U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

3.5.1.4 MISSILES GENERATED BY TORNADOES AND EXTREME WINDS

REVIEW RESPONSIBILITIES

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

Secondary - None.

I. AREAS OF REVIEW

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 high-speed winds, such as tornado, hurricane, and any other extreme winds identified in Section 3.5 of the safety analysis report (SAR), 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 extreme 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 structures, systems, and components (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.

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 SRP sections interface with this section as follows:

1. Reviews of those SSCs that should be protected against missile impact is performed under Standard Review Plan (SRP) Section 3.5.2.

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 missiles is reviewed under SRP Section 3.5.3.

3. The acceptability of the design-basis tornado parameters, including maximum wind speed is reviewed under SRP Section 2.3.1.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

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

1. General Design Criterion (GDC) 2, “Design bases for protection against natural phenomena,” of Appendix A to 10 CFR Part 50, requires structures, systems, and components 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 inspections, tests, analyses, and acceptance criteria (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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the 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 combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's 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 acceptable methods of compliance with the NRC regulations.

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

2. 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 SRP Section 2.2.3. 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 SRP section is discussed in the following paragraphs:

1. GDC 2 establishes requirements regarding the ability of SSCs important to safety to withstand a tornado without the loss of capability to perform their safety functions. Application of GDC 2 ensures that the chosen design basis reflects the most severe tornadoes historically reported for the site and surrounding region. A nuclear power plant must remain in a safe condition in the event of the most severe tornadoes that can reasonably be predicted. Designing a nuclear power plant to withstand the design-basis

maximum tornado wind speed and tornado missiles discussed in RG 1.76 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 the most severe tornado 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.

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 are dynamic events originating outside the nuclear unit; therefore, this criterion is applicable to the assessment of any missiles generated by tornadoes. 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. 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 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 SRP 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. The SAR is reviewed for the identification of the design-basis natural phenomena that could possibly generate missiles. Postulated missiles are reviewed for proper characterization.

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

3. 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 (i.e., the probability per year of damage to the total of all SSCs important to safety is 10^{-7} per year or greater), appropriate design-basis missiles are proposed.

4. All plants are required to be designed to protect safety-related equipment against damage from missiles which might be generated by the design-basis tornado 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 wind speeds are identified in Table 2 of RG 1.76.

5. 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 FSAR 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, 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.

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.

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 General Design Criteria, 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 other extreme winds is acceptable and conforms to the requirements of GDC 2 and 4, as they relate to tornado-generated missiles. This conclusion is based on the applicant having met the requirements of GDC 2 and 4 by meeting the guidance of RG 1.76.

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.

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 applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, 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.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, “Design Bases for Protection Against Natural Phenomena.”

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, “Environmental and Dynamic Effects Design Bases.”

3. Regulatory Guide 1.76, “Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants.”