2. SITE CHARACTERISTICS

This chapter discusses the envelope of site-related design parameters that the economic simplified boiling-water reactor (ESBWR) standard plant is designed to accommodate, focusing on potential nearby hazards, meteorology, hydrology, geology, seismology, and geotechnical parameters. An applicant for a combined license (COL) referencing the ESBWR design control document (DCD) will establish the actual site characteristics with respect to these areas when it applies for a COL, or it will reference an early site permit (ESP) that reflects such characteristics. In either case, the COL applicant must show that the site parameters postulated for and considered in the ESBWR design bound the actual site characteristics. Should the postulated ESBWR site design parameters not encompass the actual site characteristics, the COL applicant will need to demonstrate by some other means that the proposed facility is acceptable at the proposed site. This might be done by reanalyzing or redesigning the proposed facility.

The U.S. Nuclear Regulatory Commission (NRC) staff based its evaluation of the ESBWR envelope of site-related design parameters on a review of the EBSWR DCD Tier 2, Chapter 2, "Site Characteristics," along with the applicant's responses to the staff's requests for additional information (RAIs).

The applicant stated that it meets the requirements of Title 10, Section 52.47(a)(1)(iii), of the Code of Federal Regulations (10 CFR 52.47(a)(1)(iii)) by providing postulated site parameters for the ESBWR design and demonstrating that the standard design meets the required design criteria. The applicant presented in DCD Tier 2, Chapter 2, the envelope of site-related parameters that the ESBWR standard plant is designed to accommodate. DCD Tier 2, Table 2.0-2 lists the site design parameters. DCD Tier 2, Table 2.0-2, defines the limits imposed on the acceptance criteria in Section II of the various sections in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (hereafter referred to as the SRP), by (1) the envelope of site-related parameters that the ESBWR plant is designed to accommodate, and (2) the site-related assumptions, both implicit and explicit, used in the evaluation of the ESBWR design.

2.1 Geography and Demography

The applicant stated that a COL applicant referencing the ESBWR DCD must demonstrate that site characteristics for a given site are in conformance with the ESBWR DCD site design parameter values. The COL applicant should follow the applicable NRC guidance for preparing the COL application depending upon whether the COL applicant references an ESP or not. DCD Tier 2, Table 2.0-2, provided by reference the information related to the NRC guidance in the SRP. The pertinent sections of the SRP include Section 2.1.1, "Site Location and Description," Section 2.1.2, "Exclusion Area Authority and Control," and Section 2.1.3, "Population Distribution."

2.1.1 Site Location and Description

2.1.1.1 Regulatory Criteria

Acceptance criteria regarding site location and description are based on meeting the relevant requirements of 10 CFR 100.20(b) and 10 CFR 100.21, "Non-Seismic Site Criteria," which require population density and use characteristics of the site environs, including the exclusion area, low-population zone (LPZ), and population center distance to be considered in determining the acceptability of a site for a power reactor.

SRP Section 2.1.1 addresses the specific criteria for meeting the relevant requirements. Typically, the staff reviews the following:

- reactor location with respect to (1) latitude and longitude and the Universal Transverse Mercator coordinate system, (2) political subdivisions, and (3) prominent natural and manmade features of the area for use in independent evaluations of the exclusion area authority and control (SRP Section 2.1.2), the surrounding population (SRP Section 2.1.3), and nearby manmade hazards (SRP Section 2.2.3)

- the site area map containing the reactor and associated principal plant structures to determine (1) the distance from the reactor to the boundary lines of the exclusion area, including the direction and distance from the reactor to the nearest exclusion area boundary (EAB) line, and (2) the location, distance, and orientation of plant structures with respect to highways, railroads, and waterways that traverse or lie adjacent to the exclusion area to ensure that they are adequately described to permit analyses of the possible effects on the plant of accidents along these transportation routes (SRP Section 2.2.3)

Design certification (DC) applications do not contain this type of site-specific information, which will be addressed by the COL application.

2.1.1.2 Summary of Technical Information

The applicant specified in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply site-specific information in accordance with SRP Section 2.1.1.

2.1.1.3 Staff Evaluation

The information regarding site location and description is site specific. The applicant's statement in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply such information in accordance with SRP Section 2.1.1 is a **COL Action Item**. The staff finds this acceptable.

2.1.1.4 Conclusion

There are no postulated site parameters for a DC related to site location and description. As this information is site specific, the COL applicant will address it and the NRC will review it at

the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore the requirement that the COL applicant address these issues is acceptable.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Regulatory Criteria

Acceptance criteria regarding exclusion area authority and control are based on meeting the relevant requirements of the following Commission regulations:

- 10 CFR 100.21(a), which states that every site must have an exclusion area as defined in 10 CFR 100.3, "Definitions"

- 10 CFR 100.3, which defines the exclusion area as the 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

SRP Section 2.1.2 addresses the specific criteria for meeting the relevant requirements. Typically, the staff reviews (1) the applicant's legal authority to determine all activities within the designated exclusion area, (2) the applicant's authority and control in excluding or removing personnel and property in the event of an emergency, and (3) proposed or permitted activities in the exclusion area unrelated to operation of the reactor to ensure that they do not result in a significant hazard to public health and safety.

DC applications do not contain this type of site-specific information, which will be addressed by the COL application.

2.1.2.2 Summary of Technical Information

The applicant specified in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply site-specific information in accordance with SRP Section 2.1.2.

2.1.2.3 Staff Evaluation

The information regarding exclusion area authority and control is site specific. The applicant's statement in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply such information in accordance with SRP Section 2.1.2 is a **COL Action Item**. The staff finds this acceptable.

2.1.2.4 Conclusion

There are no postulated site parameters for a DC related to exclusion area authority and control. As this information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.1.3 Population Distribution

2.1.3.1 Regulatory Criteria

Acceptance criteria regarding population distribution in the site vicinity are based on meeting the relevant requirements of the following Commission regulations:

(1) 10 CFR 100.21(a), which states that every site must have an exclusion area and an LPZ, as defined in 10 CFR §100.3

(2) 10 CFR 100.21(b), which states that the population center distance, as defined in 10 CFR 100.3, must be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ

(3) 10 CFR 100.3, which defines the following:

- the exclusion area as the 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
- the LPZ as the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken on their behalf in the event of a serious accident
- the population center distance as the distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents

SRP Section 2.1.3 addresses the specific criteria for meeting the relevant requirements. Typically, the staff reviews the following:

- data about the population in the site vicinity
- the population in the exclusion area
- the LPZ to determine whether appropriate protective measures could be taken on behalf of the populace in that zone in the event of a serious accident
- the nearest boundary of the closest population center containing 25,000 or more residents to determine whether this boundary is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ
- the population density in the site vicinity, including weighted transient population at the time of initial site approval and within 5 years thereafter, to determine whether it exceeds 500 persons per square mile averaged over any radial distance out to 20 miles

DC applications do not contain this type of site-specific information, which will be addressed by the COL application.

2.1.3.2 Summary of Technical Information

The applicant specified in DCD Tier 2, Table 2.0-2, that the COL applicant is to describe the population distribution in accordance with SRP Section 2.1.3.

2.1.3.3 Staff Evaluation

The information regarding population distribution in the site vicinity is site specific. The applicant's statement in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply such information in accordance with SRP Section 2.1.3 is a **COL Action Item**. The staff finds this acceptable.

2.1.3.4 Conclusion

There are no postulated site parameters for a DC related to population distribution. As this information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The information provided should be sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.2 Nearby Industrial, Transportation, and Military Facilities

DCD Tier 2, Table 2.0-2, provides by reference the information related to the NRC guidance in the SRP. The pertinent sections of the SRP include Section 2.2.1-2.2.2, "Identification of Potential Hazards in Site Vicinity," and Section 2.2.3, "Evaluation of Potential Accidents."

2.2.1-2.2.2 Identification of Potential Hazards in Site Vicinity

2.2.1.1-2.2.2.1 Regulatory Criteria

Acceptance criteria regarding the identification of potential hazards in the site vicinity are based on meeting the relevant requirements of the following Commission regulations:

- 10 CFR 100.20(b), which states that the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities) must be evaluated to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low

- 10 CFR 100.21(e), which states that potential hazards associated with nearby transportation routes and industrial and military facilities must be evaluated and site parameters established such that potential hazards from such routes and facilities will pose no undue risk to the type of facility proposed to be located at the site

SRP Section 2.2.1-2.2.2 addresses the specific criteria for meeting the relevant requirements. Typically, the staff reviews the following:

- the locations and distances of industrial, military, and transportation facilities in the vicinity of the plant

- 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, in order to identify possible hazards

- statistical data with respect to hazardous materials in order to establish a basis for evaluating the potential hazard to the plant proposed to be located at the site.

