Proposed - For Interim Use and Comment

U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

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

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 control (I&C), including digital I&C) 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.

The review will be performed to assure conformance with the environmental design basis requirements of 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 4 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, GDCs 1, 2, and 23; 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 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. 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 review under this DSRS 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.

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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 and mechanical devices 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. The NRC regulations in Appendix A to 10 CFR Part 50 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 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 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.

In SRM-SECY-02-0067, "Inspections, Tests, Analyses, and Acceptance Criteria for Operational Programs (Programmatic ITAAC)," 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 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 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]." SECY-05-0197 includes the environmental qualification program as an operational program. Therefore, the description of the programs should 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.

In their FSARs, COL applicants have incorporated by reference the description of the environmental qualification program provided in the design control document (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 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 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 other DSRS sections.

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 DSRS section. Mechanical, electrical, and I&C equipment covered by this DSRS section include the following:

    A. Equipment associated with systems that are essential for emergency reactor shutdown, 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), and

    F. Certain post-accident monitoring equipment, as described in 10 CFR 50.49(b)(3) and Regulatory Guide 1.97.

2. Section 3.11 of the SAR 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. 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. For a combined license (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 for the site-specific environmental qualification for electrical, mechanical, and I&C equipment important to safety.

4. Operational Program Description and Implementation. The staff reviews the full description of the equipment 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.

5. 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 DSRS section in accordance with DSRS 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 DSRS 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 DSRS Section 14.3. The DCD Tier 1 should include ITAAC to verify the environmental qualification for important to safety mechanical, electrical, and instrumentation and control (I&C), including digital 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. For such ITAAC, the Design Commitment column should specify that mechanical, electrical, and I&C, including digital I&C equipment identified in the applicable Tier 1 table will be environmentally qualified such that each mechanical, electrical, and I&C, including digital 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. The Inspections, Tests, and Analyses column should specify that tests or type tests of the mechanical, electrical, and I&C, including digital I&C equipment listed in the applicable Tier 1 table will be conducted to demonstrate that the mechanical, electrical, and I&C, including digital 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. The Acceptance Criteria column should specify that a test report exists and concludes that the mechanical, electrical, and I&C, including digital I&C equipment listed in the applicable Tier 1 table will be conducted to demonstrate that the mechanical, electrical, and I&C, including digital 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. Applicable sections of the DCD Tier 1 should specify ITAAC to verify the environmental qualification for important to safety mechanical, electrical, and I&C, including digital 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.

6. 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.

7. Application of Risk Insights. The NRC regulations in 10 CFR 52.47(a)(27) and 52.79(a)(46) require DC and COL applicants, respectively, to submit a description of the plant-specific probabilistic risk assessment (PRA) and its results in their applications. As discussed in Part 2, "iPWR Design Pre-Application Activities and Application Reviews," of the Introduction to NUREG-0800, "Standard Review Plan," the NRC staff may incorporate risk insights into the review of DC and COL applications as described in this and other DSRS sections. When applying risk insights in its application review, the applicable NRO technical branch will focus its review on components important to safety categorized as having high risk significance. For components categorized as having low risk significance, the staff will rely on the applicant's certification of component qualification and programmatic requirements to provide reasonable confidence that the components satisfy their environmental design requirements, with confirmation of compliance with those regulatory requirements through ITAAC verification and inspection activities.

Review Interfaces

Other DSRS 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 DSRS Sections 6.2.1 through 6.2.6.

2. Review of the adequacy of the design, installation, inspection, and testing of the Reactor Core Isolation Cooling system, the Residual Heat Removal system, and the Emergency Core Cooling System, and the accident analysis is performed under DSRS Sections, 5.4.7, 6.3, and applicable sections of Chapter 15, respectively.

3. Review of the adequacy of the design, installation, inspection, and testing of I&C is performed under DSRS Chapter 7.

4. Review of the adequacy of the design, installation, inspection, and testing of electric power systems is performed under DSRS Chapter 8.

5. Review of the applicant's quality assurance (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.

6. Review of design basis radiological consequence analyses associated with design basis accidents is performed under DSRS Section 15.0.3.

7. The functional design and qualification of mechanical, electrical, and I&C equipment are addressed in several sections of DSRS Chapter 3. For example:

   A. DSRS Section 3.9.5 includes evaluation of potential adverse flow effects on mechanical and electrical equipment (such as electromatic relief valves in BWR steam systems) from pressure fluctuations and vibration caused by acoustic resonances and hydrodynamic forces.

   B. DSRS Section 3.9.6 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 and electrical equipment against natural phenomena and external events are reviewed under appropriate sections of DSRS Chapter 3 (e.g., 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). DSRS Section 3.10 includes seismic and dynamic qualification of mechanical and electrical 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 100% fuel-clad metal-water reaction, as stated in 10 CFR 50.44(c), is performed under DSRS Section 6.2.5.

