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MFN 06-206

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 37 Related to ESBWR Design Certification Application – Siting Issues, Hydrological Engineering – RAI Numbers 2.1-1, 2.2-1 through 2.2-3, 2.3-1 through 2.3-6, 14.3-22, 15.3-1, 15.3-3, and 2.4-32**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

If you have any questions about the information provided here, please let me know.

Sincerely,

/Kathy Sedney for

David H. Hinds
Manager, ESBWR

D008

Reference:

1. MFN 06-201, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 37 Related to ESBWR Design Certification Application,* June 21, 2006

Enclosure:

1. MFN 06-206 – Response to Portion of NRC Request for Additional Information Letter No. 37 Related to ESBWR Design Certification Application – Siting Issues, Hydrological Engineering – RAI Numbers 2.1-1, 2.2-1 through 2.2-3, 2.3-1 through 2.3-6, 14.3-22, 15.3-1, 15.3-3, and 2.4-32

cc:

WD Beckner	USNRC (w/o enclosures)
AE Cubbage	USNRC (with enclosures)
LA Dudes	USNRC (w/o enclosures)
GB Stramback	GE/San Jose (with enclosures)
eDRF	0000-0056-1419

Enclosure 1

MFN 06-206

Response to Portion of NRC Request for Additional Information Letter No. 37 for the ESBWR Design Certification Application Siting Issues, Hydrological Engineering RAIs 2.1-1, 2.2-1 through 2.2-3, 2.3-1 through 2.3-6, 14.3-22, 15.3-1, 15.3-3, and 2.4-32

NRC RAI 2.1-1

DCD Tier 2, Sections 2.1.1, 2.1.2, and 2.1.3 should be revised to cite current regulations and consider recent interface guidance. Changes involving regulations such as 10 CFR 50.34(a)(1); 10 CFR Part 52 and §52.17, §52.25; and 10 CFR Part 100, Subpart B and §100.3, and §100.21(a) have occurred since issuance of the Standard Review Plan.

GE Response

Agree. See attached markups for DCD Subsections 2.1.1, 2.1.2 and 2.1.3 that address this item. References are now made to the latest guidance based on draft SRP sections issued in April 1996 and other changes that have occurred to various locations in Part 10. 10 CFR 52.25 has not been specifically mentioned in the markups because it is an ESP or COL applicant scope item to address.

NRC RAI 2.2-1

DCD Tier 2, Sections 2.2.1 - 2.2.2 and 2.2.3 should be revised to cite current regulations and consider recent interface guidance.

GE Response

Agree. See response to RAI 2.1-1 and the attached markups for DCD Subsections 2.2.1 – 2.2.2 and 2.2.3 that address this item.

NRC RAI 2.2-2

DCD Tier 2, Table 2.0-1 states that the COL applicant should identify potential site hazards in the site vicinity related to certain missile energies and pressure effects compared with the design basis tornado, but does not include consideration of other potential hazards such as manufacturing plants, chemical plants, refineries, storage facilities, mining and quarrying operations, military bases, missile sites, transportation routes (air, land, and water), transportation facilities (docks, anchorages, airports), oil and gas pipelines, drilling operations and wells, and underground gas storage facilities. Table 2.0-1 should state that the COL applicant is to provide information related to identification of other potential site vicinity hazards.

GE Response

Agreed. DCD Table 2.0-1 will be updated as noted in the attached markup.

NRC RAI 2.2-3

DCD Tier 2, Table 2.0-1 states that the COL applicant is to evaluate potential site hazards in the site vicinity related to certain missile energies and pressure effects compared with the design basis tornado, but does not include consideration of other potential hazards such as explosions, flammable vapor clouds, toxic chemicals, and fires. Table 2.0-1 should state that the COL applicant is to evaluate other potential site vicinity hazards.

GE Response

Agreed. DCD Table 2.0-1 will be updated as noted in the attached markup.

NRC RAI 2.3-1

DCD Tier 2, Sections 2.3.1, 2.3.2, 2.3.3, 2.3.4, and 2.3.5 should be revised to cite current regulations and consider recent interface guidance.

GE Response

Agree. See response to RAI 2.1-1 and the attached markups for DCD Subsections 2.3.1, 2.3.2, 2.3.3, 2.3.4 and 2.3.5 that address this item.

NRC RAI 2.3-2

In DCD Tier 2, Table 2.0-1, what is the basis for selection of the extreme winds used for design of safety-related structures? For example, are the speeds based upon historical fastest mile measurements or a percent exceedance over a certain period of time?

GE Response

The extreme wind speed of 62.6 m/s (140 mph) was selected to comply with expected requirements of southeastern coastal locations. This speed is approximately in the middle of wind speeds seen in a Category 4 hurricane. It exceeds the maximum wind speed value of 54.7 m/s based on a 100-year recurrence interval that was used for the design of safety-related structures in the ABWR design certification.

DCD Table 2.0-1 will be updated to clarify the basis for this value as shown in the attached markup.

NRC RAI 2.3-3

With respect to design temperatures given in DCD Tier 2, Table 2.0-1, what is the definition of the zero and one percent design temperature exceedances? For example, is the zero percent exceedance the historical high or low value as stated in Tier I Table 5.1-1? Is the one percent exceedance an annual exceedance or is it a 100-year return value? Please revise tables and text to provide this level of detail at all places where values are given.

GE Response

The zero percent exceedance values for design temperatures given in DCD Tier 2, Table 2.0-1 are the historical high or low values as stated in Tier 1, Table 5.1-1.

The one percent exceedance values are also historical values based on a review of the data available in the ESP applications submitted by Dominion, Entergy and Exelon for the North Anna, Grand Gulf and Clinton sites, respectively. Table 1.2-6 in Volume III of the Utility Requirements Document (URD) was also reviewed. A set of parameters that bounds all three sites and the URD were selected for use in the ESBWR DCD.

The attached markup shows how the DCD tables and text will be updated to reflect this clarification.

NRC RAI 2.3-4

What is the basis for the maximum rainfall rate and maximum snow load for the roof design given in DCD Tier 2, Table 2.0-1? Is the maximum rainfall rate assumed to be over a period of five minutes?

GE Response

The maximum rainfall rate and maximum snow loads were taken from the Advanced Light Water Reactor Utility Requirements Document (URD), Volume III, Table 1.2-6. These values are also the same as those that were applied during design certification of the Advanced Boiling Water Reactor (ABWR).

As indicated in the text of Table 2.0-1 for Subsection 2.3.1, the maximum rainfall rate in the URD was obtained from National Weather Service Publication HMR No. 52 using the probable maximum precipitation (PMP) for 1 hour over a 2.6×10^6 m^2 (1 sq. mile) area with a PMP ratio of 5 minutes to 1 hour of 0.32.

DCD Table 2.0-1 will be updated to clarify that the URD is the source of these values as shown in the attached markup.

NRC RAI 2.3-5

What is the probability of occurrence per year of the tornado values listed in Table 2.0-1?

GE Response

The probability of occurrence per year for tornados of any magnitude is site specific and is addressed by COL applicants in their early site permit (ESP) and/or combined operating license (COL) applications. As noted already in Item 2.3.1 of DCD Table 2.0-1, the COL applicant must confirm the values selected for design certification are bounding or reanalyze with site-specific parameters.

