



## U.S. NUCLEAR REGULATORY COMMISSION

# STANDARD REVIEW PLAN

### 3.11 ENVIRONMENTAL QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

#### REVIEW RESPONSIBILITIES

- Primary** - Organization responsible for the review of environmental qualification of electrical equipment
- Secondary** - Organization responsible for the review of instrumentation and control systems
- Organization responsible for the review of environmental qualification of mechanical equipment
- Organization responsible for the review of radiation dose and dose rates used to determine the radiation environment for the environmental qualification of mechanical and electrical equipment

#### I. AREAS OF REVIEW

The information presented in Section 3.11 of the Final Safety Analysis Report (FSAR) should be sufficient to support the conclusion that all items of equipment that are important to safety (mechanical, electrical, and instrumentation and

Draft Revision 4 – December 2017

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#### USNRC STANDARD REVIEW PLAN

This Standard Review Plan (SRP), NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission (NRC) staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC regulations. The SRP is not a substitute for the NRC regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The SRP sections are numbered in accordance with corresponding sections in Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of RG 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)." These documents are made available to the public as part of the NRC policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to [NRO\\_SRP@nrc.gov](mailto:NRO_SRP@nrc.gov).

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control (I&C) equipment) are capable of performing their design safety functions under all normal environmental conditions, anticipated operational occurrences, and accident and post-accident environmental conditions. It includes all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrences, design basis events (as defined in 10 CFR 50.49(b)(1)(ii)), post design basis events, and containment tests.

This Standard Review Plan (SRP) section also covers instrumentation that is needed to assess plant and environs conditions during and after an accident, as described in Regulatory Guide (RG) 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants."

The U.S. Nuclear Regulatory Commission (NRC) regulations in Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," require that structures, systems, and components (SSCs) important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Appendix A to 10 CFR Part 50 states that where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency, and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 also requires that a quality assurance (QA) program be established and implemented in order to provide adequate assurance that these SSCs will satisfactorily perform their safety functions. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 specifies criteria for the QA program to provide adequate confidence that SSCs will perform their safety-related functions satisfactorily in service.

The review under this SRP section will be performed to assure conformance with the environmental design basis requirements of 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 4, "Environmental and Dynamic Effects Design Bases," which states, in part, that "Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents." The review will assure conformance with the applicable portions of other relevant regulations, including 10 CFR Part 50, Appendix A, GDC 1, "Quality Standards and Records," GDC 2, "Design Bases for Protection Against Natural Phenomena," and GDC 23, "Protection System Failure Modes"; and 10 CFR Part 50, Appendix B, Quality Assurance Criteria III, XI, and XVII.

In 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," the NRC established specific requirements for the environmental qualification of certain electric equipment important to safety located in a "harsh" environment. The regulation defined a "mild" environment 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. The NRC stated in 10 CFR 50.49 that environmental qualification of electric equipment located in a "mild" environment was not included within the scope of 10 CFR 50.49. For the purposes of this SRP section, an environment that exceeds NRC's definition of "mild" will be termed "harsh." In addition to the overall review of environmental qualification to satisfy 10 CFR Part 50, Appendix A, the review under this SRP section assures conformance to 10 CFR 50.49 for the environmental qualification of electrical equipment important to safety that is located in a harsh environment.

For mechanical equipment located in a harsh environment, compliance with the environmental design provisions of GDC 4 are generally achieved by demonstrating that the non-metallic parts/components are suitable for the postulated design basis environmental conditions.

For electrical, I&C and mechanical equipment located in mild environments, compliance with the environmental design provisions of GDC 4 are generally achieved and demonstrated by proper incorporation of all relevant environmental conditions into the design process, including the equipment specification. In addition, Regulatory Guidance for Environmental Qualification of Safety-Related Computer-based Instrumentation and Control Systems is provided in Regulatory Guide 1.209, "Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants." RG 1.209 addresses I&C equipment in mild environment simply because of the normal location of such equipment.

In SRM-SECY-02-0067, "Inspections, Tests, Analyses, and Acceptance Criteria for Operational Programs (Programmatic ITAAC)," the NRC staff recommended that combined license (COL) applications for nuclear power plants submitted in accordance with the requirements of 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," contain ITAAC for operational programs required by regulations to the extent that such ITAAC are necessary and sufficient to support the finding that the facility has been constructed and will be operated in conformity with the license, the provisions of the Atomic Energy Act, and the Commission's rules and regulations. In a Staff Requirements Memorandum (SRM) dated September 11, 2002, the Commission determined that a COL applicant is not required to have ITAAC for operational programs for a nuclear power plant licensed under 10 CFR Part 52 (with the exception of emergency planning). The Commission stated that "ITAAC for operational programs should not be necessary if the programs and their implementation are fully described in a COL application and found to be acceptable by the NRC staff at the COL stage." The Commission noted that "the burden [was] on the applicant to provide the necessary and sufficient programmatic information for approval of the COL without ITAAC."

In SRM-SECY-04-0032, "Programmatic Information Needed for Approval of a Combined License Without Inspections, Tests, Analyses, and Acceptance Criteria," the NRC staff provided recommendations to the Commission regarding the level of programmatic information needed for approval of a COL without ITAAC for operational programs. In an SRM dated May 14, 2004, the Commission stated that " 'fully described' for an operational program should be understood to mean that the program is clearly and sufficiently described in terms for scope and level of detail to allow a reasonable assurance finding of acceptability." The Commission noted that "required [operational] programs should always be described at a functional level and an increasing level of detail where implementation choices could materially and negatively affect the program effectiveness and acceptability." The Commission also stated that the staff should continue the practice of inspecting relevant licensee procedures and programs in a similar manner as was done in the past and consistent with applicable inspection programs. The staff should also continue to ensure, consistent with the inspection and enforcement processes, that licensees address pertinent issues prior to fuel loading.

The NRC staff discussed the Commission's position on operational programs for COL applications in SECY-05-0197, "Review of Operational Programs in a Combined License Application and General Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria [ITAAC]." In SECY-05-0197, the NRC staff defines operational programs for new

nuclear power plants as programs that are required by regulation, are reviewed by NRC staff for acceptability with the results documented in the safety evaluation report, and will be verified for implementation by NRC inspectors. For example, SECY-05-0197 includes the environmental qualification program, as an operational program. The description of the program would contain the information necessary for the staff to make a reasonable assurance finding on the acceptability of the operational program in the review of a COL application. The staff proposed license conditions to provide certainty as to when the operational programs are scheduled to be implemented.

