assessing the risk to

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Electronic copies of this RG, previous versions of RGs, and other recently issued guides are also available through the NRC's public web site in the NRC Library at <https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/>, under Document Collections, in Regulatory Guides. This RG is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>, under ADAMS Accession Number (No.) ML22255A125. The regulatory analysis is associated with a rulemaking and may be found in ADAMS under Accession No. ML21288A561. The associated draft guide DG-1400 may be found in ADAMS under Accession No. ML21288A562, and the staff responses to the public comments on DG-1400 may be found under ADAMS Accession No. ML22224A053.

public health and safety resulting from operation of the facility, determining the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and ascertaining the adequacy of SSCs provided for the prevention of accidents and the mitigation of their consequences. Further, 10 CFR 50.34 requires a description and analysis of the SSCs of the facility, with emphasis on performance requirements; the bases of such requirements, including technical justification; and the evaluations required to show that safety functions will be accomplished.

- 10 CFR 50.49, “Environmental qualification of electric equipment important to safety for nuclear power plants,” requires that certain electric equipment important to safety be qualified for its application and specified performance. The regulation also identifies requirements for establishing environmental qualification methods and qualification parameters. Safety-related electric equipment is referred to as “Class 1E” equipment.
- Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” Criterion III, “Design Control,” requires, in part, that test programs used to verify the adequacy of specific design features include suitable qualification testing of a prototype unit under the most adverse design conditions.
- 10 CFR Part 52 requires that SSCs important to safety in a nuclear power plant be designed to accommodate the effects of environmental conditions and that design control measures, such as testing, be used to check the adequacy of the design.

Related Guidance

- RG 1.63, “Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants” (Ref. 4), provides guidance on the design, construction, testing, qualification, installation, and external circuit protection of electric penetration assemblies in containment structures of nuclear power plants.
- RG 1.73, “Qualification Tests for Safety-Related Actuators in Nuclear Power Plants” (Ref. 5), provides guidance on environmental qualification of safety-related power-operated valve actuators in nuclear power plants.
- RG 1.89, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants” (Ref. 6), provides guidance on environmental qualification of certain electric equipment important to safety for nuclear power plants.
- RG 1.100, “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants” (Ref. 7), provides guidance on the seismic qualification of electric and active mechanical equipment for nuclear power plants.
- RG 1.211, “Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants” (Ref. 8), provides guidance on the qualification of safety-related cables and field splices for nuclear power plants.
- NUREG-1537, Parts 1 and 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,” issued February 1996 (Ref. 9), contains format and content

guidance for non-power reactor applicants and licensees, as well as a standard review plan and acceptance criteria for NRC staff.

- Final Interim Staff Guidance Implementing NUREG-1537, Parts 1 and 2, for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors, issued October 2012 (Ref. 10), contains format and content guidance for non-power aqueous homogeneous reactor and radioisotope production facility applicants and licensees, as well as a standard review plan and acceptance criteria for NRC staff.
- “Endorsement of Appendix A to Oak Ridge National Laboratory Report, ‘Proposed Guidance For Preparing and Reviewing A Molten Salt Non-Power Reactor Application,’ as Guidance for Preparing Applications for the Licensing of Non-Power Liquid Fueled Molten Salt Reactors,” dated November 18, 2020, (Ref. 11) which endorses with clarifications, “Proposed Guidance for Preparing and Reviewing a Molten Salt Non-Power Reactor Application” (ORNL/TM-2020/1478) to support the review of non-power molten salt reactors (Ref. 12).

Purpose of Regulatory Guides

The NRC issues RGs to describe methods that are acceptable to the staff for implementing specific parts of the agency’s regulations, to explain techniques that the staff uses in evaluating specific issues or postulated events, and to describe information that the staff needs in its review of applications for permits and licenses. RGs are not NRC regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs are acceptable if supported by a basis for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This RG provides voluntary guidance for implementing the mandatory information collections in 10 CFR Parts 50 and 52 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). These information collections were approved by the Office of Management and Budget (OMB), approval numbers 3150-0011 and 3150-0151 respectively. Send comments regarding this information collection to the FOIA, Library, and Information Collections Branch (T6-A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the OMB Reviewer at: OMB Office of Information and Regulatory Affairs (3150-0011 and 3150-0151), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street, NW, Washington, DC 20503; e-mail: oir_submission@omb.eop.gov.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

