



U.S. NUCLEAR REGULATORY COMMISSION

# STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

## 2.3.1 REGIONAL CLIMATOLOGY

### REVIEW RESPONSIBILITIES

Primary - ~~Accident Evaluation Branch (AEB)~~ Emergency Preparedness and Radiation Protection Branch (PERB)<sup>1</sup>

Secondary - None

### I. AREAS OF REVIEW

Information for a construction permit (CP), operating license (OL), combined license (COL), standard design certification, or early site permit<sup>2</sup> is presented by the applicant and reviewed by the staff concerning averages and extremes of climatic conditions and regional meteorological phenomena which affect the safe design and siting of the plant. The review covers the following specific areas:

1. A description of the general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems and frontal systems), general airflow patterns (wind direction and speed), temperature and humidity, precipitation (rain, snow, and sleet), and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions.
2. Seasonal and annual frequencies of severe weather phenomena, including tornadoes, waterspouts, thunderstorms, lightning, hail (including probable maximum size), and high air pollution potential.
3. Meteorological conditions used as design and operating bases, including:

DRAFT Rev. 3 - April 1996

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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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- a. The maximum snow and ice load (water equivalent) that the roofs of safety-related structures must be capable of withstanding during plant operation.
- b. Ultimate heat sink meteorological conditions resulting in maximum evaporation and drift loss of water and minimum water cooling.
- c. Tornado parameters, including translational speed, rotational speed, and the maximum pressure differential with the associated time interval.
- d. Hundred-year return period "fastest mile of wind," including vertical velocity distribution and gust factor.
- e. Probable maximum annual frequency of occurrence and time duration of freezing rain (ice storms) and, where applicable, dust (sand) storms.
- f. Maximum rainfall rate.<sup>3</sup>
- g. Other meteorological and air quality conditions used for design and operating basis considerations.

For a design certification review, the relevant information listed above should be in the site parameter envelope that must be met by the plant design.<sup>4</sup>

#### Review Interfaces<sup>5</sup>

The reviewer provides findings on meteorological parameters to the Civil Engineering and Geosciences Branch (ECGB) and other branches, as necessary, to review whether structures, systems, and components important to safety are adequately designed.<sup>6</sup> The ECGB, under SRP Section 2.3.6 (proposed), reviews the adequacy of the site parameter envelope specified in standard design certification applications.<sup>7</sup>

## II. ACCEPTANCE CRITERIA

The information regarding the regional meteorological conditions and phenomena which that affect the safe design and siting of the plant may be expressed as actual measured values for CP, OL, COL, or early site permit licensing actions or as part of the site parameter envelope for a standard design certification. The information<sup>8</sup> is acceptable if it meets the requirements of the following regulations:

1. 10 CFR Part 50, Appendix A, General Design Criterion 2 (GDC 2), "Design Bases for Protection Against Natural Phenomena," with respect to information on severe regional weather phenomena that have historically been reported for the region and that are reflected in the design bases for structures, systems, and components important to safety;
2. 10 CFR Part 50, Appendix A, General Design Criterion 4 (GDC 4), "~~Environmental Missile Design Bases~~" "Environmental and Dynamic Effects Design Bases,"<sup>9</sup> with respect to information on tornadoes that could generate missiles; and

3. ~~10 CFR Part 100, §~~<sup>10</sup> 100.10(c), with respect to the consideration that has been given to the regional meteorological characteristics of the site.

The information should be presented and substantiated in accordance with acceptable practice and data as promulgated by the National Oceanic and Atmospheric Administration (NOAA), industry standards, and regulatory guides.