9. For COL reviews of operational programs, the review of the applicant's implementation plan is performed under DSRS 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, 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 CFR 50.34(b)(3), 52.47(a)(5), 10 CFR 52.79(a)(3) and 10 CFR 52.157(e), are performed under DSRS Section 12.

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 combined license, 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: 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. 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, analyses, and maintaining all qualification records for the operational life of the plant. 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.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this

DSRS 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 DSRS 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, Regulatory Guide 1.89 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 Regulatory Guide 1.89. NUREG-0588 includes two sets of qualification criteria, Category I and Category II. Category I refers to IEEE Std 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations." Category I applies to plants whose construction permit (CP) SERs were dated after July 1, 1974. 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. Regulatory Guide 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 Regulatory Guide 1.89, as appropriate, for evaluating the environmental design and qualification of Continuous-Duty Class 1E Motors.

4. Regulatory Guide 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 Regulatory Guide 1.89, as appropriate, for evaluating the environmental design and qualification of electrical penetration assemblies.

5. Regulatory Guide 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 Regulatory Guide 1.89, as appropriate, for evaluating the environmental design and qualification of Class 1E electric valve operators.

6. Regulatory Guide 1.89, “Environmental Qualification of Certain Electric Equipment Important to Safety in Nuclear Power Plants,” 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. Regulatory Guide 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.

7. Regulatory Guide 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 DSRS section, as well as instruments and controls for the equipment described in Subsection I, Items 1(A) to 1(E), of this DSRS section. These criteria, as supplemented by those of Regulatory Guide 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 Regulatory Guide 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 Regulatory Guide 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 Regulatory Guide 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,” 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 Regulatory Guide 1.89, as appropriate, for evaluating the environmental qualification of Class 1E electric cables and field splices.

12. Regulatory Guide 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 Regulatory Guide 1.89, as appropriate, for evaluating the environmental qualification of Class 1E connection assemblies.

13. Regulatory Guide 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 Regulatory Guide 1.89, as appropriate, for evaluating the environmental qualification of lead storage batteries.

14. Regulatory Guide 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 Regulatory Guide 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 DSRS Chapter 7.

15. Regulatory Guide 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 Regulatory Guide 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, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," endorses, with some exceptions, 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., containment spray, 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 both mild and harsh environments in accordance with 10 CFR Part 50, Appendix A. In that 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, equipment located in a “mild” environment might be subjected to significant environmental conditions during normal plant operation that must be addressed in meeting the environmental design criteria in 10 CFR Part 50, Appendix A. The NRC regulations in 10 CFR 50.49 specify environmental qualification requirements to verify the design by test or a combination of test and analysis for certain electric equipment important to safety located in harsh environments.

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 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 or 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 accepted 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 shall 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 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.

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 or 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 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 guidance contained within RG 1.206 subsection C.I.3.11.5,the applicant should identify the 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. For exposure of organic components on engineered safety features (ESF) systems, the applicant should tabulate beta and gamma exposures separately for each item of equipment and list the average energy of each type of radiation. For 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.

Technical Rationale

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

1. Compliance with 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," requires that the applicant identify a list of electrical equipment and establish a program, as described therein, for qualifying electrical equipment important to safety located in a harsh environment.

   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), 52.47(a)(5), 10 CFR 52.79(a)(3) and 10 CFR 52.157(e) the applicant should

identify the 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 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 should list all assumptions used in the calculation.
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 and 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. 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 DSRS 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.

3. 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, tsunami, 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.

4. 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 for components important to safety to 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.

5. 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.

6. 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 should include provisions to ensure that appropriate quality standards are included in design documents and that deviations from established standards are controlled. A process should 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.

7. 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 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 DSRS 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.

8. 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.

9. 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 memo.

III. REVIEW PROCEDURES

For each area of review specified in subsection I of this DSRS section, the review procedure is identified below. These review procedures are based on the identified DSRS acceptance criteria. For deviations from these specific acceptance criteria, the staff should review the

applicant's evaluation of how the proposed alternatives to the DSRS criteria provide an acceptable method of complying with the relevant NRC requirements identified in subsection II.

1. Programmatic Requirements - In accordance with the guidance in NUREG – 0800 *"Introduction," Part 2* as applied to this DSRS Section, the staff will review the programs proposed by the applicant to satisfy the following programmatic requirements. If any of the proposed programs satisfies the acceptance criteria described in Subsection II, it can be used to augment or replace some of the review procedures. It should be noted that the wording of "to augment or replace" applies to nonsafety-related risk-significant SSCs, but "to replace" applies to nonsafety-related nonrisk-significant SSCs according to the "graded approach" discussion in NUREG-0800 "Introduction," Part 2. Commission regulations and policy mandate programs applicable to SSCs that include:

   A. Maintenance Rule SRP Section 17.6 (DSRS Section 13.4, Table 13.4, Item 17, Regulatory Guides 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." and RG 1.182; "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants".
   B. Quality Assurance Program SRP Sections 17.3 and 17.5 (DSRS Section 13.4, Table 13.4, Item 16).
   C. Technical Specifications (DSRS Section 16.0 and SRP Section 16.1) – including brackets value for DC and COL. Brackets are used to identify information or characteristics that are plant specific or are based on preliminary design information.
   D. Reliability Assurance Program (SRP Section 17.4).
   E. Initial Plant Test Program (Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants,"DSRS Section 14.2, and DSRS Section 13.4, Table 13.4, Item 19).
   F. ITAAC (DSRS Chapter 14).