2.2.1.2-2.2.2.2 Summary of Technical Information

The applicant specified in DCD Tier 2, Table 2.0-2, that the COL applicant is to identify and evaluate potential hazards in the site vicinity, in accordance with SRP Section 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.

2.2.1.3-2.2.2.3 Staff Evaluation

The information regarding potential hazards in the vicinity of the site is site specific. The applicant's statement in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply such information in accordance with SRP Section 2.2.1-2.2.2 is a **COL Action Item**. The staff finds this acceptable.

2.2.1.4-2.2.2.4 Conclusion

There are no postulated site parameters for a DC related to identification of potential hazards in the site vicinity. As this information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.2.3 Evaluation of Potential Accidents

2.2.3.1 Regulatory Criteria

Acceptance criteria regarding evaluation of potential accidents in the vicinity of the plant are based on meeting the relevant requirements of the following Commission regulations:

(1) 10 CFR 100.20(b), which states that the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities) must be evaluated to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low

(2) 10 CFR 100.21(e), which states that potential hazards associated with nearby transportation routes and industrial and military facilities must be evaluated and site parameters established such that potential hazards from such routes and facilities will pose no undue risk to the type of facility proposed to be located at the site.

SRP Section 2.2.3 addresses the specific criteria for meeting the relevant requirements. Typically, the staff reviews the event probability for which the expected rate of occurrence of potential exposure in excess of the guideline in 10 CFR Part 100, "Reactor Site Criteria," is estimated to exceed an order of magnitude of 10^{-7} per year.

2.2.3.2 Summary of Technical Information

Both DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, specify the site parameters used in the ESBWR standard plant design. The standard plant site design parameters specified as Tier 1 are the same as those specified as Tier 2. The following standard plant site design parameters in DCD Tier 1, Table 5.1-1, and Tier 2, Table 2.0-1, relate to potential accident situations in the vicinity of the plant:

- The probability that site proximity missiles and aircraft accidents will impact the plant is less than 10^{-7} per year.

- The maximum toxic gas concentrations at the main control room and technical support center do not exceed toxicity limits.

- There is no volcanic activity.

The applicant specified in DCD Tier 2, Table 2.0-2, that the COL applicant is to identify and evaluate potential accidents emanating from those potential hazards given in SRP Section 2.2.1-2.2.2 that have a probability of occurrence greater than 10^{-7} per year and that involve the following:

- missiles more energetic than the tornado missile spectra
- pressure effects in excess of the design-basis tornado
- explosions
- fires
- aircraft impacts
- release of flammable vapor clouds
- release of toxic chemicals

2.2.3.3 Staff Evaluation

The applicant has not classified any potential accidents in the vicinity of the plant as design-basis events. The information regarding potential accidents in the vicinity of the site is site specific. The applicant's statement in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply site-specific information in accordance with SRP Section 2.2.3 is a **COL Action Item**. The staff finds this acceptable.

2.2.3.4 Conclusion

The applicant has not classified any potential accidents in the vicinity of the plant as design-basis events. As this information is site specific, the COL applicant will address it and the staff will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.3 Meteorology

10 CFR Part 52 was published in the Federal Register on August 28, 2007 [72 FR 49352]. Pursuant to 10 CFR 52.47 (a)(1), a DC applicant must provide site parameters postulated for the design. According to 10 CFR 52.1, "Definitions," parameters are the postulated physical, environmental, and demographic features of an assumed site specified in a standard DC. As stated in 10 CFR 52.79(c)(1), if a COL application references an approved standard design, the COL final safety analysis report must contain information sufficient to demonstrate that the characteristics of the site fall within the site parameters specified in the approved design.

To ensure that a nuclear power plant has been designed in compliance with the Commission's regulations, the NRC staff evaluates the site parameters postulated for the design, including the site parameters related to climate extremes and severe weather occurrences as well as the atmospheric dispersion characteristics, to ensure that they are representative of a reasonable number of sites that may be considered within a COL application. The staff has prepared Sections 2.3.1 through 2.3.5 of this SER with open items in accordance with the review procedures described in the SRP, using information presented in the DCD and responses to staff RAIs.

2.3.1 Regional Climatology

2.3.1.1 Regulatory Criteria

Acceptance criteria regarding regional climatology are based on meeting the relevant requirements of the following Commission regulations:

- General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires, in part, that structures, systems, and components (SSCs) important to safety shall be designed to withstand the effects of natural phenomena such as tornadoes and

hurricanes without loss of capability to perform their safety functions. The design bases for these SSCs shall reflect, in part, appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- GDC 4, "Environmental and Dynamic Effects Design Bases," requires, in part, that SSCs important to safety be protected against the effects of missiles resulting from events and conditions outside the plant.

- 10 CFR 100.20(c)(2) requires that meteorological characteristics of the site that are necessary for safety analysis or may have an impact upon plant design (such as maximum probable wind speed) be considered in determining the acceptability of a site for a nuclear power plant. In addition, 10 CFR 100.21(d) requires that the physical characteristics of the site, including meteorology, be evaluated and site characteristics established so that potential threats from such physical characteristics will not pose an undue risk to the type of facility proposed to be located at the site.

Section 2.3.1 of Revision 3 to the SRP, issued March 2007, states that the climatic conditions identified as site parameters for DC applications should include the following:

- the 100-year return period (straight-line) 3-second gust wind speed to be used in establishing wind loading on plant structures

- 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 SSCs important to safety

- 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

- ambient temperature and humidity statistics for use in establishing heat loads for the design of normal plant heat sink systems, postaccident containment heat removal systems, and plant heating, ventilating, and air-conditioning (HVAC) systems

- the ultimate heat sink (UHS) meteorological conditions resulting in the maximum evaporation and drift loss of water, minimum water cooling, and, if applicable, the potential for water freezing in the UHS water storage facility

Section 2.3.1 of the SRP also states that the postulated site parameters should be representative of a reasonable number of sites that may be considered within a COL application, and a basis should be provided for each of the site parameters.

The regional climatic site parameters are selected to ensure the facility is being designed such that potential threats from the physical characteristics of a potential site (e.g., regional climatic extremes and severe weather) will not pose an undue risk to the facility. As an example, Regulatory Guide (RG) 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power

Plants," provides guidance in selecting the design-basis tornado and design-basis tornado-generated missiles that a nuclear power plant should be designed to withstand to prevent undue risk to the health and safety of the public.

2.3.1.2 Summary of Technical Information

Both DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, specify the site parameters used in the ESBWR standard plant design. The standard plant site design parameters specified as Tier 1 are the same as those specified as Tier 2. The applicant identified the regional climatic conditions described below as standard plant site design parameters in DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1.

2.3.1.2.1 Extreme Wind

The extreme wind standard plant site design parameter for seismic Category I and II structures is a 100-year 3-second gust wind speed of 67.1 meters per second (m/s) (150 miles per hour (mph)) for exposure Category D.[1] The applicant stated that this value was selected to comply with expected requirements of southeastern coastal locations. The extreme wind standard plant site design parameter for nonseismic structures is a 50-year 3-second gust wind speed of 58.1 m/s (130 mph).

2.3.1.2.2 Tornado

The tornado standard plant site design parameters include a maximum tornado wind speed of 147.5 m/s (330 mph), a maximum rotational speed of 116.2 m/s (260 mph), a translational velocity of 31.3 m/s (70 mph), a radius of 45.7 meters (m) (150 feet (ft)), a maximum pressure differential of 16.6 kilopascals (kPa) (2.4 pounds per square inch (psi)), and a rate of pressure change of 11.7 kilopascals per second (kPa/s) (1.7 pounds per square inch per second (psi/s)). The applicant stated that the maximum speed selected is based on the NRC Interim Position on RG 1.76 (see letter from L.S. Rubinstein to E.E. Kintner, dated March 25, 1988).

The tornado standard plant site design parameters also include the missile Spectra I from Revision 2 of SRP Section 3.5.1.4 applied to the full building height.