Regulatory positions and specific criteria necessary to meet the Commission's regulations identified above are as follows:

1. The description of the general climate of the region should be based on standard climatic summaries compiled by NOAA (Refs. 7, 8). Consideration of the relationships between regional synoptic-scale atmospheric processes and local (site) meteorological conditions should be based on appropriate meteorological data (Refs. 8, 9).
2. Data on severe weather phenomena should be based on standard meteorological records from nearby representative National Weather Service (NWS), military, or other stations recognized as standard installations which have long periods on record. The applicability of these data to represent site conditions during the expected period of reactor operation must be substantiated (Refs. 8, 9, 10).
3. Design basis tornado parameters should be based on Regulatory Guide 1.76 ~~(Ref. 8)~~ (Reference 11). New applicants may utilize a maximum tornado wind speed, used in the evaluation of missiles generated by the design basis tornado, of at least 482 km/hr (300 mph) in lieu of the guidance on tornado wind speeds contained in Regulatory Guide 1.76 (see References 5 and 6).<sup>11</sup>
4. Operating basis wind velocity (fastest mile of wind) should be based on the standard published by the American National Standards Institute (ANSI), with suitable corrections for local conditions (Ref. 13).
5. The ultimate heat sink meteorological data, as stated in Regulatory Guide 1.27, should be based on long-period regional records which represent site conditions.
6. Freezing rain estimates should be based on representative NWS station data.
7. Estimates of maximum rainfall rate should be based on representative NWS station data.<sup>12</sup>
8. High air pollution potential information should be based on U.S. Environmental Protection Agency (EPA) studies (Refs. 15, 16).
9. All other meteorological and air quality data used for safety-related plant design and operating bases should be documented and substantiated.

## Technical Rationale<sup>13</sup>

The technical rationale for application of these acceptance criteria is discussed in the following paragraphs:<sup>14</sup>

1. 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 earthquake, tornado, hurricane, flood, tsunami, or seiche without loss of capability to perform their safety functions.

To ensure that the nuclear plant is designed to withstand specified natural phenomena associated with the meteorology of the region in which the nuclear plant is to be sited, it is necessary to specify the most severe meteorological event that may occur as a function of frequency of occurrence. Thus, historical data must be obtained from regional observation of snow and ice load; meteorological conditions affecting the ultimate heat sink; tornado parameters; wind speed; rainfall and freezing rain; and dust, sand, and atmospheric pollution. To meet GDC 2 requirements for all meteorological phenomena, historical data is used to determine the expected frequency with which the most severe conditions occur. These data are then used to specify plant design requirements for a CP, OL, COL, or early site permit or for the site parameter envelope in the case of a standard design certification, thereby ensuring that components will continue to function as required.

Meeting these requirements will provide assurance that equipment and structures will be designed to withstand the effects of natural phenomena, thus minimizing the probability that climatology-related natural phenomena will initiate an accident or prevent safety systems from performing their intended functions.<sup>15</sup>

2. Compliance with GDC 4 requires that structures, systems, and components important to safety be designed to accommodate the effects of, and be compatible with, environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. The criterion also requires that such structures, systems, and components be appropriately protected against dynamic effects, including missiles.

For this Standard Review Plan section, the requirements of GDC 4 are imposed on facility structures and other components that may be subject to tornado-generated missiles. Tornado missiles could cause loss of function for some safety-related structures or components, thus compromising the safety of the nuclear plant.

Meeting these requirement will provide assurance that tornado-generated missiles will not result in loss of function for safety-related portions of the nuclear plant.<sup>16</sup>

3. 10 CFR 100.10(c)(2) specifies that meteorological conditions at or near the site should be considered when evaluating the acceptability of proposed sites for nuclear power plants.

The requirement to consider meteorological conditions at or near the site of a proposed nuclear power plant is imposed to provide assurance that these conditions will not

compromise the safety of the nuclear plant. Accordingly, plants must be designed to withstand the effects of all forms of severe weather historically associated with the proposed site, including the effects of snow, ice, rain, high winds, tornadoes, dust, sand, and any other meteorological condition that may affect the safe operation of the plant.

Meeting this requirement provides assurance that severe weather conditions will not compromise the safety of the proposed nuclear power plant.<sup>17</sup>

### III. REVIEW PROCEDURES

The procedures outlined below are used during CP or COL reviews to determine whether meteorological data and analyses for the proposed site meet the acceptance criteria given in subsection II of this Standard Review Plan (SRP) section. For reviews of OL applications, these procedures are used to verify that the meteorological data and analyses remain valid and that the facilities' design specifications are consistent with these data. An OL review includes a determination that the content and intent of technical specifications related to continued meteorological surveillance are acceptable and that they consider any unique meteorological conditions identified.<sup>18</sup>

#### 1. General Climate

The general climatic description of the region in which the site is located is reviewed for completeness and authenticity. Climatic parameters such as air masses, general airflow, pressure patterns, frontal systems, and temperature and humidity conditions reported by the applicant are checked against standard references (Refs. 7 and 8) for appropriateness with respect to location and period of record.