As discussed, COL applicants are responsible for providing a full description of the environmental qualification operational program. The design certification applicant may include information in its design control document (DCD) or FSAR on the environmental qualification operational program for use by the COL applicant in developing the operational program. The NRC reviews the information provided by the design certification applicant in its DCD or FSAR for acceptability for reference by COL applicants. Because operational program descriptions are the responsibility of the COL applicant, the operational program information in the DCD or FSAR provided by the design certification applicant will not receive finality per 10 CFR 52.63, "Finality of Standard Design Certifications."

In their FSARs, COL applicants have incorporated by reference the description of the environmental qualification program provided in the DCD or FSAR submitted by the design certification applicant with supplemental information or departures. The NRC reviews the program description provided in the design certification DCD/FSAR for acceptability for reference by COL applicants in preparing the safety evaluation report (SER) on the design certification application. The NRC then reviews the program description provided in the COL FSAR in preparing its SER on the COL application. Therefore, the full description of the environmental qualification program is provided by the combination of the design certification DCD/FSAR and the COL FSAR, together with the NRC SERs on the design certification application and the COL application.

Reviews to determine compliance with related requirements for (1) dynamic and seismic qualification of electrical, I&C and mechanical equipment, (2) protection of electric and mechanical equipment against other natural phenomena and external events, (3) functional qualification of mechanical equipment, (4) equipment survivability for the length of time for which its function is required, and (5) qualification of I&C equipment located in mild environments are described in SRP Appendices 7.1-B, "Guidance for Evaluation of Conformance to IEEE Std. 279," and 7.1-C, "Guidance for Evaluation of Conformance to IEEE Std. 603."

The specific areas of review are as follows:

1. Mechanical, electrical, and I&C equipment associated with systems described in this paragraph are reviewed to determine whether they are designed to meet the requirements described under the acceptance criteria of this SRP section. Mechanical, electrical, and I&C equipment covered by this SRP section include the following:
  - A. Equipment associated with systems that are essential for shutting down the reactor and maintaining it in a safe shutdown condition, containment isolation, reactor core cooling, and containment and reactor heat removal, or otherwise are

essential in preventing significant release of radioactive material to the environment,

- B. Equipment that initiates the above functions automatically,
  - C. Equipment that is used by the operators to initiate the above functions manually,
  - D. Equipment whose failure can prevent the satisfactory accomplishment of one or more of the above safety functions,
  - E. Other electrical equipment important to safety, as described in 10 CFR 50.49(b)(1) and (2),
  - F. Certain post-accident monitoring equipment, as described in 10 CFR 50.49(b)(3) and RG 1.97, and
  - G. Protection and safety systems as described in 10 CFR 50.55a(h) and RG 1.209.
2. Section 3.11 of the SAR/FSAR or the DCD is reviewed to determine whether the required environmental design and qualification of all equipment important to safety will be, or has been adequately demonstrated. The term “environmental qualification” means verification of design, limited to demonstrating that electrical or mechanical or I&C equipment are capable of performing their safety function under significant environmental stresses (i.e., harsh environments) resulting from design basis events in order to avoid common-cause failure. Environmental design requirements apply to all equipment important to safety (i.e., both mild and harsh environments).
3. At the construction permit (CP) stage, the staff review considers the conceptual approach for meeting the environmental design and qualification requirements addressing the following areas:
- A. Identification of all mechanical, electrical, and I&C equipment required to perform the functions defined in Subsection I, Item 1, above.
  - B. Identification of the environmental design bases for the equipment identified, including the definition of anticipated operational occurrences and normal, accident, and post-accident environments.
  - C. Requirements for documentation of the qualification tests and analyses that have been, or will be performed on the equipment to meet the design bases.
  - D. Demonstration of the adequacy of the environmental design and qualification.
  - E. Identification of the equipment that is required to remain functional during and following design basis events.
4. At the operating license (OL) stage, the staff’s review includes the following:
- A. A review of the applicant's environmental qualification program and the submitted results of its implementation.

- B. An audit of the applicant's records, including a review of the documentation provided in the file to permit verification of environmental design and qualification for all mechanical, electrical, and I&C equipment covered by this SRP section. Components in the scope of this SRP section that are subject to environmental design and qualification must have auditable records to document that environmental design and qualification requirements have been met. The staff's review is performed to determine (1) proper implementation of criteria established in the CP review, and (2) adequate environmental design and qualification for all electrical, mechanical, and I&C equipment covered by this SRP section.
5. The staff's review for design certification (DC) consists of an evaluation of the description of the applicant's Environmental Qualification Program (i.e., approach and methodology) for selecting and identifying mechanical, electrical, and I&C equipment (i.e., providing the equipment list) important to safety required to be environmentally qualified for the certified design for compliance with 10 CFR Part 50, Appendices A and B, and 10 CFR 50.49, as applicable, and specifying the duration of which its function is required. The staff also reviews the applicant's determination of the required functional duration for equipment important to safety, and the associated bases. For a COL applicant, the staff reviews the incorporation by reference of the environmental qualification provisions for mechanical, electrical, and I&C equipment important to safety in the design certification DCD/FSAR. The staff also reviews the description of the COL program provided by the applicant for the site-specific environmental qualification for electrical, mechanical, and I&C equipment important to safety.
6. The NRC regulations in 10 CFR 52.47, "Contents of Applications; Technical Information," state that the Commission will require, before design certification, that information normally contained in certain procurement specifications and construction and installation specifications be completed and available for audit if the information is necessary for the Commission to make its safety determination. The staff performed design specification audits for all design applications to verify that EQ requirements were properly translated into the design specification. Based on the results of these audits, staff finds it necessary to perform these audits in order to make a safety finding. Therefore, the staff will conduct an audit of the procurement specifications as discussed in the introduction of 10 CFR 52.47 for the environmental qualification of mechanical and electrical equipment. This audit could be conducted as part of the review of the COL application if NRC staff review of the design certification application and initial COL application are underway at the same time.
7. Operational Program Description and Implementation. For DC and COL applications the staff reviews the full description of the environmental qualification operational program consistent with the guidance in SECY-05-0197. The staff also reviews FSAR Section 13.4, "Operational Program Implementation," to ensure that the Environmental Qualification Program and associated implementation milestones are included.
8. Inspections, Tests, Analyses, and Acceptance Criteria. For DC and COL applications the staff reviews the applicant's proposed ITAAC associated with the SSCs related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be

completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

9. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will address COL action items (referred to as COL license information in certain DCs) and additional requirements (e.g., interface and site-specific information).