2.3.1.2.3 Precipitation (for Roof Design)

The precipitation (for roof design) standard plant site design parameters include (1) a maximum rainfall rate of 49.3 centimeters (cm) per hour (19.4 inches (in.) per hour), (2) a maximum short-term rate of 15.7 cm (6.2 in.) in 5 minutes, (3) a maximum roof load of 2873 pascals (Pa) (60 pounds-force per square foot (psf), (4) a maximum 100-year recurrence interval ground snow load of 2394 Pa (50psf), and (5) a maximum 48-hour winter rainfall of 91.4 cm (36 in.). The applicant stated that maximum rainfall rates are based on a probable maximum precipitation (PMP) for 1 hour over 2.6 square kilometers (km^2) (1 square mile (mi^2)) with a ratio of 5 minutes to 1 hour PMP of 0.32 as found in Hydrometeorological Report (HMR)-52, "Application of Probable Maximum Precipitation Estimates—United States East of the 105th

[1] SEI/ASCE 7-02 defines Exposure Category D as unobstructed areas and water surfaces outside hurricane-prone regions. This category includes smooth mud flats, salt flats, and unbroken ice.

Meridian," issued August 1982. The applicant also stated that the maximum design roof load accommodates snow load and the 48-hour PMWP specified in Structural Engineering Institute (SEI)/American Society of Civil Engineers (ASCE) 7-02, "Minimum Design Loads for Buildings and Other Structures," and HMR-53, "Seasonal Variation fo 10-square mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian."

2.3.1.2.4 Ambient Design Temperature

The ambient temperature standard plant site design parameters are as follows:

- The maximum ambient design temperature corresponding to a 2-percent exceedance value is 35.6 °C (96 °F) dry bulb with a coincident wet bulb temperature of 26.1 °C (79 °F) and 27.2 °C (81 °F) for noncoincident wet bulb. The minimum ambient design temperature corresponding to a 2-percent exceedance value is −23.3 °C (−10 °F).

- The maximum ambient design temperature corresponding to a 1-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 noncoincident wet bulb. The minimum ambient design temperature corresponding to a 1-percent exceedance value is −23.3 °C (−10 °F).

- The maximum ambient design temperature corresponding to a zero-percent exceedance value (historic limit) is 47.2 °C (117 °F) dry bulb with a coincident wet bulb temperature of 26.7 °C (80 °F) and 31.1 °C (88 °F) for noncoincident wet bulb. The minimum ambient design temperature corresponding to a zero-percent exceedance value is −40 °C (−40 °F).

The applicant stated that the zero-percent exceedance values are based on conservative estimates of historical high and low values for potential sites. The applicant also stated that the 1- and 2-percent exceedance values presented above were selected in order to bound the values presented in Electric Power Research Institute's (EPRI's) "Advanced Light Water Reactor Utility Requirements Document" (URD) and available ESP applications.

2.3.1.2.5 Ultimate Heat Sink

DCD Tier 2, Section 3.1.4.15, states that the ESBWR UHS is the isolation condenser/passive containment cooling (IC/PCC) pools. In the event of a design-basis accident, heat is transferred to the IC/PCC pools through the passive containment cooling system (PCCS). The water in the IC/PCC pools is allowed to boil, and the resulting steam is vented to the environment. Since the UHS in the ESBWR design is the atmosphere with boiling water in the IC/PCC pools providing the heat transfer mechanism, no information on limiting meteorological conditions is required for the design of the UHS.

2.3.1.2.6 COL Information

DCD Tier 2, Section 2.0.1.1, states that a COL applicant referencing the ESBWR DCD should demonstrate that the site characteristics for a given site fall within the ESBWR DCD site

parameter values. DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, list the ESBWR standard plant site design parameters. A number of these site design parameters (i.e., extreme wind, tornado, precipitation, ambient design temperature) are related to regional climatology. This is a **COL Action Item.**

DCD Tier 2, Section 2.0.1.2, states that a COL application is to provide information on site characteristics as described in DCD Tier 2, Table 2.0-2. This information may be contained in an ESP if the COL applicant is referencing such a permit. DCD Tier 2, Table 2.0-2, Section 2.3.1, states that the COL applicant will determine the basic speed of extreme wind for use in the design of non-safety-related structures that are not included as part of the ESBWR standard plant design. The COL applicant is to also confirm or reanalyze this information in accordance with SRP Section 2.3.1. This is also a **COL Action Item.**

2.3.1.3 Staff Evaluation

2.3.1.3.1 Extreme Wind

DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, of Revision 0 stated that (1) the basic speed of extreme winds used for the design of safety-related structures is 62.6 m/s (140 mph) with an importance factor of 1.15 and (2) the basic speed of extreme wind for non-safety-related structures is 49.2 m/s (110 mph) with an importance factor of 1.00. The staff asked the applicant in RAI 2.3-2 to provide the basis for the selection of the extreme winds used for the design of safety-related structures as presented in DCD Tier 2, Table 2.0-1. The staff also asked the applicant in RAI 14.3-22 to update DCD Tier 1, Table 5.1-1, to incorporate the response to RAI 2.3-2.

In its response to RAI 2.3-2 dated July 31, 2006, the applicant stated that the selected extreme wind speed of 62.6 m/s (140 mph) is approximately in the middle of wind speeds seen in a Category 4 hurricane and was selected to comply with expected requirements of southeastern coastal locations. The applicant also stated that it will update DCD Tier 2, Table 2.0-1, to (1) clarify the basis for the selection of the 62.6 m/s (140 mph) value and (2) state that the COL applicant is to determine the extreme wind site design parameter for non-safety-related, nonseismic structures. In its response to RAI 14.3-22 dated July 31, 2006, the applicant also stated that it will update DCD Tier 1, Table 5.1-1, to incorporate the response to RAI 2.3-2.

The applicant issued Revision 2 of the DCD in November 2006. The applicant revised DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, of Revision 2 to state that the extreme wind site design parameters were (1) a 100-year 3-second gust wind speed of 67.1 m/s (150 mph) for seismic Category I and II structures and (2) 49.2 m/s (110 mph) for nonseismic standard plant structures. Note that designing to a 100-year wind speed of 67.1 m/s (150 mph) specified in Revision 2 to the DCD is equivalent to designing to a basic (e.g., 50-year) 62.6 m/s (140 mph) wind speed with an importance factor of 1.15 as specified in Revision 0 of the DCD. Revision 3 of the DCD issued in February 2007 contained the same extreme wind site design parameters as Revision 2 to the DCD.

In reviewing the applicant's response to RAIs 2.3-2 and 14.3-22 and the subsequent Revision 3 to the DCD, the staff notes the following:

- The applicant stated in its response to RAI 2.3-2 that the selected extreme wind speed value of 62.6 m/s (140 mph) in DCD Revision 0 is approximately in the middle of wind speeds seen in a Category 4 hurricane. SER Table 2.3.1-1 presents the National Weather Service's definition of each Saffir-Simpson hurricane scale category, which is based on a 1-minute average wind speed. Assuming the applicant's selected 62.6 m/s (140 mph) extreme wind speed value is a 3-second gust "basic wind speed value" as defined by SEI/ASCE 7-02, SER Table 2.3.1-1 shows that the applicant's selected extreme wind speed value represents a strong Category 2 hurricane rather than a moderate Category 4 hurricane. This is because the Saffir-Simpson hurricane scale is based on 1-minute average wind speeds (National Hurricane Center, "The Saffir-Simpson Hurricane Scale," June 22, 2006) whereas the value of the maximum 3-second gust in a hurricane environment is approximately 30 percent higher than the 1-minute average wind speed (Atlantic Oceanographic and Meteorological Laboratory, "Frequently Asked Questions, Subject: D4) What Does 'Maximum Sustained Wind' Mean? How Does it Relate to Gusts in Tropical Cyclones?" April 21, 2006). Similarly, the selected extreme wind speed value of 67.1 m/s (150 mph) in DCD Revision 3 represents a weak to moderate Category 3 hurricane.

- Contrary to the statements in the applicant's responses to RAIs 2.3-2 and 14.3-22, the updated DCD Revision 3, Tier 1, Table 5.1-1, and Tier 2, Table 2.0-1, did not describe the basis for the selected extreme wind standard plant site design parameters.

