U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

3.3.1 WIND LOADS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of structural engineering

Secondary - None

I. AREAS OF REVIEW

The following areas are related to the design of structures that must withstand the effects of the specified design wind speed for the plant. These areas are reviewed to ensure conformance with 10 CFR 50, Appendix A, General Design Criterion (GDC) 2.

The specific areas of review are as follows:

1. The design wind speed, its recurrence interval, the speed variation with height, and the applicable gust factors from the standpoint of use in defining the input parameters for the structural design criteria appropriate to account for wind loadings.

2. The procedures that are used to transform the design wind speed into an equivalent pressure applied to structures are reviewed taking into consideration the geometrical configuration and physical characteristics of the structures and the distribution of wind pressure on the structures.

3. 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

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.

4. 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. The adequacy of the most severe regional and local meteorological data used to specify design wind load parameters for SSCs of the nuclear power plant that may be affected by weather phenomena is reviewed in accordance with SRP Sections 2.3.1 and 2.3.2.

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. 10 CFR 50, Appendix A, GDC 2 requires that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as tornados, hurricanes, tsunami without loss of capability to perform their safety functions as it relates to natural phenomena. The design bases for these SSCs shall reflect appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena.

2. 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 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;

3. 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. The wind used in the design shall be the most severe wind that has been historically reported for the site and surrounding area with sufficient margin for the limited accuracy, quantity, and period of time in which historical data have been accumulated.

2. The acceptance criteria for the design wind speed, its recurrence interval, the speed variation with height, the applicable gust factors, and the bases for determining these site-related parameters, are stated in SRP Sections 2.3.1 and 2.3.2. The approved values of these parameters should serve as basic input to the review and evaluation of the structural design procedures.

3. The procedures used to transform the wind speed into an equivalent pressure to be applied to structures and parts, or portions of structures, as delineated in American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) 7-05, "Minimum Design Loads for Buildings and Other Structures," are acceptable. In particular, the procedures used are acceptable if found in accordance with the following:

   A. For a design wind speed, V, the velocity pressure, q_z, evaluated at height, z, is given by:

   $$q_z = 0.00256\, K_z K_{dt} K_d V^2 I \ (lb/ft^2)$$

   where:

   K_z = velocity pressure exposure coefficient evaluated at height, z, as defined in ASCE/SEI 7-05, Table 6-3, but not less than 0.87

   K_{dt} = topographic factor equal to 1.0

   K_d = wind directionality factor equal to 1.0

   V = design wind speed in miles per hour (mi/h) as stated in SRP Section 2.3.1

   I = importance factor equal to 1.15

   B. For each wind direction considered, the upwind exposure category should be based on ground surface roughness that is determined from natural topography, vegetation, and constructed facilities. Surface roughness C is defined as open terrain with scattered obstructions having heights generally less than 30 ft. This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions. Because most nuclear power plants are located in relatively open country, K_z values in Table 6-3 should be selected from the

Exposure C column. The definition of Exposure C is provided in ASCE/SEI 7-05, Section 6.5.6.3.

C. Design wind loads should be determined in accordance with the following sections in ASCE/SEI 7-05, as applicable.

i. Section 6.5.12 – Design Wind Loads on Enclosed and Partially Enclosed Buildings

ii. Section 6.5.13 - Design Wind Loads on Open Buildings with Monoslope, Pitched, or Troughed Roofs

iii. Section 6.5.14 - Design Wind Loads on Solid Freestanding Walls and Signs

iv. Section 6.5.15 - Design Wind Loads on Other Structures

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. Compliance with GDC 2 requires that nuclear power plant SSCs important to safety shall 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 intended safety functions.

2. The acceptance criteria outlined above include reference to proven industry standards and data for evaluating wind loading on structures. These standards and data have been reviewed by and are acceptable to the staff.

3. Meeting the requirements of GDC 2 provides assurance that SSCs important to safety will withstand the most severe wind loads without loss of capability to perform their intended safety functions.

III. REVIEW PROCEDURES

The reviewer will select and emphasize 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 site-related parameters described in subsection I.1 are reviewed in accordance with SRP Sections 2.3.1 and 2.3.2. The staff reviewing structures examines these parameters to ensure that they are consistent with those contained in SRP Sections 2.3.1 and 2.3.2.

2. After the acceptability of the site-related parameters is established, the reviewer proceeds with the evaluation of the structural aspects of wind design. The procedures used by the applicant to transform wind speeds into equivalent

pressures are reviewed and compared with those procedures delineated in subsection II of this plan.

3. 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 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.

The applicant has met the requirements of GDC 2 with respect to the capability of the structures to withstand design wind loading so that their design reflects the following:

1. Appropriate consideration for the most severe wind recorded for the site with an appropriate margin;

2. Appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and

3. The importance of the safety function to be performed.

The applicant has designed the plant structures with sufficient margin to prevent structural damage during the most severe wind loadings that have been determined appropriate for the site so that the requirements in Item 1 listed above are met. The applicant has used methods provided in ASCE/SEI 7-05, which the staff reviewed and found acceptable, to transform the wind speed into an equivalent pressure on structures and to select pressure coefficients corresponding to the structure’s geometry and physical configuration.

The procedures used to determine the loadings on structures induced by the design wind speed specified for the plant are acceptable because these procedures have been used in the design of conventional structures and proven to provide an adequate basis which together with other engineering design considerations ensures that the structures will withstand such environmental forces. In addition, the design of seismic Category 1 structures, as required by Item 2 listed above, has included load combinations of the most severe wind load and the loads resulting from normal and accident conditions.

The use of these procedures provides reasonable assurance that in the event of design basis winds, the structural integrity of the plant structures that must be designed to resist the effects of the design wind speed will not be impaired and, in consequence, safety-related systems and components located within these structures are adequately protected and will perform their intended safety functions if needed, thus satisfying the requirement of Item 3 listed above.

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 docketed six months or more after the date of issuance of this SRP section, unless superceded 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. ASCE/SEI 7-05, "Minimum Design Loads for Buildings and Other Structures," American Society of Civil Engineers, Reston, Virginia, 2006.

SRP Section 3.3.1

Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in (Draft) Revision 3, dated April 1996 of this SRP. See ADAMS accession number ML052070299.

In addition this SRP section was administratively updated in accordance with NRR Office Instruction, LIC-200, Revision 1, "Standard Review Plan (SRP) Process." The revision also adds standard paragraphs to extend application of the updated SRP section to prospective submittals by applicants pursuant to 10 CFR Part 52.

The technical changes are incorporated in Revision 3, dated 2007:

1. The names and acronyms for the various branches appearing in (Draft) Revision 3 of this SRP section were removed.

2. Acceptance criteria in section II were revised to reflect wind load requirements provided in *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7/05. This standard updates the wind loading provisions in ANSI A58.1-1972 and ASCE Paper No. 3269 that were referenced in (Draft) Revision 3, dated April 1996 of this SRP.

3. The term "design wind velocity" used in (Draft) Revision 3, dated April 1996 of this SRP was replaced by the term "design wind speed" to be consistent with text in SRP Section 2.3.1.

Review Responsibilities - Reflects changes in review branches resulting from reorganization and branch consolidation. Change is reflected throughout the SRP.

I. AREAS OF REVIEW

a. Modified introductory paragraph to describe the scope and objectives of the review.

b. Added Areas of Review, subsections 3 and 4 to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

c. Removed the branch names and acronyms included in (Draft) Revision 3, dated April 1996 of this SRP.

d. Revised the first and last paragraphs in the Review Interfaces subsection to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

II. ACCEPTANCE CRITERIA

a. Added Requirements heading; introductory paragraph; and subsections 1, 2, and 3 to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

b. Removed the branch names and acronyms included in (Draft) Revision 3, dated April 1996 of this SRP.

c. Revised text, equations, and references in SRP Acceptance Criteria, Item 3 to reflect wind load requirements provided in *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7/05. This standard updates the wind loading provisions in ANSI A58.1-1972 and ASCE Paper No. 3269 that were referenced in (Draft) Revision 3, dated April 1996 of this SRP.

d. Added introductory paragraph to the Technical Rationale subsection to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

III. REVIEW PROCEDURES

a. Modified the introductory paragraphs to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

b. Removed the branch names and acronyms included in (Draft) Revision 3, dated April 1996 of this SRP.

c. Added Review Procedures, subsection 3 to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

IV. EVALUATION FINDINGS

a. Added introductory paragraph and last paragraph to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

b. Revised text to reflect wind load requirements provided in *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7/05. This standard updates the wind loading provisions in ANSI A58.1-1972 and ASCE Paper No. 3269 that were referenced in (Draft) Revision 3, dated April 1996 of this SRP.

V. IMPLEMENTATION

a. Modified text to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

VI. REFERENCES

a. Replaced ANSI A58.1-1972 (reference 2) and ASCE Paper No. 3269 (reference 3) in (Draft) Revision 3, dated April 1996 of this SRP with the current standard, ASCE/SEI 7-05, for minimum design loads.