For a COL application referencing a DC, a COL applicant must address COL action items included in the referenced DC. Additionally, a COL applicant must address additional requirements (i.e., interface and site-specific information) identified in the referenced DC.

### Review Interfaces

Other SRP sections interface with this section as follows:

1. Review of the adequacy of the design, installation, inspection, and testing of containment systems is performed under SRP Sections 6.2.1, "Containment Functional Design," through 6.2.6, "Containment Leakage Testing."
2. Review of the adequacy of the design, installation, inspection, and testing of the Reactor Core Isolation Cooling system, Residual Heat Removal function, the Emergency Core Cooling System, and the accident analysis is performed under SRP Sections 5.4.6, "Reactor Core Isolation Cooling System (BWR)," 5.4.7, "Residual Heat Removal (RHR) System," and 6.3, "Emergency Core Cooling System," and applicable sections of Chapter 15, "Transient and Accident Analyses," respectively.
3. Review of the adequacy of the design, installation, inspection, and testing of I&C is performed under SRP Chapter 7, "Instrumentation and Controls."
4. Review of the adequacy of the design, installation, inspection, and testing of electric power systems is performed under SRP Chapter 8, "Electric Power."
5. Review of the applicant's QA program to verify that it satisfies the requirements of 10 CFR Part 50, Appendix B, Criteria III, XI, and XVII is performed under SRP Chapter 17, "Quality Assurance."
6. Review of design basis radiological consequence analyses associated with design basis accidents is performed under SRP Section 15.0.3, "Design Basis Accident Radiological Consequences of Analyses for Advanced Light Water Reactors."
7. The functional design and qualification of mechanical, electrical, and I&C equipment are addressed in several sections of SRP Chapter 3, "Design of Structures, Components, Equipment, and Systems." For example:
  - A. SRP Section 3.9.5, "Reactor Pressure Vessel Internals," includes evaluation of potential adverse flow effects on mechanical, electrical, and I&C equipment from

pressure fluctuations and vibration caused by acoustic resonances and hydrodynamic forces.

- B. SRP Section 3.9.6, "Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints," includes functional design and qualification of pumps, valves, and dynamic restraints at a nuclear power plant. The review includes the potential impact of adverse environmental conditions on active mechanical and electrical equipment. For example, electric motors might produce less torque under high temperature conditions than under ambient conditions, which could impact their capability to operate their individual pumps or valves.
  - C. The design bases for protection of mechanical, electrical, and I&C equipment against natural phenomena and external events are reviewed under appropriate sections of SRP Chapter 3 (e.g., Sections 3.3.1, 3.3.2, 3.4.1, 3.5.1.1, 3.5.1.4, 3.5.1.5, and 3.5.2). SRP Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," includes seismic and dynamic qualification of mechanical, electrical, and I&C equipment.
8. Review of the adequacy of equipment functional performance during and after being exposed to the environmental conditions resulting from the release of hydrogen generated by the equivalent of a 100percent fuel-clad metal-water reaction, as stated in 10 CFR 50.44(c)(5), is performed under SRP Section 6.2.5.
  9. For COL reviews of operational programs, the review of the applicant's implementation plan is performed under SRP Section 13.4, "Operational Program Implementation."
  10. Review of the types of radiation and the radiation environment used to determine the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident, consistent with 10 CFR 50.49(e)(4), and identifying the kinds and quantities of radioactive materials expected to be produced in the operation, consistent with 10 CFR 50.34(b)(3), 10 CFR 52.47(a)(5), 10 CFR 52.79(a)(3) and 10 CFR 52.157(e), are performed under SRP Chapter 12, "Radiation Protection."
  11. Review of the chemical environment for equipment required to be qualified is performed by the organization responsible for the review of chemistry to determine .

## II. ACCEPTANCE CRITERIA

### Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."
2. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 1, "Quality Standards and Records."



3. GDC 2, "Design Bases for Protection Against Natural Phenomena."
4. GDC 4, "Environmental and Dynamic Effects Design Bases."
5. GDC 23, "Protection System Failure Modes."
6. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Section III, "Design Control."
7. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Section XI, "Test Control."
8. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Section XVII, "Quality Assurance Records."
9. 10 CFR 52.47, which states that the Commission will require, before design certification, that information normally contained in certain procurement specifications and construction and installation specifications be completed and available for audit if the information is necessary for the Commission to make its safety determination.
10. 10 CFR 52.47(a)(13) which references the "list of electrical equipment important to safety per 50.49(d)" for DC applicants.
11. 10 CFR 52.47(b)(1), which requires that a DC application contain "the proposed [ITAAC] that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the [Atomic Energy] Act, and the [NRC's] regulations."
12. 10 CFR 52.79(a)(10) which references establishing a program for qualifying the electrical equipment per 50.49(a) for COL applicants.
13. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and the NRC's regulations.
14. 10 CFR 50.34(b)(3), 10 CFR 52.47(a)(5), 10 CFR 52.79(a)(3) and 10 CFR 52.157(e) which require the applicant to describe the types and quantities of radiation used to determine the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects.

15. The general requirement for environmental design and qualification of mechanical, electrical, and I&C equipment important to safety can be summarized as follows: (1) Appendix A to 10 CFR Part 50 provides an overall requirement that mechanical, electrical and I&C equipment important to safety shall be designed to have the capability of performing its design safety functions under all anticipated operational occurrences and normal, accident, and post accident environment, and for the length of time for which its function is required. (2) The NRC regulations in 10 CFR 50.49 provide specific requirements that the environmental qualification of certain electric equipment located in a harsh environment shall be demonstrated by appropriate testing, or a combination of testing and analyses, and maintaining all qualification records for the operational life of the plant. (3) Appendix B to 10 CFR Part 50 requires that a QA program shall be established and implemented to provide assurance that the applicable requirements for environmental design and qualification of all safety-related mechanical, electrical, and I&C equipment have been satisfactorily accomplished. The environmental design and qualification of mechanical, electrical, and I&C equipment is acceptable when it can be ascertained that these requirements have been met.
16. 10 CFR 50.55a(h), "Protection and "Safety Systems," requires that protection systems of nuclear power reactors of all types must meet the requirements specified in 50.55a(h)(2) or 50.55a(h)(3).

#### SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this SRP section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the SRP acceptance criteria, is sufficient to meet the requirements in 10 CFR 52.47(a)(9), "Contents of applications; technical information." The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

If the NRC staff has endorsed a referenced standard in a regulatory guide, that standard constitutes an acceptable method for use in meeting the related regulatory requirement as described in the regulatory guide. If a referenced standard has not been endorsed in a regulatory guide, licensees and applicants may consider and use the information in the referenced standard, if appropriately justified, consistent with current regulatory practice.

1. NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment," Revision 1, July 1981 provides staff positions applicable to existing plants for assessing the compliance of an environmental qualification program with 10 CFR 50.49. For future plants, RG 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety in Nuclear Power Plants," provides the principal guidance for implementing the requirements and criteria of 10 CFR 50.49 for environmental qualification of electrical equipment that is important to safety and located in a harsh environment. However, certain NUREG-0588 Category I guidance may be used if relevant guidance is not provided in RG 1.89. NUREG-0588 includes two sets of qualification criteria, Category I and Category II. Category I refers to Institute of Electrical And Electronics Engineers (IEEE) Standard (Std.) 323-1974, "IEEE Standard

for Qualifying Class 1E Equipment for Nuclear Power Generating Stations.” Category II refers to IEEE Std. 323-1971, and is not applicable to any future plants.

2. IEEE Std. 323 contains the principles and criteria that are generic to the environmental qualification process. The following clarification related to the criteria in IEEE Std. 323 should be considered. IEEE Std. 323 requires that the service environment, including the installed configuration of the equipment, be considered as part of the qualification process. In meeting this requirement, the potential for flooding of electrical equipment that are installed above the flood level, but are subject to water and moisture intrusion, should be considered as part of environmental qualification. Operating experience (e.g., Information Notice 89-63) shows that electrical enclosures that are located above the flood level and are subject to water and moisture intrusion could result in submergence of electrical components inside the enclosures, if the enclosures do not have drainage holes. The reviewer should confirm that equipment in such locations, whose design is such that water accumulation is possible, should have measures to preclude such accumulation (e.g., enclosure drain holes) or the affected equipment should be qualified for the anticipated submergence.
3. RG 1.40, “Qualification Tests of Continuous-Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants,” endorses IEEE Std 334, “IEEE Trial Use Guide for Type Tests of Continuous-Duty Class 1 Motors Installed Inside the Containment of Nuclear Power Generating Stations.” These documents contain guidance acceptable to the staff for the environmental design and qualification of Class 1E motors, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating the environmental design and qualification of Continuous-Duty Class 1E Motors.
4. RG 1.63, “Electrical Penetration Assemblies in Containment Structures for Nuclear Power Plants,” endorses IEEE Std. 317, “IEEE Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations.” These documents contain general guidance that is acceptable to the staff for the environmental design and qualification of electrical penetration assemblies, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating the environmental design and qualification of electrical penetration assemblies.
5. RG 1.73, “Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants,” endorses IEEE Std. 382, “IEEE Trial Use Guide for Type Test of Class 1E Electric Valve Operators for Nuclear Power Generating Stations.” These documents contain guidance acceptable to the staff for the environmental design and qualification of Class 1E electric valve operators, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating the environmental design and qualification of Class 1E electric valve operators.
6. RG 1.89 provides guidance for implementing the requirements and criteria of 10 CFR 50.49 for environmental qualification of electrical equipment that is important to safety and located in a harsh environment. RG 1.89 endorses the provisions of IEEE Std. 323 as being acceptable to the staff, and provides supplementary guidance for satisfying the Commission's regulations regarding the environmental qualification of electrical equipment located in a harsh environment. The assumptions in RG 1.183, Appendix I supersede Regulatory Positions 2.c(1) and 2.c(2) and Appendix D of

Revision 1 of RG 1.89, for those applicants using the alternative source term described in RG 1.183, as their licensing basis.

7. RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," provides guidance acceptable to the staff for the environmental qualification of the post-accident monitoring equipment described in Subsection I, Item 1(F), of this SRP section, as well as instruments and controls for the equipment described in Subsection I, Items 1(A) to 1(E), of this SRP section. These criteria, as supplemented by those of RG 1.89, should be used to evaluate the environmental qualification of the I&C equipment.
8. RG 1.152, "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants," endorses IEEE Std. 7-4.3.2-2003, "Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations," These documents contain guidance acceptable to the staff for the environmental design and qualification of computer-specific requirements, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating computer-specific requirements.
9. RG 1.153, "Criteria for Safety Systems," endorses IEEE Std. 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations." These documents contain guidance acceptable to the staff for the environmental design and qualification of power, instrumentation, and control portions of the safety systems, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating power, instrumentation, and control portions of the safety systems.
10. RG 1.209, "Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants." Endorses, with some exceptions, IEEE Std. 323-2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations." These documents contain guidance acceptable to the staff for the environmental design and qualification of safety-related computer-based I&C systems in mild environments, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for satisfying the environmental qualification of safety-related computer based I&C systems.
11. RG 1.211, "Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants" replaces RG 1.131, "Qualification Tests of Electric Cables and Field Splices for Light-Water-Cooled Nuclear Power Plants." RG 1.211 endorses, with some exceptions, IEEE Std. 383-2003, "Standard for Type Test of Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations." These documents contain guidance acceptable to the staff for the environmental qualification of Class 1E electric cables and field splices, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating the environmental qualification of Class 1E electric cables and field splices.
12. RG 1.156, "Environmental Qualification of Connection Assemblies for Nuclear Power Plants," endorses IEEE Std 572, "IEEE Standard for Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations." These documents contain guidance acceptable to the staff for the environmental qualification of Class 1E connection assemblies, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating the environmental qualification of Class 1E connection assemblies.

13. RG 1.158, "Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants," endorses IEEE Std 535, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations." These documents contain guidance acceptable to the staff for the environmental qualification of Class 1E lead storage batteries, and should be used in conjunction with NUREG-0588 and RG 1.89, as appropriate, for evaluating the environmental qualification of lead storage batteries.
14. RG 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," provides guidance acceptable to the staff for determining electromagnetic compatibility for I&C equipment during service. These criteria, as supplemented by those of RG 1.89, should be used to evaluate the environmental design and qualification of safety-related I&C equipment. New digital systems and new advanced analog systems may require susceptibility testing for electromagnetic interference/radio-frequency interference (EMI/RFI) and power surges, if the environments are significant to the equipment being qualified. The functional descriptions of I&C equipment are provided in SRP Chapter 7.
15. RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," provides guidance acceptable to the staff for determining the radiation dose and dose rate for equipment during normal operation and postulated accident conditions. These criteria, as supplemented by those of RG 1.89, should be used to evaluate the accident source term used in the environmental design and qualification of equipment important to safety.