2. 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.

3. 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 DSRS Chapter 7. The regulatory requirements in 10 CFR 50.49(b)(3) reference the guidance in Revision 4 to Regulatory Guide 1.97. Applicants and licensees may use later revisions of Regulatory Guide 1.97 when appropriate.

4. 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 DSRS 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, DSRS 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 DSRS 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.

5. 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 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 DSRS section.

6. 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."

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, General Design Criteria 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 DSRS 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 DSRS 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, General Design Criteria 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 DSRS section in performing safety evaluations of mPower™-specific design certification (DC), or combined license (COL), applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM- COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor (SMR) reviews including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™ -specific DC, or COL submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), "Contents of applications; technical information."

This regulation states, in part, that the application must contain "an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application." The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9) as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from

the DSRS, the staff will use the SRP as specified in 10 CFR 52.47(a)(9). Alternatively, the staff may supplement the DSRS section by adding appropriate criteria in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41), for COL applications.

VI. REFERENCES

1. 10 CFR 50.44, “Combustible Gas Control for Nuclear Power Reactors.”

2. 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."

3. 10 CFR Part 50, 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."

4. 10 CFR Part 50, Appendix B, Criterion III, "Design Control"; Criterion XI, "Test Control"; and Criterion XVII, "Quality Assurance Records."

5. 10 CFR 52.47, “Contents of Applications; Technical Information.”

6. 10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants."

7. 10 CFR 52.80, Contents of Applications; Additional Technical Information.

8. IEEE Std 317-1983 , "IEEE Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generation Stations," Institute of Electrical and Electronics Engineers (endorsed by Regulatory Guide 1.63).

9. IEEE Std. 323-1974 and 2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers (endorsed by Regulatory Guide 1.89 and NUREG 0588, and Regulatory Guide 1.209).

10. IEEE Std. 334-1971, "IEEE Trial-Use Guide for Type Tests of Continuous-Duty Class 1 Motors Installed Inside the Containment of Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers (endorsed by Regulatory Guide 1.40).

11. IEEE Std. 382-1972, "IEEE Trial-Use Guide for Type Test of Class 1 Electric Valve Operators for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers (endorsed by Regulatory Guide 1.73).

12. IEEE Std 383-2003, "Standard for Type Test of Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers (endorsed by Draft Regulatory Guide 1.211).

13. IEEE Std. 535-1986, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers (endorsed by Regulatory Guide 1.158).

14. IEEE Std. 572-1985, "IEEE Standard for Qualification of Class 1E Connection Assemblies for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers (endorsed by Regulatory Guide 1.156).

15. NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment."

16. NUREG-0718, "Licensing Requirements for Pending Applications for Construction Permits and Manufacturing License."

17. NUREG-0737, "Clarification of TMI Action Plan Requirements."

18. NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants."

19. NUREG-1503, “Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design.”

20. NUREG-1793, “Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design.”

21. Regulatory Guide 1.40, "Qualification Tests of Continuous-Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants" (this guide endorses IEEE Std. 334-1971).

22. Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Light Water Cooled Nuclear Power Plants" (this guide endorses IEEE Std 317-1983).

23. Regulatory Guide 1.73, "Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants" (this guide endorses IEEE Std 382-1972).

24. Regulatory Guide 1.89, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants" (this guide endorses IEEE Std 323-1974).

25. Regulatory Guide 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors.” Revision 4.

26. Regulatory Guide 1.211, “Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants (this guide endorses IEEE Std 383-2003)

27. Regulatory Guide 1.156, "Environmental Qualification of Connection Assemblies for Nuclear Power Plants" (endorses IEEE Std 572-1985).

28. Regulatory Guide 1.158, "Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants" (endorses IEEE Std 535-1986).

29. NRC Regulatory Guide 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,” Revision 2, March 1997. (Revision 2, ML003761662)

30. Regulatory Guide 1.180, “Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems.”

31. Regulatory Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.”

32. Regulatory Guide 1.209, “Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants.”

33. SECY-05-0197, “Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria.”

34. NRC Inspection Manual Chapter IMC-2504, “Construction Inspection Program - Non-ITAAC Inspections,” issued April 25, 2006.

35. Regulatory Guide 1.100 (Revision 3), “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants.”