- It is unclear whether the 49.2 m/s (110 mph) extreme wind standard plant site design parameter for nonseismic structures is a 3-second gust wind speed.

Table 2.3.1-1 The Saffir-Simpson Hurricane Scale[2]

Saffir-Simpson Category	Wind speed	
	1-Minute Average	Corresponding 3-Second Gust[3]
1	74–95 mph	96–124 mph
2	96–110 mph	125–143 mph
3	111–130 mph	144–169 mph
4	131–155 mph	170–202 mph
5	>155 mph	>202 mph

Consequently, the staff issued a supplemental RAI 2.3-2 requesting that the applicant revise DCD Tier 1, Table 5.1-1, and Tier 2, Table 2.0-1, to provide the basis for the selection of the

[2] The Saffir-Simpson Hurricane Scale is a 1–5 rating based on the hurricane's intensity where the 1-minute average wind speed is the determining factor in the scale.

[3] Typically in a hurricane environment, the value of the maximum 3-second gust over a 1-minute period is on the order of 1.3 times (or 30 percent higher than) than the 1-minute sustained wind.

extreme wind standard plant site design parameters for seismic Category I and II structures as well as nonseismic standard plant structures and clarify whether the 49.2 m/s (110 mph) extreme wind standard plant site design parameter for nonseismic plant structures is a 3-second gust wind speed. In its response dated May 8, 2007, the applicant stated that it would add a note to DCD Tier 2, Table 2.0-1, stating that it selected the extreme wind site design parameter for seismic Category I and II structures to comply with expected requirements of southeastern coastal locations. The applicant also stated that the 49.2 m/s (110 mph) extreme wind site design parameter for nonseismic plant structures is a 50-year fast-mile-wind value.

The staff issued a second supplemental RAI 2.3-2 regarding the nonseismic standard plant structure extreme wind site parameter. The staff asked the applicant to (1) express this site parameter in the same 3-second gust wind speed units used to present the seismic Category I and II structure extreme wind site parameter and (2) select a 50-year wind speed value that is consistent with the 100-year wind speed value chosen for the seismic Category I and II structures. In its response to the second supplemental RAI 2.3-2 dated July 19, 2007, the applicant stated that the extreme wind standard plant site design parameter for nonseismic plant structures will be changed to a 50-year 3-second gust wind speed of 58.1 m/s (130 mph). The applicant's incorporation of these changes into a future revision of the DCD is **Confirmatory Item 2.3-2.**

Figure 6.1 of SEI/ASCE 7-02 provides a map of the continental United States showing basic wind speeds for design-basis wind loading. These basic wind speeds are 3-second gust values at 33 feet (10 meters) above the ground in Exposure C[4] and represent 50-year return periods. The applicant's extreme wind site design parameter of 67.1 m/s (150 mph) for seismic Category I and II structures was based on multiplying a 50-year return period value of 62.6 m/s (140 mph) by the square root of the SEI/ASCE 7-02 essential facilities importance factor 1.15 to account for the 100-year recurrence. Figure 6.1 of SEI/ASCE 7-02 shows that a basic (50-year return period) wind speed value of 62.6 m/s (140 mph) is exceeded only in southernmost Louisiana and Florida. The ESBWR is also designed for Exposure D, which is conservative. Consequently, the chosen extreme wind site design parameter for seismic Category I and II structures is representative of a reasonable number of sites that may be considered within a COL application.

Likewise, Figure 6.1 of SEI/ASCE 7-02 shows the 50-year return period value of 58.1 m/s (130 mph) used for the extreme wind standard plant site design parameter for nonseismic plant structures is exceeded only along the hurricane prone Gulf, Georgia, South Carolina, and North Carolina coasts as well as southern Florida. Consequently, the chosen extreme wind site design parameter for nonseismic structures is also representative of a reasonable number of sites that may be considered within a COL application. COL applicants with sites where this extreme wind parameter is exceeded will need to reevaluate the extreme wind design for nonseismic plant structures.

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[4] SEI/ASCE 7-02 defines Exposure C as open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m). This category includes flat open country, grasslands, and all water bodies in hurricane-prone regions.

2.3.1.3.2 Tornado

The applicant stated that the selected maximum tornado wind speed is based on the NRC Interim Position on RG 1.76. In fact, all the tornado standard plant site design parameters selected by the applicant (e.g., maximum wind speed, maximum rotational speed, translational velocity, radius, maximum pressure differential, and rate of pressure change) are the same as the Region I design-basis tornado characteristics specified in the NRC Interim Position on RG 1.76. Region I represents the central portion of the United States where the most severe tornadoes occur. The ESBWR tornado standard plant site design parameters are also more severe than the Region I design-basis tornado characteristics specified in the more recently published Revision 1 of RG 1.76. Consequently, the staff finds that the applicant has provided an adequate basis for the tornado standard plant site design parameters, and the applicant's tornado standard plant site design parameters are representative of a reasonable number of sites that may be considered within a COL application.

SER Section 3.5.1.4 discusses the staff's evaluation of the applicant's tornado missile standard plant site design parameters.

2.3.1.3.3 Precipitation (for Roof Design)

DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, in Revision 0 stated that the maximum snow load for roof design is 2394 Pa (50 psf). The staff requested the basis for the DCD Tier 2, Table 2.0-1, maximum roof design snow load in RAI 2.3-4. The staff also asked the applicant in RAI 14.3-22 to update DCD Tier 1, Table 5.1-1, to incorporate the response to RAI 2.3-4.

In its response to RAI 2.3-4 dated July 31, 2006, the applicant stated that it will update DCD Tier 2, Table 2.0-1, to clarify that the URD is the source of this value. In its response to RAI 14.3-22 dated July 31, 2006, the applicant also stated that it will update DCD Tier 1, Table 5.1-1, to incorporate the response to RAI 2.3-4. However, DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, in Revision 3 provided a revised maximum precipitation roof load of 2873 Pa (60 psf) and stated that the revised load accommodates snow load and PMWP as specified in SEI/ASCE 7-02 and HMR-52.

The NRC Staff's "Site Analysis Branch Position — Winter Precipitation Loads" (March 24, 1975) states that (1) winter precipitation loads to be included in the combination of normal live loads should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level, and (2) winter precipitation loads to be included in the combination of extreme live loads should be based on the addition of 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. Modifications to this procedure are allowed for certain areas where it can be satisfactorily demonstrated that the PMWP could neither fall nor remain entirely on top of the antecedent snowpack and/or roofs. Consequently, the staff issued a supplemental RAI 2.3-4 requesting that the applicant update the DCD to provide the design values and bases for winter precipitation loads to be included in the combination of (1) normal live loads and (2) extreme live loads.

In its response to the second supplemental RAI 2.3-2 dated July 19, 2007, the applicant included 100-year recurrence interval maximum ground snow load of 2394 Pa (50 psf) and a

maximum 48-hour winter rainfall of 91.4 cm (36 in.) as standard plant site design parameters for roof design in DCD Tier 2, Table 2.0-1. The applicant's incorporation of these changes into a future revision of the DCD is **Confirmatory Item 2.3-4.**

The staff evaluated whether a 100-year recurrence interval maximum ground snow load of 2394 Pa (50 psf) is representative of a reasonable number of sites that may be considered within a COL application. The staff performed this evaluation by reviewing the historic snowfall data identified in the first three docketed ESP applications (e.g., NUREG-1835, "Safety Evaluation Report for an Early Site Permit (ESP) at the North Anna ESP Site"; NUREG-1840, "Safety Evaluation Report for an Early Site Permit (ESP) at the Grand Gulf Site"; and NUREG-1844, "Safety Evaluation Report for an Early Site Permit (ESP) at the Exelon Generation Company, LLC (EGC) ESP Site" (i.e., Clinton)). NUREG-1835 identified a 100-year snowpack value of 30.5 psf (1460 Pa) for the North Anna ESP site, NUREG-1840 identified a 100-year snowpack value of 6.1 psf (292 Pa) for the Grand Gulf ESP site, and NUREG-1844 identified a 100-year snowpack value of 24.4 psf (1168 Pa) for the Clinton ESP site. The ESBWR roof design maximum ground snow load value of 2394 Pa (50 psf) is more conservative than these three ESP 100-year snowpack site characteristic values. Consequently, the staff finds that the applicant's roof design maximum ground snow load standard plant site design parameter is representative of a reasonable number of sites that may be considered within a COL application.