Radiation dose and dose rate used to determine the radiation environment for qualification of electrical and mechanical equipment must be based on an NRC staff-approved source term and methodology, as discussed in NUREG-0588 and as supplemented by Section II.B.2 of NUREG-0737, "Clarification of TMI Action Plan Requirements," and NUREG-0718, "Licensing Requirements for Pending Applications for Construction Permits and Manufacturing License," or as discussed in NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants." The radiation environment must be based on the integrated effects of the normally expected radiation environment over the equipment's installed life, plus the effects associated with the most severe design basis event during or following which the equipment is required to remain functional. The effects of beta radiation must also be considered in the qualification process. The effects of radiation exposure due to recirculatory fluid must be considered for equipment located outside the containment.

The staff's definition of what constitutes a mild radiation environment for electronic components, such as semiconductors or electronic components containing organic material, differs from that for other equipment. The staff's position, as stated in NUREG-1503, "Final SER ABWR, Chapter 3, Design of Structures, Components, Equipment, and Systems," and NUREG-1793, "Final SER AP1000, Chapter 3, Design of Structures, Components, Equipment, and Systems," is that a mild radiation environment for electronic equipment is a total integrated dose less than 10 Gy (1E3 rad), and a mild radiation environment for other equipment is less than 100 Gy (1E4 rad).

Environmental qualification for electrical equipment located in a "radiation harsh" environment (i.e., locations where radiation is the only harsh environmental condition)

can be accomplished in accordance with 10 CFR 50.49(f)(4) using analysis of test data (from identical materials) combined with radiation test information (i.e., partial test data), and appropriate consideration of margin and aging effects for nonmetallic components/materials when sufficient documentation is available to preclude the need for a type test. Equipment subject to being submerged is identified, consistent with the requirements of 10 CFR 50.49(e)(6). Consistent with 10 CFR 50.49(e)(7), synergistic effects must be considered when these effects are believed to have a significant effect on equipment performance.

16. RG 1.100, Revision 3<sup>1</sup>. “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants,” endorses, with exceptions and clarifications, IEEE Std 344-2004, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations” and American Society of Mechanical Engineers (ASME) Standard QME-1-2007, “Qualification of Active Mechanical Equipment Used in Nuclear Power Plants,” which includes provisions for the functional design and qualification of active mechanical equipment in nuclear power plants. QME-1-2007, Appendix QR-B, “Guide for Qualification of Nonmetallic Parts,” recommends a methodology and describes the documentation that should be available to demonstrate the qualification of nonmetallic parts, materials, or lubricants. It addresses the steps for the user of active mechanical equipment to follow to qualify and maintain the qualification of nonmetallic material that is part of active mechanical equipment. The NRC staff considers Non-mandatory Appendix QR-B to provide a reasonable approach to the qualification of nonmetallic material in active mechanical equipment. As stated in RG 1.100, “when a licensee commits to use a non-mandatory appendix in ASME QME-1-2007 [such as Appendix QR-B] for its qualification of active mechanical equipment, then the criteria and procedures delineated in [Appendix QR-B] become part of the basis for its qualification program, unless specific deviations are requested and justified.”
17. The effects of chemical exposure must be addressed in the environmental qualification process. The concentration of chemicals used for qualification must be equivalent to, or more severe than, that resulting from the most limiting mode of plant operation (e.g., emergency core cooling system initiation, or recirculation phase). If the chemical composition of the chemical spray can be affected by equipment malfunctions, the most severe chemical environment that results from a single failure in the spray system must be assumed. If only demineralized water spray is used, then the effect of the demineralized water spray must be included in the equipment qualification.
18. Environmental design means that components shall be designed to accommodate the effects of environmental conditions and is required for all important to safety equipment located in either mild or harsh environments in accordance with 10 CFR Part 50, Appendix A. A mild environment is defined in 10 CFR 50.49 as an environment that would not be significantly more severe than the environment that would occur during normal plant operation. The NRC regulations in 10 CFR 50.49 specify environmental qualification requirements to verify the design by test or a combination of test and analyses for certain electric and I&C equipment important to safety located in harsh environments.

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<sup>1</sup> The NRC staff is completing a revision to Regulatory Guide 1.100 to accept the 2013 edition of IEEE Std. 344 and the 2012 edition of QME-1 for use by applicants and licensees, and this Revision 4 of the guide should be used when final. Conforming updates to this SRP section will be made in a future revision.

19. Mechanical components important to safety must be designed to be compatible with postulated environmental conditions, including those associated with loss-of-coolant accidents (LOCAs) in compliance with 10 CFR Part 50, Appendix A. Under Appendix B to 10 CFR Part 50, a process must be established to determine the suitability of materials, parts, and equipment needed for safety-related functions. Also, environmental design records for safety-related mechanical equipment must be maintained in accordance with 10 CFR Part 50, Appendix B, and these records must include the results of tests and material analyses used as part of the environmental design process for each mechanical component.

For mechanical equipment, the staff concentrates its review on non-metallic materials that are sensitive to environmental effects (e.g., seals, gaskets, lubricants, fluids for hydraulic systems, and diaphragms). The reviewer confirms that the applicant has (1) identified safety-related mechanical equipment located in harsh and mild environment areas, including its required operating time; (2) identified nonmetallic subcomponents of such equipment; (3) identified the environmental conditions and process parameters for which this equipment must be qualified; (4) identified nonmetallic material capabilities; and (5) evaluated environmental effects.