The applicant's description of the role of synoptic-scale atmospheric processes on local (site) meteorological conditions is checked against the descriptions provided in References 8 and 9.

#### 2. Regional Meteorological Averages and Extremes

Since meteorological averages and extremes can only be obtained from stations in the region of the site which have long periods of record, and the stations are not usually very close to the site, a determination of the representativeness of the data to site conditions is the primary concern in the review. A determination of the adequacy of the stations and their data is also made.

Recorded meteorological averages and extremes are checked against standard publications such as Reference 9. Snow and ice load adequacy is checked for reasonableness against ANSI A58.1-1972<sup>19</sup> and regional data available in References 8, 9, and 10. References 8 and 9 provide information on other averages and extremes. References 15 and 16 provide information on high air pollution potential for verification. Extreme winds and the specific vertical velocity distribution are checked against References 12 and 13. Gust factors are checked against Reference 12. The design basis tornado parameters are checked for agreement with Regulatory Guide 1.76 (~~Ref. 8~~)<sup>20</sup> and

tornado data are verified using the procedures and data in WASH-1300 (Ref. 14)(Reference 17). For new applications, the design basis maximum tornado wind speed should be at least 482 km/hr (300 mph). Information regarding the use of this maximum wind speed in lieu of the guidance contained in Regulatory Guide 1.76 is documented in SECY 93-087 and its associated SRM.<sup>21</sup>

~~The reviewer provides the findings on meteorological parameters to the Structural Engineering Branch and other branches as necessary for review of the adequacy of the design of structures, systems, and components important to safety.<sup>22</sup>~~

### 3. Early Site Permit Reviews

10 CFR Part 52 specifies the requirements and procedures applicable to the Commission's issuance of early site permits for approval of a proposed site. Information required for an early site permit includes the number, type, and thermal power level of the facilities for which the site may be used; the types of cooling systems used; and a description of the meteorological characteristics of the proposed site. For an early site permit, the scope and level of detail for reviewing meteorological data parallel those used for a CP review.<sup>23</sup>

### 4. Standard Design Certification Reviews

For standard design certification reviews, site-related meteorological parameters must be identified in the site parameter envelope. These parameters should be representative of credible meteorological characteristics. The reviewer verifies that meteorological parameters in the site parameter envelope are consistent with the acceptance criteria given in subsection II of this SRP section.

For an application referencing a certified standard design, measured site-related meteorological parameters for the proposed site should be consistent with those identified in the site parameter envelope included in the standard design certification application.<sup>24</sup>

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>25</sup>

## IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that his evaluation supports concluding statements of the following type to be included in the staff's safety evaluation report:

The staff has reviewed available information relative to the regional meteorological conditions of importance to the safe design and siting of this plant. The staff concludes that the identification and consideration of the meteorological characteristics at the site and in the surrounding area are acceptable and meet the requirements of 10 CFR ~~Part 100~~, §100.10(c)(2) with respect to determining the acceptability of the site. This conclusion is based on the presentation and substantiation of the meteorological information in accordance with acceptable standard practice as promulgated by the National Oceanic and Atmospheric Administration and in industry standards identified in the references hereto and includes the ultimate heat sink meteorological data as stated in Regulatory Position 1.b of Regulatory Guide 1.27.

The staff concludes that the identification and consideration by the applicant of the severe regional weather phenomena at the site and the surrounding area are acceptable and meet the requirement of 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," with respect to establishing the design bases for structures, systems, and components important to safety. This conclusion is based on the presentation and substantiation of the severe regional weather phenomena in accordance with acceptable standard practice as promulgated by the National Oceanic and Atmospheric Administration and in industry standards identified in the references hereto.