B. DISCUSSION

Reason for Revision

The NRC issued RG 1.156, “Qualification of Connection Assemblies for Nuclear Power Plants,” Revision 1, in July 2011. The NRC has updated this revision of the guide (Revision 2) to endorse IEEE Std. 572-2019 to provide the latest technical information on approaches to satisfy the qualification requirements for connection assemblies. This includes guidance used in conjunction with that in RG 1.89 as an acceptable method of demonstrating compliance with the NRC regulations pertaining to the environmental qualification of connectors, terminations, and environmental seals in combination with cables or wires as assemblies for service in production and utilization facilities to ensure that the connection assemblies can perform their safety functions. Further, the revised guide modifies the title of the RG to include other nuclear facilities, as discussed in the Section A, under Applicability.

Background

IEEE Std. 572-2019 was prepared by Subcommittee 2 (Qualification) of the IEEE Nuclear Power Engineering Committee and was approved by the IEEE Standards Board on February 8, 2019. This standard describes basic procedures for qualifying connection assemblies (e.g., connectors, terminations, and environmental seals in combination with related cables or wires as assemblies). The qualification requirements in this standard, when used in conjunction with RG 1.89, allow an applicant or licensee to demonstrate and document the ability of the equipment to perform safety functions under applicable service conditions, including design-basis events.

The examples and specific discussion in this RG primarily focus on power reactors. Other applicants and licensees may also use and apply the guidance in this RG to develop plans or programs that address meeting the agency’s regulatory requirements for the qualification of connection assemblies. In particular, these applicants and licensees may use the guidance to verify adequacy of design for service. However, certain aspects of the guidance discuss regulatory requirements that may not fully apply to these applicants and licensees (e.g., Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants”).

Consideration of International Standards

The International Atomic Energy Agency (IAEA) works with member states and other partners to promote the safe, secure, and peaceful use of nuclear technologies. The IAEA develops Safety Requirements and Safety Guides for protecting people and the environment from harmful effects of ionizing radiation. This system of safety fundamentals, safety requirements, safety guides, and other relevant reports, reflects an international perspective on what constitutes a high level of safety. To inform its development of this RG, the NRC considered IAEA Safety Requirements and Safety Guides pursuant to the Commission’s International Policy Statement (Ref. 13) and Management Directive and Handbook 6.6, “Regulatory Guides” (Ref. 14).

The following IAEA Safety Requirements and Guides were considered in the development update of the Regulatory Guide:

- IAEA Safety Standards Series No. SSG-69, “Equipment Qualification for Nuclear Installations,” issued 2021 (Ref. 15)

Documents Discussed in Staff Regulatory Guidance

This RG endorses 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 approved acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified, consistent with current regulatory practice, and consistent with applicable NRC requirements.

C. STAFF REGULATORY GUIDANCE

The NRC staff considers conformance with the requirements of IEEE Std. 572-2019 an acceptable method for use in satisfying the Commission's regulations with respect to environmental qualification of connection assemblies and environmental seals in combination with cables or wires as assemblies for service in production and utilization facilities, with the following exceptions:

1. The following definition of anticipated operational occurrence (AOO) should be used instead of the definition of operational occurrence and the term normal operational occurrence in Section 3, "Definitions," of IEEE Std. 572-2019:

AOO is defined in 10 CFR Part 50, Appendix A, as "those conditions of normal operation which are expected to occur one or more times during the life of the nuclear power unit and include but are not limited to loss of power to all recirculation pumps, tripping of the turbine generator set, isolation of the main condenser, and loss of all offsite power." The definition of AOO should be used for operational occurrence and normal operational occurrence.

2. The following definition of mild environment should be used instead of the definition in Section 3, "Definitions," of IEEE Std. 572-2019:

Mild environment is defined in 10 CFR 50.49(c) as "an environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurrences."

3. The following definition of qualified life should be used instead of the definition in Section 3, "Definitions," of IEEE Std. 572-2019:

The period for which an equipment has been demonstrated, through testing, analysis and/or experience, to be capable of remaining functional during and following design basis events to ensure that the criteria specified in 10 CFR 50.49(b) are satisfied.