20. Appendix QR-B, "Guide for Qualification of Nonmetallic Parts," of ASME QME-1-2007 as endorsed in RG 1.100 (Revision 3), provides a methodology and documentation of records that the staff finds acceptable to demonstrate that non-metallic parts of mechanical equipment are designed to accommodate the effects of environmental conditions. The environmental design of non-metallic parts for mechanical equipment should consider both the external and internal service conditions of the component. The applicant should apply ASME QME-1-2007, Appendix QR-B, as accepted in RG 1.100 (Revision 3) or describe a suitable alternative in its application for NRC staff review.
21. For electrical, I&C and mechanical equipment important to safety located in a mild environment, the applicant might describe a process in its DCD/FSAR for environmental design through "design/purchase" specifications that demonstrate the capability of the equipment to perform under its applicable environmental conditions in compliance with 10 CFR Part 50, Appendix A. The specifications must contain a description of the functional requirements for a specific environmental zone during normal environmental conditions and anticipated operational occurrences. For non-metallic parts of mechanical equipment, the specification must also contain the internal service conditions of the component. A certificate of compliance provides documentation that the equipment is capable of performing its design function under the applicable environmental conditions.
22. The applicable documentation for the environmental design and qualification of safety-related mechanical, electrical, and I&C equipment must be in accordance with the Quality Assurance Program per 10 CFR 50, Appendix B-and 10 CFR 50.49(j).
23. A well-supported maintenance/surveillance program, in conjunction with a good preventive maintenance program, is needed to provide assurance that the environmental design and qualification status of equipment in both mild and harsh environments will be maintained during the operational life of the plant. The applicant should specify in its DCD/FSAR that the environmental qualification (EQ) operational program shall contain

the following aspects specific to the environmental qualification of mechanical and electrical equipment: (1) evaluation of environmental qualification results for design life to establish activities to support continued environmental qualification; (2) determination of surveillance and preventive maintenance activities based on environmental qualification results; (3) consideration of environmental qualification maintenance recommendations from equipment vendors; (4) evaluation of operating experience in developing surveillance and preventive maintenance activities for specific equipment; (5) development of plant procedures that specify individual equipment identification, appropriate references, installation requirements, surveillance and maintenance requirements, post-maintenance testing requirements, condition monitoring requirements, replacement part identification, and applicable design changes and modifications; (6) development of plant procedures for reviewing equipment performance and environmental qualification operational activities, and for trending the results to incorporate lessons learned through appropriate modifications to the environmental qualification operational program; and (7) development of plant procedures for the control and maintenance of environmental qualification records.

24. For COL reviews, Section 13.4, "Operational Program Implementation," describes the operational program and proposed implementation milestone(s) for the environmental qualification program is reviewed in accordance with 10 CFR 50.49. The implementation milestone for the environmental qualification program is to have all qualification requirements met prior to the loading of fuel. Implementation is required by a license condition.
25. Consistent with the requirements of 10 CFR 50.49(e)(4) and 10 CFR 50.49(e)(6), and the guidance contained within RG 1.206 subsection C.I.3.11.5, the applicant shall identify the type of radiation dose and dose rate used to determine the radiation environment and indicate the extent to which estimates of radiation exposures are based on a radiation source term that is consistent with NRC staff-approved source terms and methodology. The applicant shall identify whether the equipment is subject to being submerged. The applicant should tabulate the pre-DBE neutron (inside containment, where applicable), beta and gamma exposures separately for each item of equipment and list the average energy of each type of radiation, and beta and gamma exposures post DBE. For engineered safety features (ESF) systems outside containment, the applicant should indicate whether the radiation estimates account for factors affecting the source term such as containment leak rate, meteorological dispersion (if appropriate), and operation of other ESF systems. The applicant should list all assumptions used in the calculation. Synergistic effects must be considered when these effects are believed to have a significant effect on equipment performance.
26. Where the NRC staff plans to conduct an audit of the design and procurement specifications, the applicant should make available procurement specifications as discussed in the introduction of 10 CFR 52.47.

### Technical Rationale

The technical rationale for application of these acceptance criteria to reviewing this SRP section are discussed in the following paragraphs:



1. Compliance with 10 CFR 50.49 requires that the applicant identify a list of electrical and I&C equipment and establish a program, as described therein, for qualifying electrical and I&C equipment important to safety located in a harsh environment. In addition to the design requirements in Appendix A to 10 CFR Part 50, the NRC regulations in 10 CFR 50.49 provide specific requirements related to the environmental qualification of electrical and I&C equipment located in a harsh environment. The environmental qualification process described by this regulation provides requirements to ensure that equipment will be able to perform acceptably during all anticipated operating conditions, even after being degraded due to exposure to service conditions during its qualified life.

Meeting the requirements of 10 CFR 50.49, 10 CFR 50.34(b)(3), 10 CFR 52.47(a)(5), 10 CFR 52.79(a)(3), and 10 CFR 52.157(e) provides assurance that electrical and I&C equipment important to safety that are located in a harsh environment are environmentally qualified and are capable of performing their intended safety function.

2. Consistent with 10 CFR 50.49(e)(4), 10 CFR 50.49(e)(6), 10 CFR 50.49(e)(7) 10 CFR 50.34(b)(3), 10 CFR 52.47(a)(5), 10 CFR 52.79(a)(3) and 10 CFR 52.157(e) the applicant shall identify the types of radiation, the dose and dose rate used to determine the radiation environment and indicate the extent to which estimates of radiation exposures are based on a radiation source term that is consistent with NRC staff-approved source terms and methodology. The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional. The applicant shall identify whether the equipment is subject to being submerged. The applicant shall identify for which equipment synergistic effects (e.g., temperature increases following a DBE) must be considered based on when these effects are believed to have a significant effect on equipment performance. The applicant shall list all assumptions used in the calculation.

3. Compliance with GDC 1, "Quality Standards and Records," requires that components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed.

GDC 1 is applicable to this Section since it includes requirements for quality standards that must be met, and records that must be kept concerning the quality standards for design, fabrication, erection, and testing of components important to safety. Components in the scope of this SRP Section that are subject to environmental design and qualification must have auditable records to document that environmental design and qualification requirements have been met.

Meeting GDC 1 provides assurance that the equipment is of sufficiently high quality to be capable of performing their design safety functions acceptably during all anticipated operating conditions and that appropriate records are maintained to document meeting these requirements.

4. GDC 2, "Design Bases for Protection against Natural Phenomena," requires that components important to safety be designed to withstand the effects of natural

phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their safety function.

GDC 2 is applicable to this section since the design bases for components important to safety must consider the effects of the most severe natural phenomena anticipated for the site, together with normal and accident plant operating conditions and the importance of the safety function to be performed. Components in the scope of this section that are subject to environmental design and qualification must consider environmental conditions/stressors resulting from natural phenomena as part of the environmental conditions evaluated.

Meeting GDC 2 provides assurance that appropriate combinations of the effects of normal and accident conditions resulting from the effects of the natural phenomena are considered in meeting the environmental design and qualification requirements.

5. Compliance with GDC 4, "Environmental and Dynamic Effects Design Bases," requires that components important to safety be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs. Components must be protected against dynamic effects, including those of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit.

GDC 4 is applicable to this section since it provides the requirement that components important to safety be designed to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs.

