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NUREG-0800

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 ~~from~~ internal and external hazards

Secondary ~~—None—~~ Organization responsible for the review of meteorological data

I. AREAS OF REVIEW

Title 10 of the *Code of Federal Regulations* (10 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 to 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, in part, that SSCs important to safety be appropriately protected against dynamic effects, including missiles that may result from events and conditions outside the nuclear power unit.

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Draft Revision 4 – July 2013

USNRC STANDARD REVIEW PLAN

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

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

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The specific areas of review are as follows:

1. The staff reviews and evaluates the ~~applicant's~~ **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~~ **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.~~ **Missiles generated by design-basis tornadoes and hurricanes are considered in the plant design bases for all plants. Missiles from any other extreme winds are considered on a case-by-case basis when they are identified.** ~~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) ~~application reviews,~~ **the staff reviews the applicant's proposed ITAAC associated with the ~~structures, systems, and components (SSCs)~~ related to this Standard Review Plan (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 comply with or request~~ and

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Revision 3 - March 2007

USNRC STANDARD REVIEW PLAN

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~~restrictions~~ justify a departure from each requirement and restriction (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.~~ SRP Section 3.5.2, "Structures, Systems, and Components to be Protected from Externally-Generated Missiles" and Section 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~~-missiles generated from extreme wind is reviewed under SRP Section 3.5.3-, "Barrier Design Procedures."
3. The acceptability of the design-basis ~~tornado~~extreme wind parameters, including maximum wind speed is reviewed under SRP Section 2.3.1-—, "Regional Climatology."

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, in part, that 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, in part, 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. ~~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~~facility that incorporates the design certification is built and will operate in ~~accordance~~conformity with the ~~design-~~

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~~certification~~DC, the provisions of the Atomic Energy Act, (AEA), and the ~~NRC's~~ Commission's rules and regulations;

3. ~~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~~COL, the provisions of the ~~Atomic Energy Act~~AEA, and the ~~NRC's~~Commission's rules and regulations.

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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 ~~spectrums~~spectra for the design of nuclear power plants.
2. RG 1.221 describes acceptable design-basis hurricane-generated missile spectra for the design of nuclear power plants.
3. The method of identifying appropriate design-basis missiles generated by natural phenomena ~~shall~~should 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,~~ "Evaluation of Potential Accidents." A licensee or applicant may justify the acceptability of the use of another methodology 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~~the effects of natural phenomena without the loss of capability to perform their safety functions. ~~Application of~~With respect to wind and missile loads, the GDC 2 ~~ensures~~requirement that SSCs important to safety be designed to withstand the ~~chosen design basis reflects~~effects of the most severe ~~tornadoes~~natural phenomena that have been 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~~area is accounted for by considering the wind and missile 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 ~~maximum~~-tornado and hurricane wind ~~speeds~~ and ~~tornado~~ missiles discussed in RG 1.76 and RG 1.221 ensures that SSCs important to safety will be capable of performing their safety ~~function~~ functions, and there will be no undue risk to the health and safety of the public in the event of ~~the most severe tornado~~ these design-basis wind conditions. Evolutionary reactors should be designed based on regional wind speeds corresponding to strike probability of less than or equal to 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 that may result in dynamic effects, including the effects of missiles; therefore, this criterion ~~is applicable~~ applies to the assessment of ~~any~~ missiles generated by ~~tornadoes~~. For safety considerations, nuclear tornado and hurricane winds. 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 the critical characteristics set forth in RG 1.76 and RG 1.221 provides assurance that the necessary SSCs will be available to mitigate the potential effects of ~~a tornado~~ extreme winds and missiles associated with such winds on plant SSCs important to 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~~ applicant's analysis of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

4.—In accordance with 10 CFR 52.47(a)(8), (21), and (22), for an application for certification of a standard reactor design submitted under 10 CFR Part 52, the applicant is required to (1) 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), (2) 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; and (3) demonstrate how the operating experience insights have been incorporated into the plant design. 10 CFR 52.79(a)(17), (20), and (37) apply requirements identical to those of 10 CFR 52.47(a)(8), (21), and (22), respectively to applicants for COLs. 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.

1. SRP Sections 3.5.2 and 19.3 provide guidance on the identification of all “SSCs subject to missile (externally-generated) protection.”

2. 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.

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

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

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

47. 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~~. extreme winds for that plant. The wind and missile loadings derived from the extreme wind characteristics for the site form part of the facility design basis. 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, and Tables 1 and 2 of RG 1.221.

58. 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~~ Final Safety Analysis Report (FSAR) meets the acceptance criteria. ~~DCs~~DC rules 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. The reviewer should ensure that the DC applicant has chosen reasonable values for the extreme wind site parameters (i.e., values that are not restricted to a very small number of potential sites in the United States).

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).

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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

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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' determines whether 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 conform~~ to applicable regulatory guides and national standards, which, in turn, establishes compliance with the Commission's regulations as set forth in the GDC. Should the applicant choose design criteria that do not conform to applicable NRC guidance, the staff will determine whether the applicant has justified the use of such criteria as establishing compliance with the Commission's regulations.

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2. The staff concludes ~~that whether~~ 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.~~ If the applicant has followed the the guidance of RG 1.76, and RG 1.221, the staff may then conclude that the applicant has met the requirements of GDC 2 and 4 ~~by meeting the guidance of RG 1.76.~~

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For DC and COL reviews, the findings will also summarize the ~~staff's~~ 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~~ Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

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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** RG 1.76, “Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants.”

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4. **RG 1.221**, “Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants.”

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

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

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**SRP SECTION 3.5.1.4
Description of Changes**

Section 3.5.1.4 "MISSILES GENERATED BY EXTREME WINDS"

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Section 3.5.1.4 Revision 3, dated March 2007 of this SRP. See the Agencywide Documents Access and Management System (ADAMS) Accession No. ML070380174.

This section has been updated primarily to reflect new guidance for hurricane winds and associated missiles, from RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," (ADAMS, Accession No. ML110940300).

Technical changes incorporated in this revision include:

1. Changed title to simply extreme winds in order to keep broad and incorporate both tornados and hurricanes (this change is incorporated throughout this SRP Section).
2. Added meteorology as secondary organization.
- I. AREAS OF REVIEW
 1. Added general wording about applicable GDCs.
 2. Hurricanes were added as part of the plant design basis along with tornados based on the issuance of RG 1.221.
 3. Added reference to SRP Section 19.3 as an SRP interface.
- II. ACCEPTANCE CRITERIA
 1. RG 1.221, for hurricanes and hurricane missiles, was added under SRP acceptance criteria.
 2. Additional wording was added to ensure hurricanes are included in the review along with tornados.
- III. REVIEW PROCEDURES
 1. Generic wording was added to discuss important aspects of contents of application regulation.
 2. Additional clarifications were added to due new RG 1.221.
- IV. EVALUATION FINDINGS
 - 1, Reworded to more clearly set forth the logic behind the staff review.
- IV. REFERENCES
 1. One reference was added due to new guidance for design-basis hurricanes and hurricane missiles.

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