The staff concludes that the identification and consideration of tornadoes are acceptable and meet the requirements of 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases," with respect to determining the design basis tornado for the generation of missiles. This conclusion is based on the applicant's conformance with the position set forth in Regulatory Guide 1.76 or, for new applicants, utilization of a maximum tornado wind speed of at least 482 km/hr (300 mph).<sup>26</sup>

This statement should be preceded by a resume of the general climate and the meteorological design parameters used for the plant.

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>27</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>28</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>29</sup>

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

## 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 Missile Design Bases."
3. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."<sup>30</sup>
4. 10 CFR ~~Part 100, Section~~ 100.10(c)(2).
5. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, April 2, 1993."<sup>31</sup>
6. Staff Requirements Memorandum, "SECY-93-078 - Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," dated July 21, 1992.<sup>32</sup>
7. U.S. Department of Commerce, "Climatic Atlas of the United States," Environmental Data Service, NOAA, June 1968.
8. U.S. Department of Commerce, "Local Climatological Data - Annual Summary with Comparative Data," Environmental Data Service, NOAA, published annually for all first-order NWS stations.
9. U.S. Department of Commerce, "State Climatological Summary," Environmental Data Service, NOAA, published annually by State.
10. U.S. Department of Commerce, "Storm Data," Environmental Data Service, NOAA, published monthly.
11. Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants."
12. ANSI A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," American National Standards Institute (1972).
13. H. C. S. Thom, "New Distribution of Extreme Winds in the United States," Journal of the Structural Division, Proceedings of the American Society of Civil Engineers, pp. 1787-1801, July 1968.



14. Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants."
15. G. C. Holzworth, "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States," AP-101, Office of Air Programs, USEPA, January 1972.
16. J. Korshover, "Climatology of Stagnating Anticyclones East of the Rocky Mountains, 1936-1970," Publication No. 99-AP-34, Public Health Service, October 1971.
17. E. H. Markee, Jr., et al., "Technical Basis for Interim Regional Tornado Criteria," WASH-1300, USAEC, May 1974.

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**SRP Draft Section 2.3.1**  
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 PRB name and abbreviation                | Changed PRB to Emergency Preparedness and Radiation Protection Branch (PERB).  |
| 2.   | Integrated Impact No. 227                        | Identified the different types of review, including standard design certification.   |
| 3.   | Integrated Impact No. 227                        | Added maximum rainfall rate to site parameter envelope components.   |
| 4.   | Integrated Impact No. 227                        | Identified site parameter envelope needed for standard design certification.   |
| 5.   | SRP-UDP format item                              | Added "Review Interfaces" to AREAS OF REVIEW.  |
| 6.   | SRP-UDP format item                              | Relocated review interfaces paragraph deleted from REVIEW PROCEDURES, paragraph 6.   |
| 7.   | Integrated Impact 227                            | Included a review interface to new SRP section 2.3.6 for review of DC site parameter envelope.   |
| 8.   | Integrated Impact No. 227                        | Identified types of application reviews considering actual site parameters and provided for site parameter envelope for standard design certification.   |
| 9.   | Editorial  | Provided correct GDC title.  |
| 10.  | Editorial  | Provided correct citation format for the Code of Federal Regulations (global change for this section).   |
| 11.  | <b>Integrated Impact 226</b>                     | Added a specific criterion that new applicants may use a design basis max tornado wind speed of 482 km/hr (300 mph). This position, which is from SECY 93-087, is applicable to new applicants only based on current SRP-UDP guidance. |
| 12.  | Integrated Impact No. 227                        | Added maximum rainfall rate to design parameters.  |
| 13.  | SRP-UDP format item, develop technical rationale | Added "Technical Rationale" to ACCEPTANCE CRITERIA and used numbered paragraphs to describe the bases for referencing the regulations.   |
| 14.  | SRP-UDP format item, develop technical rationale | Added lead-in sentence for "Technical Rationale."  |
| 15.  | SRP-UDP format item, develop technical rationale | Added technical rationale for GDC 2.   |
| 16.  | SRP-UDP format item, develop technical rationale | Added technical rationale for GDC 4.   |
| 17.  | SRP-UDP format item, develop technical rationale | Added technical rationale for 10 CFR 100.10(c)(2).   |