Meeting GDC 4 ensures that equipment important to safety are environmentally designed and qualified, and provides assurance that the equipment will be able to accommodate the effects of, and be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs.

6. Compliance with GDC 23, "Protection System Failure Modes," requires that protection systems be designed to fail in a safe state, or in a state demonstrated to be acceptable on some other defined basis, if conditions such as postulated adverse environments (e.g., extreme heat or cold, pressure, steam, water, or radiation) are experienced.

GDC 23 is applicable to this section since the environmental design and qualification of protection systems must ensure that the protection systems will fail in a safe state, or in a state demonstrated to be acceptable on some other defined basis, if they are subjected to harsh conditions such as postulated adverse environments. Components in the scope of this section that are subject to environmental design and qualification requirements must consider the failure mode of the equipment.

Meeting GDC 23 provides assurance that the failure mode of protection system components is considered in the environmental design and qualification process.

7. Compliance with 10 CFR Part 50, Appendix B, Criterion III, "Design Control," requires that measures be established to ensure that applicable regulatory requirements and the associated design bases are correctly translated into specifications, drawings, procedures, and instructions. These measures shall include provisions to ensure that appropriate quality standards are included in design documents and that deviations from established standards are controlled. A process shall also be established to determine the suitability of equipment that is essential to safety-related functions and to identify, control, and coordinate design interfaces between participating design organizations. Where a test program is used to verify the adequacy of a specific design feature, it shall include suitable qualification testing of a prototype unit under the most adverse design conditions.

10 CFR 50, Appendix B, Criterion III is applicable to this Section since it includes requirements for test programs that are used to verify the adequacy of a specific design feature. Such test programs must include suitable qualification testing of a prototype unit under the most adverse design conditions. For components in the scope of this section that are subject to environmental qualification testing, the test program must address these requirements.

Meeting 10 CFR Part 50, Appendix B, Criterion III provides assurance that the environmental qualification process includes suitable qualification testing of a prototype unit under the most adverse design conditions.

8. Compliance with 10 CFR Part 50, Appendix B, Criterion XI, "Test Control," requires that a test control plan be established to ensure that all tests needed to demonstrate a component's capability to perform satisfactorily in service be identified and performed in accordance with written procedures that incorporate the requirements and acceptance limits contained in applicable design documents.

10 CFR Part 50, Appendix B, Criterion XI is applicable to this Section since it includes requirements for developing a test control plan to ensure that all tests needed to demonstrate a component's capability to perform satisfactorily in service be identified and performed in accordance with written procedures that incorporate the requirements and acceptance limits contained in applicable design documents. Components in the scope of this SRP Section that are subject to testing to verify conformance to environmental design and qualification requirements must consider these requirements for a test control plan.

Meeting 10 CFR Part 50, Appendix B, Criterion XI provides assurance that a test control plan is established for components subject to testing for environmental design and qualification to ensure that all tests needed to demonstrate a component's capability to perform satisfactorily in service are identified and performed in accordance with written procedures that incorporate the requirements and acceptance limits contained in applicable design documents.

9. Compliance with 10 CFR Part 50, Appendix B, Criterion XVII, "Quality Assurance Records," requires that sufficient records be maintained to furnish evidence of activities affecting quality. The records must include inspections, tests, audits, monitoring of work performance, and materials analysis. Records must be identifiable and retrievable.

10 CFR 50, Appendix B, Criterion XVII is applicable to this Section since it includes requirements for records that must be maintained to furnish evidence of activities affecting quality. Environmental design and qualification are activities that can affect quality; therefore, components in the scope of this section that are subject to environmental design and qualification must have identifiable and retrievable records that document the fact that they meet these requirements.

Meeting 10 CFR Part 50, Appendix B, Criterion XVII provides assurance that identifiable and retrievable records are maintained to furnish evidence of activities affecting quality, which includes environmental design and qualification.

10. In SRM-SECY-05-0197, the Commission approved the use of a license condition for operational program implementation milestones that are fully described or referenced in the final safety analysis report. The 10 CFR 50.49 environmental qualification regulation for electrical and I&C equipment located in a harsh environment was identified as an operational program in that memorandum.

### III. REVIEW PROCEDURES

For each area of review specified in subsection I of this SRP section, the review procedure is identified below. These review procedures are based on the identified SRP acceptance criteria. For deviations from these specific acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to the SRP criteria provide an acceptable method of complying with the relevant NRC requirements identified in subsection II.

1. At the CP stage, the staff reviews the program that the applicant has described in the preliminary safety analysis report (PSAR) for the environmental design and qualification of the mechanical, electrical, and I&C equipment. The program is measured against the acceptance criteria listed in Subsection II of this SRP section. Of particular interest to the reviewer is the proper use of test and analytical procedures. Equipment should be tested unless testing of the component is impractical due to size limitations or partial type-test data are provided to support the analytical assumptions and conclusions reached. The environmental design and qualification program is reviewed for the identification of normal, accident, and post-accident environmental conditions; anticipated operational occurrences; required operating time; and chemical, submergence, aging, synergistic effects, and margin considerations, including the acceptance criteria of the test results.
2. At the OL stage, the staff reviews the program again, as described by the applicant in the FSAR. In addition, the FSAR is reviewed for documentation of the successful implementation of the environmental design and qualification program, including test and analytical results. The reviewer verifies that the applicant's list of systems, which includes the list of equipment associated with each such system, is consistent with the definition of the systems and equipment described in Subsection I, Item 1, of this SRP section.

At the time of the OL application, the reviewer confirms that complete records are retained at a facility in an auditable and readily accessible form, which describe the environmental design and qualification method used for all mechanical, electrical, and I&C equipment in sufficient detail to document the degree of compliance with the

requirements discussed herein. The reviewer also confirms that, thereafter, such records will be updated and maintained current as equipment is replaced, tested, or otherwise qualified.

To confirm the extent to which the equipment meets the requirements of Subsection II, the staff audits the environmental design and qualification files and records, and conducts a plant site review. For selected equipment, the staff reviews the test procedure and test results, and examines the equipment configuration and mounting, and then determines whether the test or analysis referenced demonstrates compliance with the established criteria. The staff may require that component evaluation worksheets for all equipment be submitted to the staff. After the audit, the applicant may be required to submit certain selected documents and reports for further staff review. If the staff has reviewed an applicant's environmental design and qualification files and records for a previous application, they may elect not to require the applicant to submit all the qualification summary data sheets, but instead elect to audit the environmental design and qualification files and records.