In its response to supplemental RAI 2.3-4 dated May 8, 2007, the applicant stated that the roof design maximum 48-hr winter rainfall standard plant site design parameter of 91.4 cm (36 in.) would result in an additional weight of 10 cm (4 in.) of water on the roof because the lower lip of the roof scuppers is 10 cm (4 in.) above the roof. Assuming all primary roof drains are clogged, the additional weight of 10 cm (4 in.) of water on the roof would be 996 Pa (21 psf). However, the applicant should also provide an additional roof design 48-hour PMWP standard plant site design parameter to account for additional weight if at least part of the 48-hour PMWP falls as frozen precipitation (e.g., snow and/or ice) and therefore remains on the roof. This is **Open Item 2.3-4.**

SER Section 2.4.2 discusses the staff's evaluation of the applicant's maximum rainfall rate standard plant site design parameters.

2.3.1.3.4 Ambient Design Temperature

DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, of Revision 0 stated that the maximum design ambient temperature corresponding to a 1-percent exceedance value was 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 noncoincident web bulb temperature. The minimum design temperature corresponding to a 1-percent exceedance value was −23.3 °C (−10 °F). The zero-percent exceedance dry bulb temperature was 46.1 °C (115 °F) with a coincident wet bulb temperature of 26.7 °C (80 °F) and 29.4 °C (85 °F) for noncoincident wet bulb temperature. The minimum design temperature corresponding to a zero-percent exceedance value was −40 °C (−40 °F).

The staff asked the applicant in RAI 2.3-3 to provide a definition of the zero- and one-percent exceedance design temperatures presented in Revision 0 to DCD Tier 2, Table 2.0-1. The staff also asked the applicant in RAI 14.3-22 to update DCD Tier 1, Table 5.1-1, to incorporate the response to RAI 2.3-3.

In its response to RAI 2.3-3 dated July 31, 2006, the applicant stated that the zero-exceedance values are historical high or low values as stated in DCD Tier 1, Table 5.1-1. The applicant also stated that the 1-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. The applicant stated that it selected a set of parameters that bounds all three ESP sites and the URD for use as standard plant site design parameters for the ESBWR.

In Revision 2 of the DCD dated November 2006, the applicant added 2-percent exceedance ambient design temperatures as standard plant site design parameters. The maximum design ambient temperature corresponding to a 2-percent exceedance value was 35.6 °C (96 °F) dry bulb with a coincident wet bulb temperature of 26.1 °C (79 °F) and 27.2 °C (81 °F) for noncoincident web bulb temperature. The minimum design temperature corresponding to a 2-percent exceedance value was −23.3 °C (−10 °F). Revision 3 of the DCD issued in February 2007 contained the same ambient temperature standard plant site design parameter values as DCD Revision 2.

To determine whether the applicant's ambient design temperature standard plant site design parameters bound a reasonable number of sites that may be considered within a COL application, the staff compared the applicant's ambient design temperature standard plant site design parameters to the ambient air temperature and humidity site characteristics identified in the first three docketed ESP applications (e.g., NUREG-1835, NUREG-1840, and NUREG-1844). In performing this comparison, the staff considers the zero-percent exceedance or historic limit ambient design temperature standard plant site design parameters presented in the ESBWR DCD to be equivalent to the 100-year return period ambient air temperature and humidity site characteristic values presented in the first three docketed ESP applications.

The staff found that the ESP 100-year return period maximum dry bulb temperature site characteristic for Clinton, 47.2 °C (117 °F), was higher than the applicant's zero-percent exceedance (historic limit) standard plant site design parameter of 46.1 °C (115 °F). Likewise, the staff found that the ESP 100-year return period maximum noncoincident wet bulb temperature site characteristics for North Anna and Clinton, 31.1 °C (88 °F) and 30.0 °C (86 °F), respectively, were higher than the applicant's zero-percent exceedance (historic limit) standard plant site design parameter of 29.4 °C (85 °F). Consequently, the applicant's zero-percent exceedance (historic limit) maximum dry bulb temperature and maximum noncoincident wet bulb temperature standard plant site design parameters may not bound a reasonable number of sites that may be considered within a COL application.

The staff issued a supplemental RAI 2.3-3 requesting that the applicant revise the ESBWR zero-percent exceedance (historic limit) maximum dry bulb and maximum noncoincident wet bulb temperature standard plant site design parameters to be more inclusive of a number of sites that may be considered within a COL application. In its response dated May 8, 2007, the applicant stated that it would change its zero-percent exceedance maximum dry bulb

temperature and maximum noncoincident wet bulb temperature standard plant site design parameters to 47.2 °C (117 °F) and 31.1 °C (88 °F), respectively. The incorporation of these changes into a future revision of the DCD is **Confirmatory Item 2.3-3.**

2.3.1.4 Conclusion

Due to the open items that remain to be resolved (Open Item 2.3-4 and Confirmatory Items 2.3-2, 2.3-3, and 2.3-4), the staff was unable to finalize its conclusions regarding acceptability. The applicant has selected the standard plant site design parameters referenced above for plant design inputs, but the staff does not claim that they are representative of any particular percentile of possible sites in the United States and does not assert the acceptability of the basis for the choice of values with respect to siting. The regional climatology is site specific and will be addressed by the COL applicant. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in COL or construction permit (CP) application.

2.3.2 Local Meteorology

2.3.2.1 Regulatory Criteria

Acceptance criteria regarding local meteorology are based on meeting the relevant requirements of the following Commission regulations:

- GDC 2 in Appendix A to 10 CFR Part 50 requires, in part, that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as tornadoes and hurricanes without loss of capability to perform their safety functions. The design bases for these SSCs shall reflect, in part, appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

- GDC 4 requires, in part, that SSCs important to safety be protected against the effects of missiles resulting from events and conditions outside the plant.

- 10 CFR 100.20(c)(2) requires that meteorological characteristics of the site that are necessary for safety analysis or may have an impact upon plant design (such as maximum probable wind speed) be considered in determining the acceptability of a site for a nuclear power plant. In addition, 10 CFR 100.21(d) requires that the physical characteristics of the site, including meteorology, be evaluated and site characteristics established so that potential threats from such physical characteristics will not pose an undue risk to the type of facility proposed to be located at the site.

Section 2.3.2 of the SRP typically involves reviewing the following:

- summaries of local meteorological data based on onsite measurements and National Weather Service station summaries or other standard installation summaries from appropriate nearby locations

- a discussion and evaluation of the influence of the plant and its facilities on the local meteorological and air quality conditions, including identifying potential changes in normal and extreme values

- a complete topographical description of the site and environs out to a distance of 80 km (50 mi).

DC applications do not contain this type of site-specific information, which will be addressed by the COL application.

2.3.2.2 Summary of Technical Information

DCD Tier 2, Section 2.0.1.2, states that a COL application is to provide information on site characteristics as described in DCD Tier 2, Table 2.0-2. This information may be contained in an ESP if the COL applicant is referencing such a permit. DCD Tier 2, Table 2.0-2, Section 2.3.2, states that the COL applicant is to supply site-specific information in accordance with SRP Section 2.3.2. This is a **COL Action Item.**

2.3.2.3 Staff Evaluation

Because summaries of local meteorological conditions and the impacts of the plant and its facilities on the local meteorological conditions (e.g., effects of plant structures, terrain modification, and heat and moisture sources related to plant operation) is site specific, the applicant's statement in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply site-specific information in accordance with SRP Section 2.3.2 is acceptable.

2.3.2.4 Conclusion

There are no postulated site parameters for a DC related to local meteorology. Local meteorological conditions are site specific and will be addressed by the COL applicant. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application.