The maximum tornado wind speed value selected for use in design of the ESBWR as reported in DCD Table 2.0-1 is 10% higher than the value used in previous plant design certifications such as the ABWR. Subsequent to the submittal of the ESBWR DCD, the NRC published Draft Regulatory Guide DG-1143 (Reference 1), which states that a maximum tornado wind speed of "134 m/s (300 mi/h) is appropriate for tornadoes for the central portion of the United States; a maximum wind speed of 116 m/s (260 mi/h) is appropriate for a large region of the United States along the east coast, the northern border, and western great plains; and a maximum wind speed of 89 m/s (200 mi/h) is appropriate for the western United States." The value used for design of the ESBWR exceeds all the values accepted as appropriate for maximum wind speeds in DG-1143.

DCD Table 2.0-1 will be marked up to clarify the basis for the maximum tornado wind speed as shown in the attached markup.

Reference:

1. "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," (Proposed Revision 1 of Regulatory Guide 1.76, dated April 1974), Draft Regulatory Guide DG-1143, U.S. Nuclear Regulatory Commission, January 2006.

NRC RAI 2.3-6

The DCD should be revised to state that the COL applicant is to provide information on limiting meteorological conditions for design of the ultimate heat sink. Such information includes the: 1) worst 1-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures, 2) worst 5-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures resulting in minimum water cooling, 3) worst 30-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures, and 4) maximum annual cumulative degree-days below freezing. Guidance is provided in Regulatory Guide 1.27.

GE Response

The Ultimate Heat Sink in the ESBWR is the atmosphere with the IC/PCC pools inside the Reactor Building providing the heat transfer mechanism. See DCD Tables 1.9-21 and 1.9-21a, as well as the note in DCD Subsection 2.5.4.12, for discussion of applicability of Regulatory Guide 1.27 to plants with passive decay heat removal systems. DCD Subsection 9.2.5 provides more information on the Ultimate Heat Sink. No information on limiting meteorological conditions is required for the design of the Ultimate Heat Sink.

The COL applicant needs to provide information on the limiting meteorological conditions for the design of the nonsafety-related Normal Power Heat Sink and the nonsafety-related Auxiliary Heat Sink (see DCD Subsection 9.2.1.2), which are not credited for demonstrating compliance with the requirements of Regulatory Guide 1.27. The Normal Power Heat Sink is connected to the Circulating Water System and receives heat from the Main Condenser. The Auxiliary Heat Sink is connected to the Plant Service Water System (PSWS) and receives heat from the Reactor Component Cooling Water System (RCCWS) and from the Turbine Component Cooling Water System (TCCWS).

COL applicant information on limiting meteorological conditions is also used in the design of plant heating, ventilation and air conditioning (HVAC) systems.

Thus, the requested DCD revision is not appropriate. However, the second sub-bullet under the third bullet in DCD Subsection 2.3.1 is somewhat misleading as written. It will be modified as shown in the attached markup to clarify that the use of limiting meteorological conditions only affects the design of the Normal Power and Auxiliary Heat Sinks for ESBWR, both of which are nonsafety-related.

NRC RAI 14.3-22

DCD Tier 1, Table 5.5-1 should be updated to incorporate responses to Questions 2.3-2 through 2.3-5 above regarding site parameter meteorological conditions applicable to the ESBWR.

GE Response

DCD Tier 1, Table 5.1-1 will be updated to incorporate the responses to RAIs 2.3-2 through 2.3-5 consistent with the attached markup.

NRC RAI 15.3-1

The draft GESTAR revision cited as DCD Tier 2, Reference 15.3-3, has been revised and is under review by the NRC staff. The DCD should be updated to cite the revised GESTAR amendment following approval.

GE Response

The NRC staff and GE/GNF have agreed to the final RAI responses and GESTAR II text. The final GNF transmittal letters are: (1) FLN-2006-018, May 11, 2006, Subject: Response to NRC Request for Additional Information Regarding Amendment 28 to GESTAR II (TAC No. MC3559), and (2) FLN-2006-020, June 2, 2006, Subject: Transmittal of Updated Attachments Supporting GESTAR II Amendment 28 and Associated GESTAR II Sections (TAC No. MC3559).

DCD Reference 15.3-3 will be updated as soon as the Safety Evaluation for GESTAR II Amendment 28 is complete. The final reference will be the GESTAR Revision (Acceptance version) that implements Amendment 28 and includes the Safety Evaluation. The expectation is that Amendment 28 will be implemented in Revision 16, but this depends on the timing of the Amendment 28 Safety Evaluation.

NRC RAI 15.3-3

DCD Tier 2, Section 15.3.10.5 states that individual plants must periodically (once every few years) verify that they are within the limiting site meteorological criteria contained in the GESTAR report. What is the mechanism to accomplish this goal?

GE Response

The words in GESTAR II associated with the confirmation that a specific plant meets the limitations and assumptions of the generic dose analysis have been modified since stated in DCD Tier 2, Section 15.3.10.5. Section 5.3 of the GESTAR II U.S Supplement was expanded such that the plant can perform the required dose parameter confirmation.

The confirmation that the generic dose analysis for the Fuel Loading Error (FLE) is applicable to a specific plant will be recorded by the fuel reload input documentation known as the Fuel Reload-Licensing Engineering Data (FRED) form. The FRED form is the mechanism by which GNF gathers the utility/plant reload design and analysis information for each reload core design. The information required to confirm the applicability of the generic FLE dose analysis will be made a part of the FRED form. Hence, it will be confirmed for each reload cycle. The plant's analysis basis for the FLE will be documented in the Supplemental Reload Licensing Report (SRLR).

No DCD changes will be made in response to this RAI.

NRC RAI 2.4-32

Address potential accidental flooding of safety related compartments located well below grade resulting from unanticipated defects or other non-mechanistic causes. What provisions are there in the standard design to detect and mitigate flooding of lower compartments?

GE Response

See DCD Section 3.4 for flood evaluation from internal and external sources. The protection features for flooding are valid when the flooding source is external.

The Equipment and Floor Drain System (EFDS) provides Seismic Category I Class 1E level instrumentation in lower elevations of the Control Building and the Reactor Building to detect flooding from any source.

Watertight doors are provided at appropriate locations in the lower elevations of the Control and Reactor Buildings to minimize the amount of safety-related equipment that could be affected by a flooding event. In addition, the passive safety-related systems (i.e., the Isolation Condenser, Gravity-Driven Cooling System and Passive Containment Cooling System) are all located at elevations where they cannot be adversely impacted by flooding.

No DCD changes will be made in response to this RAI.

2. SITE CHARACTERISTICS

2.0 INTRODUCTION

This chapter defines the envelope of site-related parameters that the ESBWR Reference Plant is designed to accommodate. These parameters envelope most potential sites in the U.S. A summary of the site envelope design parameters is given in Table 2.0-1.

The particular site characteristics information will be provided in the Combined Operating License (COL) applicant's safety analysis report (SAR) in accordance with 10 CFR 52.79. Sections 2.1 through 2.5 of this chapter, which is the same format as Chapter 2 of NUREG-0800 Standard Review Plan (SRP), define the limits imposed on the SRP Section II acceptance criteria by (1) the envelope of site-related parameters that the ESBWR plant is designed to accommodate, and (2) the assumptions, both implicit and explicit, related to site characteristics employed in the evaluation of the ESBWR design.

