U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

3.5.1.4 MISSILES GENERATED BY EXTREME WINDS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for review of the plant design for protection of structures, systems, and components from internal and external hazards

Secondary - Organization responsible for the review of meteorological data

I. AREAS OF REVIEW

Title 10 of the *Code of Federal Regulations* (CFR), Part 50, Appendix A, General Design Criterion (GDC) 2, "Design bases for protection against natural phenomena," requires structures, systems, and components (SSCs) important to safety shall be designed to withstand the effects of natural phenomena such as tornadoes and hurricanes without loss of capability to perform their safety functions. GDC 4, "Environmental and dynamic effects design bases," requires that SSCs important to safety be appropriately protected against the effects of missiles that may result from events and conditions outside the nuclear power unit.

The mPower™ integral pressurized-water reactor (iPWR) includes the deeply embedded concrete reactor building, underground steel containment, and fully protected spent fuel pool below the grade level. The safety-related and risk-significant SSCs inside these structures are generally protected from direct hit of missiles generated from extreme wind conditions. Although the direct hit probability is reduced, the review cannot be eliminated.

The specific areas of review are as follows:

1. The staff reviews and evaluates the applicant's assessment of possible hazards attributable to missiles generated by extreme winds, such as tornado, hurricane, and any other high speed winds identified in Section 3.5 of the final safety analysis report (FSAR), to ensure that the applicant has chosen and properly characterized appropriate design-basis missiles, and to ensure that the effects caused by those missiles are acceptable. Currently, missiles generated by design-basis tornadoes are considered in the plant design bases for all plants. Missiles from hurricane and other high speed winds are considered on a case-by-case basis when they are identified.

2. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the SSCs related to this design-specific review standard (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

ADAMS Accession No. ML12313A399

ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with DSRS Section 14.3.

3. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

   For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other DSRS sections interface with this section as follows:

1. Reviews of those SSCs that should be protected against missile impact are performed under DSRS Section 3.5.2, "Structures, Systems, and Components to be Protected from Externally-Generated Missiles", and SRP 19.3 "Regulatory Treatment of Non-Safety Systems for Passive Advanced Light Water Reactors."

2. The acceptability of the design analysis, procedures, and criteria used to establish the ability of seismic Category I structures and/or missile barriers to withstand the effects of tornado and hurricane missiles is reviewed under DSRS Section 3.5.3, "Barrier Design Procedures."

3. The acceptability of the design-basis tornado parameters, as well as maximum tornado and hurricane wind speed is reviewed under Standard Review Plan (SRP) Section 2.3.1, "Regional Climatology."

II. ACCEPTANCE CRITERIA

Requirements

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

1. GDC 2, "Design bases for protection against natural phenomena," of Appendix A to Title 10 of the *Code of Federal Regulations* (CFR), Part 50, requires SSCs important to safety shall be designed to withstand the effects of natural phenomena such as tornadoes and hurricanes without loss of capability to perform their safety functions.

2. GDC 4, "Environmental and dynamic effects design bases," of Appendix A to 10 CFR Part 50, requires that SSCs important to safety be appropriately protected against the effects of missiles that may result from events and conditions outside the nuclear power unit.

3. 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 DC has been constructed and will be operated in conformity with the DC,

the provisions of the Atomic Energy Act (AEA), and the U.S. Nuclear Regulatory Commission's (NRC's) regulations.

4. 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 AEA, and the NRC's regulations.

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 intent of 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.

1. Regulatory Guide (RG) 1.76 describes acceptable design-basis tornado-generated missile spectrum for the design of nuclear power plants.

2. RG 1.221 describes acceptable design-basis hurricane-generated missile spectrum for the design of nuclear power plants.