2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Regulatory Criteria

Acceptance criteria regarding onsite meteorological measurements programs are based on meeting the relevant requirements of the following Commission regulations:

- 10 CFR 100.20(c)(2), with respect to the meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design in determining the acceptability of a site for a nuclear power plant

- 10 CFR 100.21©, with respect to the meteorological data used to evaluate site atmospheric dispersion characteristics and establish dispersion parameters such that

(1) radiological effluent release limits associated with normal operation can be met for any individual located off site, and (2) radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and LPZ

- GDC 19, "Control Room," in Appendix A to 10 CFR Part 50, with respect to the meteorological considerations used to evaluate the personnel exposures inside the control room during radiological and airborne hazardous material accident conditions

- 10 CFR 50.47(b)(4), 10 CFR 50.47(b)(8), and 10 CFR 50.47(b)(9), as well as Section IV.E.2 of Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," with respect to the onsite meteorological information available for determining the magnitude and continuously assessing the impact of the releases of radioactive materials to the environment during a radiological emergency

- Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, with respect to meteorological data used in determining the compliance with numerical guides for design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonable achievable (ALARA)

- Subpart D, "Radiation Dose Limits for Individual Members of the Public," of 10 CFR Part 20, "Standards for Protection Against Radiation," with respect to the meteorological data used to demonstrate compliance with dose limits for individual members of the public

SRP Section 2.3.3 typically involves reviewing the following:

- the onsite meteorological monitoring program instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, data acquisition and reduction procedures

- the resulting onsite meteorological database, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions

RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," describes a suitable onsite meteorological monitoring program.

DC applications do not contain this type of site-specific information, which will be addressed by the COL application.

2.3.3.2 Summary of Technical Information

DCD Tier 2, Section 2.0.1.2, states that a COL application is to provide information on site characteristics as described in DCD Tier 2, Table 2.0-2. This information may be contained in

an ESP if the COL applicant is referencing such a permit. DCD Tier 2, Table 2.0-2, Section 2.3.3, states that the COL applicant is to supply site-specific information in accordance with SRP Section 2.3.3. This is a **COL Action Item.**

2.3.3.3 Staff Evaluation

Because the onsite meteorological monitoring program and the resulting data are site specific, the applicant's statement in DCD Tier 2, Table 2.0-2, that the COL applicant is to supply site-specific information in accordance with SRP Section 2.3.3 is acceptable.

2.3.3.4 Conclusion

The onsite meteorological monitoring program and the resulting data are site specific and will be addressed by the COL applicant.

2.3.4 Short-Term Atmospheric Dispersion Estimates for Accidental Releases

2.3.4.1 Regulatory Criteria

Acceptance criteria regarding short-term dispersion estimates for accidental releases are based on meeting the relevant requirements of the following Commission regulations:

- GDC 19, with respect to the meteorological considerations used to evaluate the personnel exposures inside the control room during radiological and airborne hazardous material accident conditions

- 10 CFR 52.47(a)(2)(iv), with respect to an assessment of the plant design features intended to mitigate the radiological consequences of accidents, which includes consideration of postulated site meteorology, to evaluate the offsite radiological consequences at any point on the EAB and on the outer boundary of the LPZ

- 10 CFR 100.21(c)(2), with respect to the atmospheric dispersion characteristics used in the evaluation of EAB and LPZ radiological dose consequences for postulated accidents

Section 2.3.4 of Revision 3 to the SRP issued March 2007 states that the DC applicant should include EAB, LPZ, and control room atmospheric dispersion factors (χ/Q values) for the appropriate time periods in the list of site parameters. The DC application should also contain figures and tables showing the design features that would be used by the COL applicant to generate control room χ/Q values (e.g., intake heights, release heights, building cross-sectional areas, distance to receptors). Section 2.3.4 of the SRP also states that the postulated site parameters should be representative of a reasonable number of sites that may be considered within a COL application and a basis should be provided for each of the site parameters.

The EAB and LPZ χ/Q values are used to help demonstrate that the offsite radiological consequences of accidents meet specified radiation dose guidelines for the EAB and LPZ as specified in 10 CFR 52.47(a)(2)(iv). RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," presents criteria for characterizing atmospheric dispersion conditions for evaluating the consequences of radiological releases to the EAB and LPZ.

The control room χ/Q values are used to help demonstrate that the control room radiological consequences of accidents meet specified radiation dose guidelines specified in GDC 19. RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," presents criteria for characterizing atmospheric dispersion conditions for evaluating the consequences of radiological releases to the control room.

2.3.4.2 Summary of Technical Information

Both DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1 specify the site parameters used in the ESBWR standard plant design. The standard plant site design parameters specified as Tier 1 are the same as those specified as Tier 2. SER Table 2.3.4-1 provides a list of the short-term (accident release) χ/Q values identified by GEH as standard plant site design parameters. These standard plant site design parameters are used (with exceptions noted below) in the infrequent event radiological consequence analyses presented in DCD Tier 2, Section 15.3, and in the accident radiological consequence analyses presented in DCD Tier 2, Section 15.4. SER Table 2.3.4-2 lists the release pathways assumed by GEH for each of the radiological consequence analyses presented in DCD Tier 2, Sections 15.3 and 15.4.

The radiological consequence analyses presented in DCD Tier 2, Section 15.3, for infrequent events relied upon the EAB, LPZ, and control room χ/Q standard plant site design parameters presented in DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, except for the mislocated and misoriented fuel assembly loading error consequence analyses, which relied on the fuel loading error event radiological analysis associated with Global Nuclear Fuel, "Transmittal of Updated Attachments Supporting GESTAR II Amendment 28 and Associated GESTAR II Sections" (June 2, 2006). GEH stated in DCD Tier 2, Section 15.3.17, that the COL holder should confirm the applicability of the generic radiological dose assessment for misloaded fuel bundles to the site meteorological characteristics.

Likewise, the radiological consequence analyses presented in DCD Tier 2, Section 15.4, for accidents relied upon the EAB, LPZ, and control room standard plant site design parameter χ/Q values presented in DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, except for the feedwater line break accident and the reactor water cleanup/shutdown cooling (RWCU/SDC) system failure outside containment consequence analyses, which used an EAB χ/Q value of 1.00×10^{-3} seconds per cubic meter (s/m^3). GEH stated in DCD Tier 2, Section 15.4.11, that the COL applicants must confirm the atmospheric dispersion factors for the following release locations:

- All release points must have an EAB χ/Q value less than or equal to that presented in DCD Tier 2, Table 2.0-1, for all events.

- All release points must have LPZ χ/Q values less than or equal to those presented in Table 2.0-1 for all events.

- Fuel-handling accident (FHA) releases from the reactor building or the fuel building must have control room air intake χ/Q values less than or equal to those presented in Table 2.0-1.

- Loss of coolant accident (LOCA) releases from the reactor building, PCCS ventilation stack, and main condenser must have control room louver χ/Q values less than or equal to those presented in Table 2.0-1.

- Main steamline break (MSLB) accident releases from the turbine building must have control room air intake χ/Q values less than or equal to those presented in Table 2.0-1.

- Instrument line break accident releases from the reactor building must have control room air intake χ/Q values less than or equal to those presented in Table 2.0-1.

- DCD Tier 2, Section 15.4.7.5.4, gives the feedwater line break analysis assumptions.

- DCD Tier 2, Section 15.4.9.5.4, gives the RWCU/SDC line break analysis assumptions.

DCD Tier 2, Section 2.0.1.1, states that a COL applicant referencing the ESBWR DCD should demonstrate that the site characteristics for a given site fall within the ESBWR DCD site parameter values. DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, list the ESBWR standard plant site design parameters. A number of these site design parameters (i.e., EAB χ/Q, LPZ χ/Q, control room χ/Q) are related to short-term atmospheric dispersion estimates for accidental releases. Footnote 11 to DCD Tier 1, Table 5.1-1, and footnote 11 to DCD Tier 2, Table 2.0-1, also state that if a selected site has a χ/Q value that exceeds the ESBWR reference site value, the COL applicant will address how the radiological consequences associated with the controlling design-basis accident continue to meet the dose reference values provided in 10 CFR 50.34(a) and control room operator dose limits provided in GDC 19 using site-specific χ/Q values. This is a **COL Action Item.**

DCD Tier 2, Section 2.0.1.2, states that a COL application is to provide information on site characteristics as described in DCD Tier 2, Table 2.0-2. This information may be contained in an ESP if the COL applicant is referencing such a permit. DCD Tier 2, Table 2.0-2, Section 2.3.4, states that the COL applicant is to supply site-specific information in accordance with SRP Section 2.3.4 to show that the site meteorological dispersion values, as calculated in accordance with RGs 1.145 and 1.194 and compared to dose values given in DCD Tier 2, Chapter 15, result in doses less than stipulated in 10 CFR 50.34(a) and the applicable portions of SRP Chapters 11 and 15. This is also a **COL Action Item.**

2.3.4.3 Staff Evaluation

The staff reviewed the radiological consequence analyses presented in DCD Tier 2, Sections 15.3 and 15.4; the fuel loading error radiological consequence analysis presented in GESTAR II Amendment 28; the control building (CB) habitability systems description presented in DCD Tier 2, Section 6.4; and the GEH responses to RAIs 2.3-8, 2.3-9, 15.3-1, and 15.3-2 to

determine whether the assumed fission product transport to the environment for each infrequent event and accident was compatible with the χ/Q values used to model the release pathway.