The acceptance criteria for ITAAC are based on meeting 10 CFR 52.97(b)(1), which sets forth the comprehensive requirements for ITAAC. For design certification reviews, the scope of ITAAC is limited to the scope of the certified design as required by 10 CFR 52.47(b). The requirements for site parameters for the standard design are contained in 10 CFR 52.47(a)(1)(iii). The design certification applicant must provide postulated site parameters for the design, and an analysis and evaluation of the design in terms of such parameters. The following are addressed to demonstrate that the standard design meets the above criteria.

The site parameters used in the ESBWR Standard Plant design are specified in both Tier 1 and DCD Tier 2 Chapter 2. The site parameters specified in Tier 1 are the top-level bounding site parameters used in the selection of a suitable site for a facility referencing the certified design. Because they were used in bounding evaluations of the certified design, they define the requirements for the design that must be met by a site. This ensures that a facility built on the site remains in conformance with the design certification. Appropriate values for site parameters have been selected that make the design suitable for many sites. The site parameters specified in the DCD Tier 2 Chapter 2 are consistent with those in Tier 1.

The analyses and evaluations of the design are contained in the various sections of the DCD Tier 2. For example, the safe shutdown earthquake parameter is discussed in structural and piping analyses in Chapter 3, atmospheric dispersion parameters are discussed in radiological analyses in Chapter 15, and elevation parameters are discussed in the flooding analyses in Chapter 15. Supporting information for the ITAAC utilizes these site parameters, as discussed in SRP Sections 14.3.2 and 14.3.3.

Site parameters are specified for the following parameters:

- Maximum ground water level
- Maximum flood level
- Precipitation (rain and snowfall)
- Ambient Design Temperature
- Extreme Wind

- Tornado (maximum speed, pressure drop, missile spectra)
- Soil Properties (minimum bearing capacity, minimum shear wave velocity, liquefaction potential)
- Seismology (SSE response spectra, using figures)
- Meteorological Dispersion (Values at Exclusion Area Boundary [EAB] and Low Population Zone [LPZ] at appropriate time intervals for short and long term)

The site parameters include a requirement that liquefaction not occur underneath structures, systems, and components resulting from the site-specific SSE. In addition, although the design for the sites takes into consideration the 0.3g Regulatory Guide 1.60 spectra, the evaluation of the sites for liquefaction potential uses the site-specific SSE with acceptance criteria demonstrating adequate margin for no liquefaction.

Site parameters for external missile spectra are specified in Tier 1 and in Tier 2 Chapter 2. The design basis for missiles is specified in the DCD Tier 2 Section 3.5, such that external missiles are adequately addressed in the design for buildings and structures, and verified by appropriate ITAAC.

An applicant for a combined license shall include a commitment in the site specific portion of the SAR for a facility to: (1) notify the staff immediately if previously unknown geologic features, such as faults, liquefiable soils, etc, are encountered during excavations at the site; (2) geologically map all excavations for Seismic Category I structures, as a minimum; and (3) notify the staff when the excavations are open for examination and evaluation.

An applicant for a combined license must demonstrate that the site parameters in the design certification rule are met at a given site as part of an application and issuance of a combined license under Subpart C of 10 CFR Part 52. If the site cannot meet these site parameters, an exemption must be requested in accordance with the change process in the rule certifying the design.

Also, consideration of hazards and parameters that were not previously considered as part of the design certification is done as part of a combined license application on a site-specific basis. Examples may include proximity to air traffic patterns, toxic hazards, and transportation.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.1.1	Site Location and Description	ESBWR parameters selected to envelope most potential sites in the U.S. COL applicant to supply site-specific information in accordance with SRP 2.1.1.
2.1.2	Exclusion Area Authority and Control	ESBWR design considers an area whose boundary has a Chi/Q less than or equal to 1.0×10^{-3} s/m^3. COL applicant to supply site-specific information in accordance with SRP 2.1.2.
2.1.3	Population Distribution	ESBWR DCD: None. COL applicant to describe the population distribution in accordance with SRP 2.1.3.
2.2.1 – 2.2.2	Identification of Potential Hazards in Site Vicinity	ESBWR DCD: No assumptions made regarding site-specific potential hazards. COL applicant to identify and evaluate potential hazards in the site vicinity, in accordance with SRP 2.2.1 – 2.2.2. Potential hazards include manufacturing plants, chemical plants, refineries, storage facilities, mining and quarrying operations, military bases, missile sites, transportation routes (air, land and water), transportation facilities (docks, anchorages, airports), oil and gas pipelines, drilling operations and wells, and underground gas storage facilities.
2.2.3	Evaluation of Potential Accidents	ESBWR DCD: See ESBWR DCD sections 6.2, 6.3, and Chapter 15. COL applicant to identify and evaluate potential accidents emanating from those potential hazards identified in SRP 2.2.1 – 2.2.2, above that have a probability of occurrence $> 10^{-7}$ per year which involve: (1) missiles more energetic than the tornado missile spectra, or (2) pressure effects in excess of the design basis tornado, or (3) explosions, or (4) fires, or (5) aircraft impacts, or (6) release of flammable vapor clouds, or (7) release of toxic chemicals.
2.3.1	Regional Climatology	ESBWR DCD: The basic speed (3 sec gust) of extreme winds used for design of seismic category I or II structures is 62.6 m/sec (140 mph). This speed is

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

<table>
<tr><th>Subsection</th><th>Subject</th><th>Parameters/Considerations/Limits</th></tr>
<tr><td></td><td></td><td>approximately in the middle of wind speeds seen in a Category 4 hurricane and has a recurrence interval of greater than 100 years. The basic speed of extreme wind for nonsafety-related, non-seismic (NS) structures is determined by the COL applicant. The following importance factors and exposure categories are used for scaling wind forces for types of structures:

<table>
<tr><th>Seismic Category</th><th>Importance Factor</th><th>Exposure Category</th></tr>
<tr><td>I or II</td><td>1.15</td><td>D</td></tr>
<tr><td>NS</td><td>Determined by the COL applicant</td><td>Determined by the COL applicant</td></tr>
</table>

The maximum design ambient temperature corresponding to a one percent exceedance value is 37.8°C (100°F) dry bulb with a coincident wet bulb temperature of 26.1°C (79°F) and 27.8°C (82°F) for non-coincident wet bulb. The minimum design temperature corresponding to a one percent exceedance value is -23.3°C (-10°F). These values were selected to bound values presented in the Utility Requirements Document (URD) and in available ESP applications.
The zero percent exceedance dry bulb temperature is 46.1°C (115°F) with a coincident wet bulb temperature of 26.7°C (80°F) and 29.4°C (85 °F) for non-coincident wet bulb. The minimum temperature for this exceedance value is -40°C (-40°F). These are historical extreme values.
The maximum rainfall rate for roof design is 49.3 cm/h (19.4 in./h), which is based on the probable maximum precipitation (PMP) for one hour over one square mile with a ratio of 5 minutes to one hour PMP of 0.32, as found in National Weather Service Publication HMR No. 52. The maximum short-term rainfall rate is 15.7 cm (6.2 in.). The maximum snow load for roof design is 2394 Pa (50 lbf/sq ft). These values for rainfall rates and</td></tr>
</table>