3. For new reactor license applications submitted under Part 52, the applicant is required (1) by 10 CFR 52.47(a)(21) to address the proposed technical resolution of unresolved safety issues (USIs) and medium- and high-priority generic safety issues (GSIs) that are identified in the version of NUREG-0933 current on the date 6 months before application and that are technically relevant to the design; (2) by 10 CFR 52.47(a)(22) to demonstrate how the operating experience insights have been incorporated into the plant design; and (3) by 10 CFR 52.47(a)(8) to provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v). These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding SER section.
4. For new applications, the 10 CFR 50.49(b)(3) requirement to qualify certain types of post-accident monitoring (PAM) equipment located in a harsh environment applies to those instruments identified as requiring such qualification based on the applicant's submittal and the NRC review thereof, including the review conducted under SRP Chapter 7, Chapter 11 and Chapter 12. The regulatory requirements in 10 CFR 50.49(b)(3) reference the guidance in Revision 4 to RG 1.97. Applicants and licensees may use later revisions of RG 1.97 when appropriate.
5. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including additional requirements (i.e., interface and site-specific information), specified in the design certification DCD/FSAR meets the acceptance criteria described in this SRP section. The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

Together with the review of SRP Section 3.9.6, the staff will conduct an audit of the procurement specifications for the environmental qualification of mechanical, electrical, and I&C equipment important to safety for compliance with 10 CFR 52.47.

6. For review of a COL application, the NRC staff confirms whether the COL applicant has incorporated by reference in its FSAR the provisions in the design certification DCD/FSAR for the capability of mechanical, electrical, and I&C equipment important to safety to perform their design functions under their applicable environmental conditions in compliance with the design criteria in 10 CFR Part 50, Appendix A. In addition, the staff reviews the requirements of the 10 CFR 50.49 environmental qualification program for certain electrical and I&C equipment important to safety located in harsh environments and the proposed implementation milestones. The staff also reviews environmental design and qualification provisions for nonmetallic parts of mechanical equipment for consistency with ASME QME-1-2007, Appendix QR-B as accepted in Revision 3 to RG 1.100 or the applicant's proposed alternative to satisfy the regulatory requirement. The staff also confirms that the COL application describes the EQ operational program consistent with this SRP section.
7. The reviewer verifies that the Environmental Qualification Program is fully described as specified in SECY-05-0197, and that implementation milestones have been identified. The reviewer verifies that the program and implementation milestones are included in FSAR Table 13.4-x and will be identified as a license condition.

Implementation of this program will be inspected in accordance with NRC Inspection Manual Chapter IMC-2504, "Construction Inspection Program - Non-ITAAC Inspections."

8. The reviewer verifies that consistent with 10 CFR 50.49(b)(1)(i) the required functional duration for equipment important to safety, have been described and that the associated bases, support the assumed function durations.

#### IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The staff concludes that the environmental design and qualification of mechanical, electrical and I&C equipment that are important to safety is acceptable and meets the relevant requirements of 10 CFR 50.49; 10 CFR Part 50, Appendix A, GDC 1, 2, 4, and 23; and 10 CFR Part 50, Appendix B, Quality Assurance Criteria III, XI, and XVII; with respect to systems and components being designed to withstand the effects of, and being capable of performing their safety function, in the environmental conditions associated with normal operation, maintenance, testing, and accident conditions.

This conclusion is based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that

mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program is in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of SRP Section 3.11.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

The applicant described the Environmental Qualification Program and its implementation in conformance with the relevant requirements of 10 CFR 50.49; 10 CFR Part 50, Appendix A, GDC 1, 2, 4, and 23; and 10 CFR Part 50, Appendix B, Quality Assurance Criteria III, XI, and XVII. Implementation milestones are contained in FSAR Table 13.4-x and will be addressed as a license condition.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

#### V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC, or COL, applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

Each plant is required to have complete environmental design and qualification records, including an environmental qualification file for 10 CFR 50.49 equipment, that demonstrate compliance with this review plan (or uses established bases for alternate requirements) before submittal of an OL application.

For COL applicants referencing a certified design, the staff will review specific details of the plant's environmental design and qualification program using the acceptance criteria and review procedures described in this SRP section.

#### VI. REFERENCES

1. American Society of Mechanical Engineers, ASME QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants."
2. Institute of Electrical And Electronics Engineers, IEEE Std 317-1983, "IEEE Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generation Stations."
3. Institute of Electrical And Electronics Engineers, IEEE Std. 323-1974 and 2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."

4. Institute of Electrical And Electronics Engineers, IEEE Std. 334-2006, "IEEE Standard for Qualifying Continuous Duty Class 1E Motors for Nuclear Power Generating Stations."
5. Institute of Electrical And Electronics Engineers, IEEE Std. 382-2006, "IEEE Standard for Qualification of Safety-Related Actuators for Nuclear Power Generating Stations."
6. Institute of Electrical And Electronics Engineers, IEEE Std 383-2003, "Standard for Type Test of Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations."
7. Institute of Electrical And Electronics Engineers, IEEE Std. 535-1986, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations."
8. Institute of Electrical And Electronics Engineers, IEEE Std. 572-2006, "IEEE Standard for Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations."
9. Institute of Electrical And Electronics Engineers, IEEE Std. 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."
10. U.S. *Code of Federal Regulations*, "Combustible Gas Control for Nuclear Power Reactors." § 50.44, Title 10, "Energy."
11. U.S. *Code of Federal Regulations*, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," § 50.49, Title 10, "Energy."
12. U.S. *Code of Federal Regulations*, Appendix A, General Design Criterion 1, "Quality Standards and Records"; General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena"; General Design Criterion 4, "Environmental and Dynamic Effects Design Bases"; and General Design Criterion 23, "Protection System Failure Modes," Part 50, Title 10, "Energy."
13. U.S. *Code of Federal Regulations*, "Design Control"; Criterion XI, "Test Control"; and Criterion XVII, "Quality Assurance Records," Part 50, Title 10, "Energy," Appendix B, Criterion III.
14. U.S. *Code of Federal Regulations*, "Contents of Applications; Technical Information." § 52.47, Title 10, "Energy."
15. U.S. *Code of Federal Regulations*, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," § 50.65, Title 10, "Energy."
16. U.S. *Code of Federal Regulations*, "Contents of Applications; Additional Technical Information." § 52.80, Title 10, "Energy."
17. U.S. Nuclear Regulatory Commission, NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment."



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