Revision 3 to DCD Tier 2, Reference 15.3-3, cites an August 2004 version of the GESTAR II Amendment 28 report that had been submitted to the staff for review. The staff asked the applicant in RAI 15.3-1 to update DCD Tier 2, Reference 15.3-3, to cite a revised version of the GESTAR II Amendment 28 report following staff approval. In its response to RAI 15.3-1 dated July 31, 2006, the applicant stated that it would update DCD Tier 2, Reference 15.3-3, as soon as the safety evaluation for GESTAR II Amendment 28 is complete. The final reference will be the GESTAR revision (accepted version) that implements Amendment 28 and includes the safety evaluation. This is **Confirmatory Item 15.3-1.**

2.3.4.3.1 Offsite χ/Q Values

SRP Section 2.3.4 states that the DC applicant should include EAB and LPZ χ/Q values for the appropriate time periods in the list of site parameters. Revision 0 to the DCD did not identify the EAB and LPZ χ/Q values used in the Chapter 15 radiological consequence analyses as standard plant site design parameters. In RAI 2.3-8, the staff asked GEH to provide EAB and LPZ χ/Q values as standard plant site design parameters in DCD Tier 2, Table 2.0-1. The staff also asked the applicant in RAI 14.3-24 to update DCD Tier 1, Table 5.1-1, to include LPZ χ/Q values.

In its response to RAI 2.3-8 dated October 20, 2006, GEH agreed to provide the requested EAB and LPZ χ/Q values as standard plant site design parameters in DCD Tier 2, Chapter 2. In its response to RAI 14.3-24 dated October 20, 2006, GEH also agreed to list LPZ χ/Q values in DCD Tier 1, Table 5.1-1. The applicant's response to RAI 2.3-8 also stated that the requested EAB and LPZ χ/Q values will be taken from GE Energy Report NEDE-33279P, "ESBWR Containment Fission Product Removal Evaluation Model." This GE Energy report summarizes the methodology used by GEH to evaluate the potential dose consequences resulting from a LOCA. Chapter 5 of NEDE-33279P states that the EAB and LPZ χ/Q values were "back calculated" to determine the bounding values that would result in doses just under regulatory limits. GEH included the EAB and LPZ χ/Q values from NEDE-33279P as site design parameters in Revision 2 to DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1.

In reviewing Revision 3 to DCD Tier 2, Sections 2, 15.3, and 15.4, the staff notes that DCD Tier 2, Tables 15.4-14 and 15-4.21, indicate that a χ/Q value of 1.00×10^{-3} s/m^3 is used to calculate doses at the EAB for the feedwater line break and the RWCU/SDC line break accidents, respectively. The applicant should explain why the EAB χ/Q value used in these radiological consequence analyses differs from the EAB χ/Q value of 2.00×10^{-3} s/m^3 listed as a standard plant site design parameter in DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1. The use of a lower EAB χ/Q value in these DCD radiological consequence analyses results in lower calculated doses for the EAB. This is identified as **Open Item 2.3-8.**

GEH provided a description of assumed release pathways to the environment for several infrequent events and accidents in its response to RAI 2.3-9 dated November 13, 2006. One of the release pathways discussed is the main plant stack, which is not part of the ESBWR standard plant design. Because the main plant stack is not part of the ESBWR standard plant

design, the DCD should explicitly state that the COL applicant should confirm at the COL stage that the main plant stack EAB and LPZ χ/Q site characteristic values are less than or equal to the ESBWR EAB and LPZ χ/Q standard plant site design parameters. This is identified as part of **Open Item 2.3-9.**

In order to determine whether the ESBWR EAB and LPZ χ/Q standard plant site design parameters bound a reasonable number of sites that may be considered within a COL application, the staff compared the ESBWR EAB and LPZ χ/Q standard plant site design parameters to the EAB and LPZ χ/Q site characteristics identified in the first three docketed ESP applications (e.g., NUREG-1835, NUREG-1840, and NUREG-1844). The staff found that the ESBWR EAB and LPZ χ/Q standard plant site design parameters were higher than the EAB and LPZ χ/Q site characteristics presented in the three ESP applications.[5] Consequently, pending resolution of Open Item 2.3-8, the staff finds that the applicant has provided an adequate basis for the EAB and LPZ χ/Q standard plant site design parameters.

GESTAR II Amendment 28 gives the offsite radiological analysis for the mislocated and misoriented fuel assembly loading error events. A bounding EAB and LPZ χ/Q value of 5.04×10^{-3} s/m^3 was back-calculated using the alternative source term (AST) regulatory dose criteria for the EAB and LPZ. This means any site with EAB and LPZ χ/Q site characteristics of less than 5.04×10^{-3} s/m^3 will result in doses less than the regulatory criteria. Since the GESTAR II EAB and LPZ χ/Q value of 5.04×10^{-3} s/m^3 is greater than any of the ESBWR standard plant site design parameter EAB and LPZ χ/Q values listed in SER Table 2.3.4-1, the ESBWR standard plant site design parameter EAB and LPZ χ/Q values are more limiting.

2.3.4.3.2 Control Room χ/Q Values

SRP Section 2.3.4 states that the DC applicant should include control room χ/Q values for the appropriate time periods in the list of site parameters. Revision 0 to the DCD did not identify the control room χ/Q values used in the Chapter 15 radiological consequence analyses as standard plant site design parameters. In RAI 2.3-8, the staff asked GEH to provide control room χ/Q values as site design parameters in DCD Tier 2, Table 2.0-1. The staff also asked the applicant in RAI 14.3-24 to update DCD Tier 1, Table 5.1-1, to include control room χ/Q values.

In its response to RAI 2.3-8 dated October 20, 2006, GEH agreed to provide the requested control room χ/Q values as site design parameters in DCD Tier 2, Chapter 2. In its response to RAI 14.3-24 dated October 20, 2006, GEH also agreed to list control room χ/Q values in DCD Tier 1, Table 5.1-1. The applicant's response to RAI 2.3-8 also stated that it will take the requested control room χ/Q values from GE Energy Report NEDE-33279P. The GE Energy report presents control room χ/Q values for three release pathways—(1) containment leakage through the reactor building east wall, (2) PCCS leakage that is assumed to be ducted to the top of the reactor building, and (3) main steam isolation valve (MSIV) leakage from the main condenser in the turbine building. Chapter 5 of NEDE-33279P states that these control room

[5] Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing a site design parameter χ/Q value and a site characteristic χ/Q value, the site is acceptable for the design if the site characteristic χ/Q value is smaller than the site design parameter χ/Q value. Such a comparison shows that the site has better dispersion characteristics than that required by the reactor design.

χ/Q values were chosen based on the ESBWR design and the worst alignment for the assumed plant layout. Revision 2 to DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, include the control room χ/Q values from NEDE-33279P as site design parameters. Neither NEDE-33279P nor Revision 2 to the DCD indicated whether the provided control room χ/Q values were to be used for the filtered air intake, unfiltered inleakage, or both.

In Revision 3 to the DCD, GEH revised the control room χ/Q values listed as standard plant site design parameters in DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1. Two sets of control room χ/Q values are provided for reactor building, PCCS/reactor building roof, and turbine building release pathways—one set for unfiltered inleakage and the second set for the filtered air intake.

SRP Section 2.3.4 states that the DC application should contain figures and tables showing the design features that would be used by the COL applicant to generate control room χ/Q values (e.g., intake heights, release heights, building cross-sectional areas, distance to receptors). Revision 0 to the DCD did not contain figures and tables showing the design features that would be needed by the COL applicant to generate site specific control room χ/Q values at the COL stage. In RAI 2.3-9, the staff asked GEH to provide figures showing control room intake, unfiltered in leakage, and postulated design-basis accident release locations to the environment. These figures should provide a basis for determining the distances and directions between potential accident release pathways and intake and inleakage pathways to the control room necessary to execute the ARCON96 atmospheric dispersion computer code (NUREG/CR-6331, Revision 1) using the guidance provided in RG 1.194. The COL applicant will need to execute the ARCON96 model at the COL stage using site-specific meteorological data in order to generate site-specific control room χ/Q values for comparison with the ESBWR control room χ/Q standard plant site design parameters.