4. Paragraph 5 of Section 4, "Background," states that "it is necessary to establish a qualified life and qualified condition for connection assemblies required to function during and/or following a design basis event, extreme natural event, and/or severe accident conditions" and should be replaced with the following:

It is necessary to establish a qualified life to meet the requirements of 10 CFR 50.49.

5. Item b) in Section 5.1, "Qualification by type testing," of IEEE Std. 572-2019 states "the test conditions are at least as severe as the service conditions, plus margin, including DBEs, extreme natural events and severe accidents given in the qualification specification," and should be clarified with the following:

Margin is applied to design basis event profiles and not for severe accident conditions. Further, test conditions are at least as severe as service conditions.

6. Section 6.2.8, "Design extension conditions," of IEEE Std. 572-2019 states that "the qualification test program shall include, as appropriate, tests for environmental conditions that are beyond the design basis of the plant, such as extreme natural events and severe accidents," should be replaced with the following:

The qualification test program is not required to include design extension conditions but may be included.

D. IMPLEMENTATION

The NRC staff may use this RG as a reference in its regulatory processes, such as licensing, inspection, or enforcement. However, the NRC staff does not intend to use the guidance in this RG to support NRC staff actions in a manner that would constitute backfitting as that term is defined in 10 CFR 50.109, "Backfitting," and as described in NRC Management Directive 8.4, "Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests," (Ref. 16), nor does the NRC staff intend to use the guidance to affect the issue finality of an approval under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The staff also does not intend to use the guidance to support NRC staff actions in a manner that constitutes forward fitting as that term is defined and described in Management Directive 8.4. If a licensee believes that the NRC is using this RG in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfitting or forward fitting appeal with the NRC in accordance with the process in Management Directive 8.4.

REFERENCES¹

1. Institute of Electrical and Electronics Engineers (IEEE) Standard 572-2019, “IEEE Standard for Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations and Other Nuclear Facilities,” Piscataway, NJ, February 2019.²
2. *U.S. Code of Federal Regulations (CFR)*, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Chapter 1, Title 10, “Energy.”
3. CFR, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Part 52, Chapter 1, Title 10, “Energy.”
4. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 1.63, “Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants,” Washington, DC.
5. NRC, RG 1.73, “Qualification Tests for Safety-Related Actuators in Nuclear Power Plants,” Washington, DC.
6. NRC, RG 1.89, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants,” Washington, DC.
7. NRC, RG 1.100, “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants,” Washington, DC.
8. NRC, RG 1.211, “Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants,” Washington, DC.
9. NRC, NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,” Washington, DC, February 1996.
10. NRC, Interim Staff Guidance Implementing NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,” Part 1 and Part 2, Washington, DC, October 2012.

1 Publicly available NRC-published documents are available electronically through the NRC Library on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/> and through the NRC’s Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>. 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. For problems with ADAMS, contact the PDR staff at 301-415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail PDR.Resource@nrc.gov.

2 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.

11. NRC, “Endorsement of Appendix A to Oak Ridge National Laboratory Report, ‘Proposed Guidance For Preparing and Reviewing A Molten Salt Non-Power Reactor Application,’ as Guidance for Preparing Applications for the Licensing of Non-Power Liquid Fueled Molten Salt Reactors,” Washington, DC. (ADAMS Accession No. ML20251A008)
12. Oak Ridge National Laboratory, ORNL/TM-2020/1478, “Proposed Guidance for Preparing and Reviewing a Molten Salt Non-Power Reactor Application, Oak Ridge, TN. (ML20219A771)
13. NRC, “Nuclear Regulatory Commission International Policy Statement,” *Federal Register*, Vol. 79, No. 132, July 10, 2014, pp. 39415–39418.
14. NRC, Management Directive and Handbook 6.6, “Regulatory Guides,” Washington, DC, May 2, 2016 (ML18073A170).
15. International Atomic Energy Agency (IAEA), IAEA Safety Standards Series No. SSG-69, “Equipment Qualification for Nuclear Installations,” 2021.³
16. NRC, Management Directive 8.4, “Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests,” September 20, 2019 (ML18093B087).

3 Copies of International Atomic Energy Agency (IAEA) documents may be obtained through its Web site: <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 Official.Mail@IAEA.org.