**SRP Draft Section 2.3.1**  
Attachment A - Proposed Changes in Order of Occurrence

| Item | Source   | Description   |
|------|--|---|
| 18.  | SRP-UDP format item                                      | Added paragraph to differentiate between the CP or COL and the OL review.   |
| 19.  | Integrated Impact No. 225 Update Code or Standard        | The reference to ANSI A58.1-1972 needs to be updated to ANSI ASCE-7-1988, provided a comparison of the two versions by the staff supports the update of the citation.   |
| 20.  | Editorial, SRP-UDP guidance                              | RGs do not need a reference citation.   |
| 21.  | <b>Integrated Impact 226</b>                             | Added a sentence to Review Procedures allowing new applicants to use a 482 km/hr (300mph) design basis tornado wind speed.  |
| 22.  | Editorial, SRP-UDP Guidance                              | Relocated this statement to Areas of Review, Review Interfaces.   |
| 23.  | SRP-UDP format item                                      | Added paragraph to identify scope of early site review.   |
| 24.  | Integrated Impact No. 227                                | Added paragraphs to identify requirements of a site parameter envelope for a standard design certification and for an OL/COL applicant referencing a certified design.  |
| 25.  | SRP-UDP Guidance, Implementation of 10 CFR 52            | Added standard paragraph to address application of Review Procedures in design certification reviews.   |
| 26.  | <b>Integrated Impact 226</b>                             | Added a sentence to Evaluation Findings noting that new applicants should use a maximum tornado wind speed of at least 482 km/hr (300mph).  |
| 27.  | 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. |
| 28.  | 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.  |
| 29.  | SRP-UDP Guidance   | Added standard paragraph to indicate applicability of this section to reviews of future applications.   |
| 30.  | Integrated Impact No. 227                                | Added reference to 10 CFR Part 52 and renumbered subsequent reference.  |
| 31.  | Integrated Impact No. 226                                | Added reference to SECY 93-087.   |
| 32.  | Integrated Impact No. 226                                | Added reference to SRM dated July 21, 1993, and renumbered subsequent references.   |

**SRP Draft Section 2.3.1**  
Attachment B - Cross Reference of Integrated Impacts

| <b>Integrated Impact No.</b> | <b>Issue</b>   | <b>SRP Subsections Affected</b>  |
|------------------------------|--|--|
| 225                          | Update the reference to ANSI A58.1 to its current version.   | No changes were made to SRP Section 2.3.1.   |
| 226                          | Revise SRP to incorporate new staff position on design basis tornado wind loadings, as recommended in SECY-93-087 and approved in SRM dated July 21, 1993.   | Subsection II, Acceptance Criteria, third paragraph, subparagraph 3.<br><br>Subsection III, Review Procedures, paragraph 2, second paragraph.<br><br>Subsection IV, Evaluation Findings, third paragraph<br><br>Subsection VI, References, Reference 5.<br><br>Subsection VI, References, Reference 6.   |
| 227                          | Revise SRP Section 2.3.1 to reflect site parameter-related requirements of 10 CFR 52, for applications referencing a standard plant design.  | Subsection I, AREAS OF REVIEW, first paragraph, subparagraph 3.f, and second paragraph.<br><br>Subsection I, AREAS OF REVIEW, Review Interfaces<br><br>Subsection II, ACCEPTANCE CRITERIA, first paragraph, and third paragraph item 7.<br><br>Subsection III, REVIEW PROCEDURES, subparagraph 4.<br><br>Subsection VI, REFERENCES, Reference 3. |
| 1190                         | Revise the Acceptance Criteria, Review Procedures, and Evaluation Findings as necessary to incorporate the guidance of the proposed draft Regulatory Guide RS 705-4.   | No changes to the SRP, pending issuance of final RG.   |
| 1260                         | Revise the Acceptance Criteria, Review Procedures, and Evaluation Findings as necessary to incorporate the guidance of the proposed draft Regulatory Guide DG-4004 (previously DG-4003) (proposed revision 2 to RG 4.7). | No changes to the SRP, pending issuance of final RG.   |