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
		maximum snow load were taken directly from Table 1.2-6 of Volume III of the URD. The maximum tornado wind speed is 147.5m/s (330 mph), with a rotational velocity of 116.2 m/s (260 mph), a translational velocity of 31.3 m/s (70 mph), and a radius of 45.7 m (150 ft). The maximum atmospheric pressure differential is 16.6 kPa (2.4 psi) and the rate of pressure change is 11.7 kPa/s (1.7 psi/s). The missile spectra is per Spectra I of Standard Review Plan 3.5.1.4. The maximum tornado wind speed selected is 10% greater than the maximum value that is accepted as appropriate in Draft Guide DG-1143. COL applicant to confirm or reanalyze in accordance with SRP 2.3.1.
2.3.2	Local Meteorology	ESBWR DCD: None; see subsection 2.3.1 of this table for ESBWR bounding parameters. COL applicant to supply site-specific information in accordance with SRP 2.3.2.
2.3.3	Onsite Meteorological Measurement Programs	ESBWR DCD: None; see subsection 2.3.1 for ESBWR bounding parameters.. COL applicant to supply site-specific information in accordance with the SRP 2.3.3.
2.3.4	Short-Term Diffusion Estimates for Accidental Atmospheric Releases	ESBWR DCD: See Chapter 15 COL applicant to supply site-specific information in accordance with the SRP 2.3.4 to show that the site meteorological dispersion values as calculated in accordance with Regulatory Guide 1.145, and compared to dose values given in Chapter 15, result in doses less than stipulated in 10 CFR 50.34(a) and the applicable portions of SRP Sections 11 and 15.
2.3.5	Long-Term Diffusion Estimates	ESBWR long-term diffusion estimates are given in Chapter 12. COL applicant to supply site-specific information in accordance with the SRP 2.3.5.

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site and Location Description

ESBWR parameters are presented in Table 2.0-1.

The COL applicant identifies the plant location and description in accordance with the requirements of SRP 2.1.1 to include the following:

Reactor location is presented

- as identified by latitude and longitude and by the Universal Transverse Mercator (UTM) coordinate system;
- with respect to political subdivisions; and
- with respect to prominent natural and man-made features of the area to ascertain the accuracy of the COL applicant's safety analysis report (SAR) description and for use in independent reviews of the exclusion area authority and control (Subsection 2.1.2), the surrounding population (Subsection 2.1.3) and nearby man-made hazards (Subsection 2.2.3).

The site area which contains the reactors and associated principal plant structures is described to identify the distance from the reactor to boundary lines of the exclusion area, including the direction and distance from the reactor to the nearest exclusion area boundary line. The location, distance, and orientation of plant structures with respect to highways, railroads, and waterways which traverse or lie adjacent to the exclusion area are presented to ensure that they are adequately described to permit analyses (Subsection 2.2.3) of the possible effects on the plant of accidents on these transportation routes.

The description of the restricted area will be provided to verify that adequate information has been provided to determine general population doses from normal liquid and gaseous releases.

For the design certification, site parameters have been postulated as a basis for the ESBWR Standard Plant design.

Information included in this section will allow three types of safety analyses to be conducted. The first addresses exposure of the public to radiation at the boundary of the restricted area of the plant. The second addresses the consequences in the unlikely event that a serious release of radioactive material should occur. The third addresses the effect that accidents on, or routine use of, transportation routes on or near the site will have on the operation of the plant.

The acceptance criteria for site location and description are based on meeting the relevant requirements of the following sections of Title 10 CFR: Part 20, "Standards for Protection Against Radiation," Subpart D, "Radiation Dose Limits for Individual Members of the Public;" Part 100, "Reactor Site Criteria," Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997;" and Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," §52.17, "Contents of Applications;" and Part 50, "Domestic Licensing of Production and Utilization Facilities," §50.34, "Contents of Applications; Technical Information." The relevant requirements of these regulations are:

- 10 CFR 20.1301 effectively places limits on the annual average releases in gaseous and liquid effluents at the boundary of the restricted area by placing limits on the exposure an individual would receive if continually present at the boundary of the restricted area.

  10 CFR 20.1003 defines restricted area.

- 10 CFR 100, Subpart B, "Factors to be Considered when Evaluating Sites," and 10 CFR 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," require that the site location and the engineered features included as safeguards against the hazardous consequences of an accident, should one occur, should ensure a low risk of public exposure. In particular, in determining the acceptability of a site for a power reactor, consideration will be given to population density and use characteristics of the site environs, including the exclusion area, low population zone, and population center distance.

  - 10 CFR Part 100.21(a) requires that the COL applicant determine an exclusion area as defined in 10 CFR 100.3.
  - 10 CFR 100.3(a) defines exclusion area, and sets forth requirements regarding activities in that area.

- 10 CFR Part 50, §50.34 requires that the preliminary and final safety analysis reports (PSAR and FSAR) include a description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design.

  The information submitted by the COL applicant is adequate and meets the 10 CFR Part 50, §50.34 requirements if it satisfies the following criteria:

  - The site location including the boundaries of the restricted area, showing proposed effluent release points, is described in sufficient detail to allow determinations (in Sections 11.1, 11.2, and 11.3) that 10 CFR 20, Subpart D is met.
  - The site location including the exclusion area and the location of the plant within the area are described in sufficient detail to allow a determination (in Subsections 2.1.2, 2.1.3, and those in Chapter 15) that 10 CFR 100, Subpart B, and 10 CFR 52.17 are met.
  - Highways, railroads, and waterways, which traverse the exclusion area, are described in sufficient detail to allow a determination that 10 CFR 100.3(a) is met.

2.1.2 Exclusion Area Authority and Control

ESBWR parameters are presented in Table 2.0-1.

The COL applicant describes the exclusion area authority and control in accordance with SRP 2.1.2 to include the following:

The COL applicant's legal authority to determine all activities within the designated exclusion area is described. 10 CFR Part 100, §100.3(a) requires that a reactor licensee have authority to determine all activities within the designated exclusion area, including the exclusion or removal of personnel and property.

In any case where the COL applicant does not own all the land, including mineral rights, within the designated exclusion area, the legality of the applicant's authority must be established. In such a case, assistance may be required of the NRC legal staff in determining whether or not the

designated exclusion area meets the requirements of 10 CFR Part 100. Also, in some cases public roads that lie within the proposed exclusion area may have to be abandoned or relocated to permit plant construction. Legal assistance may be required to assure that no legal impediments to such abandonment or relocation are likely to ensue. Part 100 permits the exclusion area to be traversed by a highway, railroad, or waterway provided arrangements are made to control these areas in event of an emergency.

The COL applicant must also demonstrate that proposed activities in the exclusion area unrelated to operation of the reactor do not result in significant hazard to the public health and safety. Activities that may be permitted within the designated exclusion area, and that will not be related to routine operation of the plant, are described.

The COL applicant demonstrates meeting the relevant requirements of 10 CFR Part 100 with respect to the applicant's legal authority with the designated exclusion area. 10 CFR Part 100 in Section 100.3(a) states as follows:

"Exclusion area" means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad or waterway, provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety. Residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity. Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

To meet the requirements of 10 CFR Part 100 the COL applicant demonstrates that it has the authority within the exclusion area as required by Section 100.3(a), or must provide reasonable assurance that it will have such authority prior to start of construction. Absolute ownership of all lands within the exclusion area, including mineral rights, is considered to carry with it the required authority to determine all activities on this land and is acceptable.

Where the required authority is contingent upon future procurement of ownership (e.g., by eminent domain proceedings), or by lease, easement, contract, or other means, the exclusion area may be acceptable if the information provided by the applicant provides reasonable assurance that the required authority will be obtained prior to start of construction.

Activities unrelated to plant operation within the exclusion area are acceptable provided:

- Such activities, including accidents associated with such activities, represent no hazard to the plant or have been shown to be accommodated as part of the plant design basis (see Subsection 2.2.3).
- The applicant is aware of such activities and has made appropriate arrangements to evacuate persons engaged in such activities, in the event of an accident, and
- There is reasonable assurance that, in the event of an accident, persons engaged in such activities can be evacuated without receiving radiation doses in excess of the guideline values given in 10 CFR 50.34(a).

Where the designated exclusion area extends into bodies of water such as a lake, reservoir, or river which is routinely accessible to the public, the applicant must have made appropriate arrangements with the local, state, Federal, or other public agency having authority over the

particular body of water and the arrangements made provide for the exclusion and ready removal in an emergency, by either the applicant or the public agency in authority, of any persons on those portions of the body of water which lie within the designated exclusion area.

2.1.3 Population Distribution

ESBWR DCD: None, as noted in Table 2.0-1.

COL applicant to describe the population distribution in accordance with SRP 2.1.3 to include the following:

The population data in the site environs are presented in the COL applicant's SAR, to demonstrate that the exclusion area, low population zone and population center distance for the site comply with the requirements of 10 CFR Part 100, Subpart B, and 10 CFR 52.17, and to demonstrate that the population density is such that consideration need not be given to alternate sites with lower population density.

The COL applicant demonstrates meeting the relevant requirements of the following regulations:

- 10 CFR 50.34(a)(1) as it relates to having each applicant provide a description and safety assessment of the site in the SAR, with special attention to the site evaluation factors identified in 10 CFR Part 100, Subpart B.
- 10 CFR 100.20 and 10 CFR 52.17 as they relates to determining the acceptability of a site for a power reactor. The applicant takes the following item, among others, into consideration.

  Population density and use characteristics of the site environs, including the exclusion area, low population zone, and population center distance.

10 CFR Part 100 also provides definitions and other requirements for determining an exclusion area, low population zone, and population center distance in Sections 100.3 and 100.21, respectively.

The requirements of 10 CFR 50.34(a)(1), 10 CFR 52.17 and 10 CFR 100, Subpart B are deemed to have been met if the population density and use characteristics of the site meet the following:

- Either there are no residents in the exclusion area, or if so, such residents are subject to ready removal, in case of necessity.
- The specified low population zone is acceptable if it is determined that appropriate protective measures could be taken in behalf of the enclosed populace in the event of a serious accident.
- The nearest boundary of the closest population center (as defined in 10 CFR 100, Subpart B) is at least one and one third times the distance from the reactor to the outer boundary of the low population zone.
- The population center distance is acceptable if there are no likely concentrations of greater than 25,000 people over the plant lifetime closer than the distance designated by the applicant as the population center distance. The boundary of the population center shall be determined upon considerations of population distribution. Political boundaries are not controlling.
- The population data supplied by the applicant in the COL SAR is acceptable if

- it contains population data for the latest census, projected year of plant startup and projected year of end of plant life, all in the geographical format given in Section 2.1.3 of Regulatory Guide 1.70;
- it describes the methodology and sources used to obtain the population data, including the projections;
- it includes information on transient populations in the site vicinity; and
- the population data in the site vicinity, including projections, is verified by other means such as U.S. Census publications, publications from State and local governments, and other independent projections, to be reasonable.

- If the population density exceeds the guidelines given in Position C.3 of Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," the COL applicant will be required to give special attention to the consideration of alternative sites with lower population densities. A site that exceeds the population density guidelines of Position C.3 of Regulatory Guide 4.7 can nevertheless be selected and approved if, on balance, it offers advantages compared with available alternative sites when all of the environmental, safety, and economic aspects of the proposed and alternative sites are considered.

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

2.2.1 – 2.2.2 Identification of Potential Hazards in Site Vicinity

ESBWR DCD: No assumptions made regarding site-specific potential hazards.

The COL applicant describes the identification of potential hazards in the site vicinity in accordance with SRP 2.2.1 – 2.2.2 to include the following:

The site and its vicinity are presented including location and separation distance with respect to industrial, military, and transportation facilities and routes. Such facilities and routes include air, ground, and water traffic, pipelines, and fixed manufacturing, processing, and storage facilities, including onsite storage facilities for compressed or liquid hydrogen, liquid oxygen, and propane. The description focuses on potential external hazards or hazardous materials that are present or which may reasonably be expected to be present during the projected lifetime of the plant. The purpose of this presentation is to establish the information concerning the presence and magnitude of potential external hazards so that the reviews and evaluations described in Standard Review Plan (SRP) Sections 2.2.3, 3.5.1.5, and 3.5.1.6 can be performed. Control room habitability with respect to toxic chemicals and smoke is presented in Section 6.4.

10 CFR 100.20 and 10 CFR 52.17 require that site acceptance be based on the consideration of factors relating to the proposed reactor design and the characteristics peculiar to the site. One of the factors involves the use characteristics of the site environs. In accordance with 10 CFR 50.34, the COL applicant submits in the safety analysis report information needed for evaluating these factors. Guidelines for specific information requirements are described in Chapter 2, Sections 2.2.1 and 2.2.2 of Regulatory Guide (RG) 1.70.

The information submitted by the applicant is adequate and meets the 10 CFR 50.34, 10 CFR 52.17 and 10 CFR 100, §100.20 requirements and Regulatory Guide 1.70 guidelines if it satisfies the following criteria:

- Data in the COL SAR adequately describes the locations and distances of industrial, military, and transportation facilities in the vicinity of the plant, and is in agreement with data obtained from other sources, when available.
- Descriptions of the nature and extent of activities conducted at the site and in its vicinity, including the products and materials likely to be processed, stored, used, or transported, are adequate to permit identification of possible hazards.
- Sufficient statistical data with respect to hazardous materials are provided to establish a basis for evaluating the potential hazard to the plant.

2.2.3 Evaluation of Postulated Accidents

ESBWR DCD: See Sections 6.2 and 6.3, and Chapter 15.

The COL applicant describes the evaluation of potential accidents in accordance with SRP 2.2.3 to include the following:

The applicant's identification of potential accident situations onsite and in the vicinity of the plant with the potential to affect safety-related features is presented to demonstrate the completeness of and the bases upon which these potential accidents were or were not accommodated in the design. (See Standard Review Plan (SRP) Sections 2.2.1 and 2.2.2.)

The COL applicant's probability analyses of potential accidents involving hazardous materials or activities in the vicinity of the plant, if such analyses have been performed, are also presented to demonstrate that appropriate data and analytical models have been utilized.

The analyses of the consequences of accidents onsite and those involving nearby industrial, military, and transportation facilities, which have been identified as design basis events are presented.

Acceptance criteria are based on meeting the relevant requirements of 10 CFR 50.34(a), 10 CFR 52.17 and 10 CFR 100, Subpart B, as they relate to the factors to be considered in the evaluation of sites, which indicates that reactors should reflect through their design, construction, and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products. In addition, 10 CFR 100.20 indicates that the site location, in conjunction with other considerations, should ensure a low risk of public exposure.

Specific criteria necessary to meet the relevant requirements of 10 CFR 100.20 are described in the following paragraphs:

Offsite and onsite hazards which have the potential for causing onsite accidents leading to the release of significant quantities of radioactive fission products, and thus pose an undue risk of public exposure, should have a sufficiently low probability of occurrence and be within the scope of the low probability of occurrence criterion of 10 CFR 100.20. Specific guidance with respect to such hazards is provided in Chapter 2, Section 2.2.3 of Regulatory Guide (RG) 1.70. As indicated therein, the identification of design basis events resulting from the presence of hazardous materials or activities onsite and in the vicinity of the plant is acceptable if the design basis events include each postulated type of accident for which the expected rate of occurrence of potential exposures in excess of the 10 CFR 50.34(a) guidelines is estimated to exceed the NRC staff objective of approximately 10^{-7} per year. Because of the difficulty of assigning accurate numerical values to the expected rate of unprecedented potential hazards generally considered in this section, judgment must be used as to the acceptability of the overall risk presented.

The probability of occurrence of the initiating events leading to potential consequences in excess of 10 CFR 50.34(a) exposure guidelines are estimated using assumptions that are as representative of the specific site as is practicable. In addition, because of the low probabilities of the events under consideration, data are often not available to permit accurate calculation of probabilities. Accordingly, the expected rate of occurrence of potential exposures in excess of the 10 CFR 50.34(a) guidelines of approximately 10^{-6} per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The effects of design basis events have been adequately considered if analyses of the effects of those accidents on the safety-related features of the plant have been performed and measures have been taken (e.g., hardening, fire protection) to mitigate the consequences of such events.

2.3 METEOROLOGY

2.3.1 Regional Climatology

ESBWR DCD: See Item 2.3.1 of Table 2.0-1 for ESBWR bounding parameters. Zero percent exceedance values are based on historical high and low values. One percent exceedance values were selected in order to bound the values presented in the Utility Requirements Document (URD) and available Early Site Permit applications.

COL applicant shall provide information in accordance with SRP 2.3.1 concerning averages and extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant. The review covers the following specific areas:

- 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.
- Seasonal and annual frequencies of severe weather phenomena, including hurricanes, tornadoes and waterspouts, thunderstorms, lightning, hail (including probable maximum size), freezing rain (ice storms), dust (sand storms), and high air pollution potential.
- Meteorological conditions used as design and operating bases including:
  - The weight of the 100-year return period snowpack and the weight of the 48-hour probable maximum winter precipitation (PMWP) for use in determining the weight of snow and ice on the roofs of safety-related structures.
  - The ultimate heat sink (UHS) meteorological conditions resulting in maximum evaporation and drift loss of water, minimum water cooling, and, if applicable, the potential for water freezing in the UHS water storage facility. For ESBWR the meteorological conditions only have an impact on the design of the nonsafety-related normal power and auxiliary heat sinks. The Ultimate Heat Sink in the ESBWR is the atmosphere with the IC/PCC pools inside the Reactor Building providing the heat transfer mechanism.
  - The tornado parameters (including maximum wind speed, translational speed, rotational speed, and maximum pressure differential with the associated time interval) to be used in establishing pressure and tornado missile loadings on safety-related structures, systems and components (SSCs).
  - The 100-year return period (straight-line) 3-second gust wind speed to be used in establishing wind loading on plant structures.
  - Ambient temperature and humidity statistics (e.g., 0.4%, 2%, 99%, and 99.6% annual exceedance dry-bulb temperatures; 0.4% annual exceedance wet-bulb temperature; 100-year return period maximum dry-bulb and wet-bulb temperatures; 100-year return period minimum dry-bulb temperature) for use in establishing heat loads for the design of normal plant heat sink systems, post-accident containment heat removal systems, and plant heating, ventilating, and air conditioning systems.

– Other site-specific meteorological and air quality conditions used as bases for design or operation.

The information regarding the regional meteorological conditions and phenomena that could affect the safe design and siting of the plant is provided as site-specific climate characteristics in the ESP or COL application. The information is acceptable if it meets the requirements of the following regulations:

- 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 are reflected in the design bases for structures, systems and components important to safety,
- 10 CFR Part 50, Appendix A, General Design Criterion 4 (GDC 4), "Environmental Missile Design Bases," with respect to information on tornadoes that could generate missiles, and
- 10 CFR Part 100, §100.20(c)(2) and §100.21(d) with respect to the consideration given to the regional meteorological characteristics of the site.

As needed, the ESP or COL applicant may propose site-specific climate characteristics that will form a set of minimum values for the design and construction of the plant.

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:

- The description of the general climate of the region should be based on standard climatic summaries compiled by NOAA. Consideration of the relationships between regional synoptic-scale atmospheric processes and local (site) meteorological conditions should be based on appropriate meteorological data.
- 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 that have long periods of data on record. The applicability of these data to represent site conditions during the expected period of reactor operation must be substantiated.
- The tornado parameters should be based on Regulatory Guide 1.76 (Reference 8). Alternatively, an applicant may specify any tornado parameters that are appropriately justified, provided that a technical evaluation of site-specific data is conducted.
- The basic (straight-line) 100-year return period 3-second gust wind speed should be based on appropriate standards, with suitable corrections for local conditions.
- In accordance with Regulatory Guide 1.27, the UHS meteorological data that would result in the maximum evaporation and drift loss of water and minimum water cooling should be based on long-period regional records that represent site conditions. If applicable, the potential for water freezing in the UHS water storage facility should also be analyzed. The maximum accumulated degree-days below freezing recorded in the site region during the winter (or during the worst-case freezing spell in warmer climates) may

be a reasonable conservative site characteristic for evaluating the potential for water freezing in a UHS water storage facility. Suitable information should be compiled from at least 30 years of meteorological data found in databases for nearby representative locations.

- Consistent with the staff's branch position on winter precipitation loads, the winter precipitation loads to be included in the combination of normal live loads to be considered in the design of a nuclear power plant that might be constructed on the proposed site should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level. Likewise, the winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant that might be constructed on the proposed site should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP at ground level for the month corresponding to the selected snowpack. A COL applicant may choose and justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs.

  The weight of the 100-year return period snowpack should be based on data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions. For the purposes of determining the extreme winter precipitation load, the 48-hour PMWP is defined as the theoretically greatest depth of precipitation for a 48-hour period that is physically possible over a 25.9-square-kilometer (10-square-mile) area at a particular geographical location during the winter months (e.g., December, January, February). The weight of the 48-hour PMWP should be determined in accordance with reports published by NOAA's Hydrometeorological Design Studies Center.

- Ambient temperature and humidity statistics should be derived from data recorded at nearby representative climatic stations or obtained from appropriate standards with suitable corrections for local conditions.

- High air pollution potential information should be based on U.S. Environmental Protection Agency (EPA) studies.

- All other meteorological and air quality conditions identified by the applicant as climate site characteristics for ESP applications or used as design and operating bases for COL applications should be documented and substantiated.

2.3.2 Local Meteorology

ESBWR DCD: None; see Item 2.3.1 of Table 2.0-1 for ESBWR bounding parameters.

Information is presented by the COL applicant in accordance with SRP 2.3.2 concerning the local (site) meteorological parameters, an assessment of the potential influence of the plant and its facilities on local meteorological conditions, and a topographical description of the site and its environs. The information covers the following specific areas.

- A description of the local (site) meteorology in terms of airflow, temperature, atmospheric water vapor, precipitation, fog, atmospheric stability, and air quality.

- An assessment of the influence of the plant and its facilities on the local meteorological parameters listed above, including the effects of plant structures, terrain modification, and heat and moisture sources due to plant operation.
- A topographical description of the site and its environs, as modified by the plant structures, including the site boundary, exclusion zone, and low population zone.

For the ESBWR standard plant, this information is provided as a site parameter envelope that must be met by the plant design.

The information regarding the local meteorological and topographic descriptions of the site area applicable for a COL or ESP application should be adequately documented such that meteorological impacts on plant design and operation as well as the impact of the plant on local meteorological conditions can be reliably predicted. The information should be fully documented and substantiated to ensure that it represents conditions at and near the site. The information is acceptable if it meets the requirements of the following regulations:

- 10 CFR Part 50, Appendix A, General Design Criterion 2 (GDC 2), "Design Bases for Protection Against Natural Phenomena," with respect to information on the most severe local weather phenomena that have historically been reported for the site and the surrounding area and that are reflected in the design bases for structures, systems, and components important to safety,
- 10 CFR 100.20(c) with respect to the consideration that has been given to the local meteorological and air quality characteristics of the site and other physical characteristics of the site that can influence the local meteorology.

Specific criteria necessary to meet the requirements of GDC 2 and 10 CFR Part 100 are as follows:

- Local summaries of meteorological data based on onsite measurements in accordance with Regulatory Guide 1.23 and National Weather Service station summaries or other standard installation summaries from appropriate nearby locations should be presented as specified in Regulatory Guide 1.70, Section 2.3.2.
- A complete topographical description of the site and environs out to a distance of 80 km (50 mi) from the plant, as described in Regulatory Guide 1.70, Section 2.3.2.2, should be provided.
- A discussion and evaluation of the influence of the plant and its facilities on the local meteorological and air quality conditions should be provided. A discussion of potential changes in the normal and extreme values as presented in the safety analysis report (SAR) resulting from plant construction and operation should be made. The acceptability of the information is determined through comparison with standard assessments.

2.3.3 On-site Meteorological Measurements Program

ESBWR DCD: None; see Item 2.3.1 of Table 2.0-1 for ESBWR bounding parameters. Information is presented by the COL applicant in accordance with SRP 2.3.3 concerning the onsite meteorological measurements programs including instrumentation and measured data. The information covers the following specific areas:

- Meteorological instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures.
- Meteorological data, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions.
- Additional meteorological measurement and information availability requirements for emergency preparedness pursuant to 10 CFR 50.47 and Appendix E to 10 CFR Part 50.

Acceptance criteria for the onsite meteorological measurement program are based on the relevant requirements of the following regulations:

- 10 CFR 100.20(c)(2) as related to meteorological data collected for use in characterizing meteorological conditions of the site and surrounding area.
- 10 CFR 100.21(a) as related to meteorological data used in the evaluation to determine an exclusion area and a low population zone.
- 10 CFR Part 50, Appendix I as related to meteorological data used in determining the compliance with the numerical guides for doses to meet the criterion of "as low as is reasonably achievable" (ALARA).
- 10 CFR 50.47 and Appendix E to 10 CFR Part 50 as related to additional requirements for meteorological measurements and instrument reliability to facilitate emergency preparedness planning.

Specific criteria necessary to meet 10 CFR 50.47, Appendices E and I to 10 CFR Part 50, and 10 CFR Part 100 are as follows:

- The onsite meteorological measurements programs should produce data which can be summarized to provide a description of the meteorological characteristics of the site and its vicinity for the purpose of making atmospheric dispersion estimates for both postulated accidental and expected routine airborne releases of effluents and for comparison with offsite sources to determine the appropriateness of climatological data used for design considerations. The criteria for an acceptable onsite meteorological measurements program are documented in the Regulatory Position, Section C, of Regulatory Guide 1.23.
- The following additional criteria are used to judge the acceptability of meteorological data summaries for atmospheric dispersion estimates:
  - For the early site permit application, at least one annual cycle of onsite meteorological data should be provided at docketing.
  - Prior to its approval, the COL applicant's final safety analysis report (FSAR) shall contain at least two consecutive annual cycles.
- To meet the requirements specified in 10 CFR 50.47 and Appendix E to 10 CFR Part 50, equipment shall be installed to determine the magnitude, and to assess the impact, of a release of airborne radioactive material to the environment on a continuous basis. Accordingly, onsite meteorological monitoring equipment must be able to function throughout the course of an accident. Additional criteria and guidance necessary to verify adequate dose projection capability during radiological emergencies using realtime

meteorological information, as required by 10 CFR 50, Appendix E are applied under the reviews described in the Review Interfaces in subsection I.

Meteorological data should be presented in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class in the format described in Regulatory Guide 1.23. A listing of each hour of the hourly-averaged parameters should be provided in the format described in Appendix A to SRP Section 2.3.3.

Evidence of how well these data represent long-term conditions at the site should be presented.

2.3.4 Short-Term Diffusion Estimates for Accidental Atmospheric Releases

ESBWR DCD: See Section 15.4.

COL applicant to provide information, in accordance with SRP 2.3.4, concerning atmospheric dispersion estimates for postulated accidental releases of effluents to the atmosphere. The information covers the following specific areas:

- Atmospheric transport and diffusion models to calculate relative concentrations for postulated accidental radioactive and hazardous airborne releases.
- Meteorological data summaries used as input to diffusion models.
- Derivation of diffusion parameters.
- Probability distributions of relative concentrations.
- Determination of relative concentrations used for assessment of consequences of postulated radioactive atmospheric releases for design basis accidents and for other accidents, and of onsite and offsite hazardous airborne releases.

For the ESBWR Standard Plant, the probability distributions are specified in the site parameter envelope.

The COL applicant provides conservative estimates of atmospheric transport and diffusion conditions at appropriate distances from the source for postulated accidental releases of radioactive and hazardous materials to the atmosphere. The plant is considered as both a source and a receptor.

The information is provided to demonstrate compliance with the following regulations:

- 10 CFR Part 50, Appendix A, General Design Criterion 19 (GDC 19), "Control Room," with respect to the meteorological considerations used to evaluate the personnel radiation exposures inside the control room during design basis accident conditions.
- 10 CFR 100.21(a), with respect to the meteorological considerations used in the evaluation to determine an acceptable exclusion area and low population zone.

Regulatory Guides that provide information, recommendations and guidance, and in general describe a basis acceptable to implement the requirements of GDC 19 and 10 CFR 100.21(a) include Regulatory Guides 1.5, 1.23, 1.24, 1.25, 1.77, 1.78, and 1.145.

ESBWR short-term diffusion estimates are given in Section 15.4. They are shown to result in doses less than stipulated in 10 CFR 50.34(a) and in the applicable portions of SRP Sections 11 and 15.

Site-specific short-term diffusion estimates will reasonably reflect state-of-the-art atmospheric diffusion knowledge. The following information is specifically required:

- A description of the atmospheric dispersion models used to calculate relative concentrations in air resulting from accidental releases of radioactive and hazardous gases to the atmosphere. The models should be documented in detail and substantiated within the limits of the model so that the staff can evaluate their appropriateness to site, plant, and release characteristics.
- Meteorological data used for the evaluation (as input to the dispersion models) which represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release.
- A discussion of atmospheric diffusion parameters, such as lateral and vertical plume spread (σ_y and σ_z) as a function of distance, topography, and atmospheric conditions, should be related to measured meteorological parameters. The methodology for establishing these relationships should be appropriate for estimating the consequences of accidents within the range of distances which are of interest with respect to site characteristics and established regulatory criteria.
- Cumulative probability distributions of relative concentrations (X/Q) should be constructed to describe the probabilities of these X/Q values being exceeded. All cumulative probability distributions of X/Q should be presented for appropriate distances (e.g., the exclusion area boundary distance and the outer boundary of the low population zone) and time periods as specified in Section 2.3.4.2 of Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants." The methods of generating these distributions should be adequately described.
- Relative concentrations used for assessment of consequences of atmospheric radioactive releases for design basis and other accidents, and for onsite and offsite releases of hazardous airborne materials.

2.3.5 Long-Term Diffusion Estimates

ESBWR long-term diffusion estimates are given within Chapter 12.

Information will be presented in the COL application in accordance with SRP 2.3.5 concerning atmospheric diffusion estimates for routine releases of effluents to the atmosphere. The presentation reviews the following specific areas:

- Atmospheric dispersion models to calculate concentrations in air and amount of material deposited as a result of routine releases of radioactive material to the atmosphere.
- Meteorological data used as input to diffusion models.
- Derivation of diffusion parameters.
- Relative concentration (X/Q) and relative deposition (D/Q) values used for assessment of consequences of routine airborne radioactive releases.
- Points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations.

For the ESBWR Standard Plant, values of X/Q are specified in the site parameter envelope.

Characterization of atmospheric transport and diffusion conditions is necessary for estimating the radiological consequences of routine releases of radioactive materials to the atmosphere to demonstrate compliance with the numerical guides for doses contained in 10 CFR Part 50, Appendix I.

The following regulatory guides provide acceptable criteria for complying with SRP Section 2.3.5:

- Regulatory Guide 1.109 presents identification criteria to be used for specific receptors of interest.
- Regulatory Guide 1.111 provides criteria for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases. Use of the model described in NUREG/CR-2919 is acceptable.
- Regulatory Guide 1.112 presents identification criteria to be used for release points and release characteristics.

Specifically, the ESP or COL application will provide the following information:

- A description of the atmospheric dispersion models used by the applicant to calculate concentrations in air and amount of material deposited as a result of routine releases of radioactive gases to the atmosphere. The models should be sufficiently documented and substantiated to allow a review of their appropriateness to site, plant, and release characteristics.
- A discussion of atmospheric diffusion parameters, such as vertical plume spread (σ_z) as a function of distance and wind speed, related to measured meteorological parameters. Use of these parameters should be substantiated as to their appropriateness for use in estimating the consequences of routine releases from the site boundary to a radius of 80 km (50 mi) from the plant.
- Meteorological data used as input to the dispersion models. Data used for this evaluation should represent hourly average values of wind speed, wind direction, and atmospheric stability which are appropriate for each mode of release and which are characteristic of annual average atmospheric transport and diffusion conditions in the vicinity of the plant. (See SRP Section 2.3.3 for data acceptability criteria, and see Regulatory Guide 1.23 for data formats.)
- Relative concentration (X/Q) and relative deposition (D/Q) values used for assessment of consequences of routine radioactive gas releases as described in Section 2.3.5.2 of Regulatory Guide 1.70.
- Points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations.

Table 5.1-1

Site Parameters

Parameter	Value
Exclusion Area Boundary (EAB):	An area whose boundary has a Chi/Q less than or equal to 1.0×10^{-3} sec/m^3
Extreme Wind: Basic Wind Speed:(1)	 62.6 m/s (2)
Design Ambient Temperatures: 1% Exceedance Values (6) Maximum: Minimum: 0% Exceedance Values (Historical Limit) Maximum: Minimum:	 37.8°C dry bulb/26.1°C wet bulb (coincident), 27.8°C wet bulb (non-coincident) –23.3°C 46.1°C dry bulb/26.7°C wet bulb (coincident), 29.4°C wet bulb (non-coincident) –40.0°C
Precipitation (for Roof Design): (3) Maximum rainfall rate: Maximum snow load:	 49.3 cm/hr 2.39 kPa
Tornado: Maximum tornado wind speed: Translational velocity Radius: Maximum pressure drop: Rate of pressure drop: Missile Spectra:	 147.5 m/s (7) 31.3 m/s 45.7 m 16.6 kPa 11.7 kPa/s Spectrum I of SRP 3.5.1.4
Maximum Ground Water Level:	0.61 m below grade
Maximum Flood (or Tsunami) Level:	0.30 m below grade or less
Seismology (4): SSE Response Spectra:	 See Figures 5.1-1 and 5.1-2
Soil Properties: Minimum Static Bearing Capacity: Minimum Shear Wave Velocity: Liquefaction Potential:	 718 kPa 300 m/s (5) None at the site-specific SSE level

Notes:

(1) Value to be utilized for design of nonsafety-related structures is site-specific.

(2) Value to be utilized only for design of safety-related structures. It was selected to to comply with expected requirements of southeastern costal locations. This speed is approximately in the middle of wind speeds seen in a Category 4 hurricane. It exceeds the maximum wind speed that corresponds to a 100-year recurrence interval.

(3) Probable maximum precipitation (PMP) based on the maximum value for one hour over 2.6 km^2 with ratio of 5 minutes to 1 hour PMP of 0.32. Maximum short-term rate: 15.7 cm in 5 min. Maximum rainfall rate and maximum snow load were obtained from Volume III, Table 1.2-6 of the Utility Requirements Document (URD).

(4) SSE design ground response spectra are shown in Figures 5.1 1 and 5.1-2 in the horizontal and vertical directions respectively. They are defined as free-field outcrop spectra at the foundation level (bottom of the base slab).

(5) This is the minimum shear wave velocity at the foundation level.

(6) Values selected bound those presented in Volume III, Table 1.2-6, of the URD and available ESP applications.

(7) Value selected is 10% greater than the maximum value that is accepted as appropriate in Draft Guide DG-1143.