3. The method of identifying appropriate design-basis missiles generated by natural phenomena shall be consistent with the acceptance criteria defined for the evaluation of potential accidents from external sources in DSRS Section 2.2.3, "Evaluation of Potential Accidents." Other methodologies used by licensees and applicants with appropriate rationale may be acceptable on a case-by-case basis.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS section is discussed in the following paragraphs:

1. GDC 2 establishes requirements regarding the ability of SSCs important to safety to withstand the effects of natural phenomena without the loss of capability to perform their safety functions. The GDC 2 requirement that SSCs important to safety be designed to withstand the effects of the most severe of the natural phenomena that have been historically reported for the site and surrounding area is accounted for by considering the extreme environmental loads associated with the 10^{-7} per year design-basis tornado and hurricane specified in RG 1.76 and RG 1.221, respectively. Designing a nuclear power plant to withstand the design-basis tornado and hurricane wind speeds and missiles discussed in RG 1.76 and RG 1.221, ensures that SSCs important to safety will be capable of performing their safety function, and there will be no undue risk to the health and safety of the public in the event of extreme wind conditions. Evolutionary reactors should be designed based on regional wind speeds corresponding to strike probability of 10^{-7} per year, as defined in RG 1.76 and RG 1.221.

2. GDC 4 establishes requirements regarding the ability of SSCs important to safety to be protected from dynamic effects, including the effects of missiles, from events and conditions outside the nuclear unit. Tornadoes and hurricanes are dynamic events originating outside the nuclear unit; therefore, this criterion is applicable to the assessment of any missiles generated by extreme winds such as tornadoes and hurricanes. For safety considerations, nuclear power plant design must consider the impact of direct action of tornado wind and the moving ambient pressure field, as well as the impact of tornado generated missiles. Hurricane effects considered in the design should include combinations of hurricane wind effects and hurricane-generated missile impact effects. Protection from a spectrum of missiles exemplified by missiles with critical characteristics provides assurance that the necessary SSCs will be available to mitigate the potential effects of a tornado or hurricane on plant safety.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified DSRS acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. In accordance with 10 CFR 52.47(a)(8),(21), and (22), for new reactor license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues and medium- and high-priority generic safety issues 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) demonstrate how the operating experience insights have been incorporated into the plant design; and, (3) 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 safety evaluation report (SER) section.

2. DSRS Section 3.5.2, "Structures, Systems, and Components to be Protected from Externally-Generated Missiles" provide guidance on the identification of all the "SSCs subject to missile (externally-generated) protection."

3. The safety analysis report is reviewed for the identification of the design-basis natural phenomena that could possibly generate missiles. Postulated missiles are reviewed for proper characterization.

4. RG 1.76 provides guidance on the definition and characterization of the design-basis tornado as discussed in Subsection II.

5. RG 1.221 provides guidance on the definition and characterization of the design-basis hurricane as discussed in Subsection II.

6. The design-basis natural phenomena for the site are reviewed with respect to the potential for missile generation. For phenomena with greater potential for missile generation than the design-basis tornado or hurricane (i.e., initiating frequency is10^{-7} per year or greater), appropriate design-basis missiles are proposed.

7. All plants are required to be designed to protect SSCs subject to missile protection against damage from missiles, which might be generated by the design-basis tornado and hurricane for that plant. The reviewer verifies that the applicant has postulated missiles that include at least (1) a massive high-kinetic-energy missile that deforms on impact, (2) a rigid missile to test penetration resistance, and (3) a small rigid missile of a size sufficient to just pass through any openings in protective barriers. Acceptable missiles and their associated speeds are identified in Table 2 of RG 1.76, and Tables 1 and 2 of RG 1.221.

8. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the application as the design control document (DCD). 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.

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 SER. The reviewer also states the bases for those conclusions.

1. The basis for acceptance in the staff review is the conformance of the applicants' design criteria for the protection from the effects of natural phenomena to the Commission's regulations as set forth in the GDC, and to applicable regulatory guides and national standards.

2. The staff concludes that the assessment of possible hazards attributable to missiles generated by the design-basis tornado and hurricane and other extreme winds is acceptable and conforms to the requirements of GDC 2 and 4. This conclusion is based on the applicant having met the requirements of GDC 2 and 4 by meeting the guidance of RG 1.76, and RG 1.221.

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.

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), combined license (COL), or ESP 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 (Agencywide Documents Access and Management System Accession No. ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor 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, COL, or ESP applications 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 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 52.17 (a)(1)(xii) and 10 CFR 52.79 (a)(41), for ESP and COL applications, respectively.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases."

3. RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants."

4. RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants."