



U.S. NUCLEAR REGULATORY COMMISSION  
**STANDARD REVIEW PLAN**  
OFFICE OF NUCLEAR REACTOR REGULATION

### 3.3.1 WIND LOADINGS

#### REVIEW RESPONSIBILITIES

Primary - ~~Structural Engineering Branch (SEB)~~Civil Engineering and Geosciences Branch (ECGB)<sup>1</sup>

Secondary - None

#### I. AREAS OF REVIEW

The following areas relating to the design of structures that have to withstand the effects of the design wind specified for the plant are reviewed to assure<sup>2</sup> conformance with the requirements of General Design Criterion 2 (GDC 2)<sup>3</sup> (Ref. 1).<sup>4</sup>

1. The design wind velocity, and its recurrence interval, the velocity variation with height,<sup>5</sup> and the applicable gust factors are reviewed from the standpoint of use in defining the input parameters for the structural design criteria appropriate to account for wind loadings. The bases for the selection and the values of these parameters are within the review responsibility of the Meteorology Section of the Accident Evaluation Branch (AEB) as stated in SRP Sections 2.3.1 and 2.3.2.<sup>6</sup>
2. The procedures that are utilized to transform the design wind velocity into an effective 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.

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#### USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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## Review Interfaces<sup>7</sup>

The bases for the selection and the values of the design wind velocity, design wind recurrence interval, wind velocity variation with height, and the applicable gust factors are within the review responsibility of the Emergency Preparedness and Radiation Protection Branch (PERB) as stated in Standard Review Plan (SRP) Sections 2.3.1 and 2.3.2.<sup>8</sup>

For those areas of review identified as part of the primary responsibility of other branches, the acceptance criteria and methods of application are contained in the referenced SRP section.<sup>9</sup>

## II. ACCEPTANCE CRITERIA

SEB The ECGB<sup>10</sup> accepts the design of structures that must withstand the effects of the design wind load if the relevant requirements of General Design Criterion 2 concerning natural phenomena are complied with. The criteria necessary to meet the relevant requirements of GDC 2 are as follows:

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 has been accumulated.
2. The acceptance criteria for the design wind velocity, and its recurrence interval, the velocity variation with height, the applicable gust factors, and the bases for determining these site-related parameters,<sup>11</sup> are established by the ~~Accident Evaluation Branch (AEB)~~ PERB<sup>12</sup> and are contained 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 utilized to transform the wind velocity into an effective pressure to be applied to structures and parts and portions of structures, as delineated in ANSI A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures" (Ref. 2) are acceptable. In particular, the procedures utilized are acceptable if found in accordance with the following:

For a design wind velocity of  $V_{30}$  mph specified at a height of 30 feet above the ground, the velocity pressure,  $q_{30}$ , is given by:

$$q_{30} = 0.00256 (V_{30})^2 \text{ psf}$$

The effective pressure for structures,  $q_f$ , and for portions thereof,  $q_p$ , at various heights above the ground should be in accordance with Table 5 and Table 6 of ANSI A58.1, respectively. Since most nuclear power plants are located in relatively open country, Exposure C as defined in ANSI A58.1, should be selected for both tables.

Depending upon the structure geometry and physical configuration, pressure coefficients may be selected in accordance with Section 6.4 of

ANSI A58.1. Geometrical shapes that are not covered in this document are reviewed on a case-by-case basis. ASCE Paper No. 3269, "Wind Forces on Structures," (Ref. 3)<sup>13</sup> may be used to obtain the effective wind pressures for cases which ANSI A58.1 does not cover.

### Technical Rationale<sup>14</sup>

The technical rationale for application of these acceptance criteria to reviewing compliance with GDC 2 is as follows:

Compliance with GDC 2 requires that nuclear power plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their intended safety functions.

The acceptance criteria outlined above includes 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.

Meeting the requirements of GDC 2 provides assurance that structures, systems, and components important to safety will withstand the most severe wind loads likely to occur without loss of capability to perform their intended safety functions.<sup>15</sup>

### III. REVIEW PROCEDURES

The reviewer selects and emphasizes material from the review procedures described below as may be appropriate for a particular case.

1. The site-related parameters described in subsection I.1 are reviewed by the ~~Accident Evaluation Branch (AEB)~~ PERB<sup>16</sup> under SRP Sections 2.3.1 and 2.3.2. The structural reviewer examines the ~~approved values of~~ forces and loads that the applicant derives from<sup>17</sup> these parameters to ~~assure~~ ensure<sup>18</sup> that they are consistent ~~with those contained in SRP Sections 2.3.1 and 2.3.2.~~<sup>19</sup>
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 velocities into effective pressures are reviewed and compared with those procedures delineated in subsection II of this plan.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.<sup>20</sup>

#### IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided to satisfy the requirements of this SRP section, and concludes that his the<sup>21</sup> evaluation is sufficiently complete and adequate to support the following type of conclusive statement to be included in the staff's safety evaluation report (SER):<sup>22</sup>

The staff concludes that the plant design is acceptable and meets the requirements of General Design Criterion 2. This conclusion is based on the following:

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—

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.

<sup>23</sup>The applicant has met these requirements by using ANSI A58.1 and ASCE paper No. 3269, which the staff has reviewed and found acceptable;. The methods and data provided in these documents were used to transform the wind velocity into an effective pressure on structures and for selecting<sup>24</sup> to select pressure coefficients corresponding to the structures geometry and physical configuration.

<sup>25</sup>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 of Item 1 listed above are met. In addition, the design of seismic Category 1 structures, as required by Item 2 listed above, has included in an acceptable manner load combinations which occur as a result of the most severe wind load and the loads resulting from normal and accident conditions.

<sup>26</sup>The procedures used to determine the loadings on structures induced by the design wind specified for the plant are acceptable since these procedures have been used in the design of conventional structures and proven to provide a conservative basis which together with other engineering design considerations assures<sup>27</sup> that the structures will withstand such environmental forces. The use of these procedures provides reasonable assurance that in the event of design basis winds, the structural integrity of the plant structures that have to be designed for the design wind 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 design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections,

tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.<sup>28</sup>

## V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.<sup>29</sup> Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of 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.<sup>30</sup>

## VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."
2. ANSI A58.1-1972<sup>31</sup>, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," Committee A58.1, American National Standards Institute.<sup>32</sup>
3. ASCE Paper No. 3269, "Wind Forces on Structures," Final Report, Task Committee on Wind Forces, Committee on Loads and Stresses, Structural Division,<sup>33</sup> Transactions of the American Society of Civil Engineers, Vol. 126, Part II (1961).

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**SRP Draft Section 3.3.1**  
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current primary review branch designation and abbreviation	Deleted "Structural Engineering Branch (SEB)" and substituted "Civil Engineering and Geosciences Branch (ECGB)."
2.	Editorial	Substituted "ensure" for "assure."
3.	Editorial	Provided "GDC 2" as initialism for General Design Criterion.
4.	SRP-UDP format item	Deleted unnecessary reference callout.
5.	Editorial	Added commas and deleted the word "and" to appropriately punctuate a list of items.
6.	SRP-UDP format item	Deleted sentence referring to review interface branch responsibility. This information is updated and presented in the new "Review Interfaces" subsection included in the text that follows.
7.	SRP-UDP format item	Added "Review Interfaces" subsection to AREAS OF REVIEW.
8.	SRP-UDP format item	Added a description of the review interface branch adapted from information previously provided in this section and updated review interface branch designation and abbreviation.
9.	Editorial	Added standard paragraph on review interfaces between PRBs.
10.	Current primary review branch abbreviation	Deleted "SEB" and substituted "The ECGB."
11.	Editorial	Added commas and deleted the word "and" to appropriately punctuate a list of items in the sentence.
12.	Current review interface branch abbreviation	Deleted "Accident Evaluation Branch (AEB)" and substituted "PERB" (as defined previously).
13.	SRP-UDP format item	Deleted unnecessary reference callout.
14.	SRP-UDP format item	Added "Technical Rationale" under ACCEPTANCE CRITERIA in accordance with new standard format.
15.	SRP-UDP format item	Added technical rationale for GDC 2.
16.	Current review interface branch abbreviation	Deleted "Accident Evaluation Branch (AEB)" and substituted "PERB" (as defined previously).
17.	Editorial	Deleted "approved values of" and substituted "forces and loads that the applicant derives from" in the sentence to clarify the structural reviewers responsibility.

**SRP Draft Section 3.3.1**  
Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
18.	Editorial	Substituted "ensure" for "assure."
19.	Editorial	Deleted the phrase "with those contained in SRP Sections 2.3.1 and 2.3.2" at the end of the sentence to clarify the structural reviewers responsibility.
20.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
21.	Editorial	Modified to eliminate gender-specific pronoun.
22.	Editorial	Provided "SER" as initialism for "safety evaluation report."
23.	Editorial	Indented paragraph to show that it is part of standard evaluation finding.
24.	Editorial	Deleted the word "has," which is redundant. Split sentence in two and revised wording for clarification and accuracy.
25.	Editorial	Indented paragraph to show that it is part of standard evaluation finding.
26.	Editorial	Indented paragraph to show that it is part of standard evaluation finding.
27.	Editorial	Substituted "assures" for "ensures."
28.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
29.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
30.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
31.	<b>Integrated Impact 1469</b>	Added the applicable version date to the reference for ANSI A58.1.
32.	Integrated Impact No. 521	This is a placeholder integrated impact. Consideration should be given to updating the cited version of ANSI A58.1, to the latest version, ANSI/ASME 7-88.
33.	Editorial	Cited authors of paper.



**SRP Draft Section 3.3.1**  
Attachment B - Cross Reference of Integrated Impacts

<b>Integrated Impact No.</b>	<b>Issue</b>	<b>SRP Subsections Affected</b>
521	Update citation of ANSI A58.1 to the current version (ANSI/ASCE 7-88).	This is a placeholder integrated impact and will not be processed further.
1469	Update the citation of ANSI A58.1 to cite the 1972 version.	REFERENCES