In its response to RAI 2.3-9 dated November 13, 2006, GEH described the location of the control room air intake as being on the control room building roof (elevation 13.5 m (44.3 ft). The applicant also identified three locations as potential unfiltered inleakage locations:

(1) CB louvers located on the west wall of the CB

(2) CB northwest corner, which represents the closest point on the CB to the turbine building (and condenser)

(3) [[

]]

The GEH response to RAI 2.3-9 also identified several release locations depending on the design-basis accident being analyzed:

- Reactor Building Leakage: This release is assumed to be a diffusion source released through the east face of the reactor building. The initial diffusion coefficients (plume dimensions) were determined by dividing the height and width of the east face of the

reactor building by six in accordance with RG 1.194. The release height was set equal to the mid-height of the reactor building's east face above grade. GEH stated that it is pursuing a design change to ensure that the distance between the reactor building east wall and the CB west wall is at least 10 m (33 ft). This release pathway is used to model the LOCA and RWCU/SDC line break. This release pathway is also used to model one of the two FHA release scenarios.

- Reactor Building Roof: LOCA containment leakage through the PCCS is assumed to be ducted to the top of the reactor building. The release is assumed to be a point source with a release height equal to the height of the reactor building.

- Turbine Building Condenser: One of the two LOCA MSIV leakage scenarios and one of the two 1,000 failed fuel rod scenarios assume releases occur via the main condenser, which is located in the turbine building. [[

]] The release is assumed to be diffuse with the initial diffusion coefficients (plume dimensions) being determined by dividing the height and width of the condenser by six in accordance with RG 1.194.

- Turbine Building Leakage: The second LOCA MSIV leakage scenario, the MSLB analysis, the instrument line break analysis, and the feedwater line break analysis assume releases occur via leakage over the entire area of the turbine building. The initial diffusion coefficients (plume dimensions) are determined by dividing the height and width of the turbine building by six in accordance with RG 1.194. The release height is set equal to the mid-height of the turbine building above grade.

- Fuel Building Equipment (Cask) Door: The second FHA scenario assumes releases occur through cask doors that are located on the west side of the fuel building. [[

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- Radwaste Building Release: The liquid radwaste tank failure assumes releases occur from the radwaste building, which is west of the turbine building. [[

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- Main Plant Stack: The second 1,000 failed fuel rod scenario assumes releases occur through the off-gas system that vents through the main plant stack.

SER Table 2.3.4-2 contains inputs provided by GEH for each source/receptor combination for use by the COL applicant as input to the ARCON96 atmospheric dispersion computer code for generating site-specific control room χ/Q values using site-specific meteorological data.

In reviewing the applicant's response to RAI 2.3-9 and Revision 3 to DCD Tier 2, Sections 2, 15.3, and 15.4, the staff notes the following:

a. One of the release pathways discussed in the applicant's response to RAI 2.3-9 dated November 13, 2006, is the main plant stack, which is not part of the ESBWR standard plant design. Because the main plant stack is not part of the ESBWR standard plant

design, the DCD should explicitly state that the COL applicant should confirm at the COL stage that the main plant stack EAB and LPZ χ/Q site characteristic values are less than or equal to the ESBWR EAB and LPZ χ/Q standard plant site design parameters.

b. The applicant's response to RAI 2.3-9 discusses potential release pathways to the environment (e.g., reactor building leakage, reactor building roof, turbine building condenser, turbine building leakage, fuel building cask door, radwaste building) and control room receptors (e.g., control room air intake, CB inleakage locations) for various infrequent events and accidents.

   (i) The applicant should provide one scaled general arrangement drawing showing all potential release pathways and receptors. Plant north should be indicated on this drawing.

   (ii) The applicant should provide bounding control room χ/Q values for all source/receptor combinations as standard plant site design parameters in DCD Tier 1, Table 5.1-1, and Tier 2, Table 2.0-1.

c. The applicant's response to RAI 2.3-9 also provides a table of source/receptor inputs to the ARCON96 computer code for each source/receptor combination.

   (i) For each source/receptor combination, the applicant should add to its table of ARCON96 source/receptor inputs the building vertical cross-sectional area perpendicular to the wind for the buildings that have the largest impact on building wakes as discussed in the fifth item listed in Table A-2 of RG 1.194. ARCON96 uses this building area to account for enhanced dispersion in the wake of buildings, and it may be different from the building area used to establish the initial diffusion coefficients for a diffuse area source.

   (ii) For each source/receptor combination, the applicant should add the direction from the receptor to the source in degrees from plant north to its table of ARCON96 source/receptor inputs.

   (iii) The applicant should confirm that the "calculated distance to receptor" parameter identified in its table of ARCON96 source/receptor inputs is the horizontal distance to the release point.

   (iv) The applicant should add its table of ARCON96 source/receptor inputs to the DCD for use by future COL applicants. The applicant should also include a nonproprietary version of the table in the DCD.

d. Several accidents are assumed to have release pathways to the environment through a diffuse area source (e.g., the FHA, LOCA containment leakage, and instrument line break are assumed to be diffuse source releases from the reactor building; the LOCA MSIV leakage, MSLB, and instrument line break are assumed to be diffuse source releases from the turbine building). Regulatory Position 3.2.4.1 of RG 1.194 states that diffuse source modeling should be used only for those situations in which the activity

being released is homogeneously distributed throughout the building and when the assumed release rate from the building surface would be reasonably constant over the surface of the building.

(i) Regulatory Position 3.2.4.5 of RG 1.194 states that the height and width of the diffuse area source (e.g., the building surface) should be the maximum vertical and horizontal dimensions of the above-grade building cross-sectional area perpendicular to the line of sight from the building center to the control room intake. These dimensions should be projected onto a vertical plane perpendicular to the line of sight and located at the closest point on the building surface to the receptor. The applicant should confirm that this is the approach it used to calculate the diffuse area sources for the reactor building and turbine building leakage pathways. [[

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(ii) Since leakage is more likely to occur at a penetration, the applicant should consider the potential impact of building penetrations exposed to the environment. If the penetration release would be more limiting, the diffuse area source model should not be used. In particular, one of the assumed release pathways for the LOCA inside containment radiological analysis is MSIV leakage to the turbine building condenser. DCD Tier 2, Section 15.4.4.5.2.4 states that the two major points of release from the turbine building are expected to be (1) the truck doors at the far end of the turbine building and (2) the turbine building vent panels located midway on the turbine building on the side away from the reactor building. In contrast, the applicant's response to RAI 2.3-9 states that one of the release scenarios evaluated for MSIV leakage to the turbine building condenser is a diffuse release over the entire area of the turbine building. The applicant should resolve this apparent conflict in the assumed MSIV leakage pathways to the environment by identifying all potential release pathways from the turbine building for all those accidents that have airborne releases in the turbine building and provide the appropriate ARCON96 source/receptor inputs.

(iii) The applicant's response to RAI 2.3-9 states that one potential release location for the FHA is the reactor building, which was assumed to be a diffuse source. ESBWR Technical Specification 3.6.3.1 does not require the reactor building to be operable during Mode 6 (refueling). The applicant should confirm that there are no other potential release pathways from the reactor building during refueling (e.g., an open equipment hatch or personnel air lock) that could result in control room χ/Q values that are higher than assuming a diffuse source release from the reactor building. If such release pathways are possible, the applicant should provide the appropriate ARCON96 source/receptor inputs.

(iv) Revision 3 to DCD Tier 2, Figure 1.2-10, shows blowout panels located on the upper levels of the north and south walls of the reactor building. The applicant should confirm that there are no high-energy accident releases within the reactor

building that could potentially pressurize the reactor building and blow out these panels. If such release pathways are possible, the applicant should provide the appropriate ARCON96 source/receptor inputs.

e. Airborne radiological releases from a number of the infrequent events (e.g., 1,000 failed fuel rods, liquid containing tank failure) and accidents (e.g., FHA, instrument line break, MSLB) are assumed to occur in buildings (e.g., reactor building, turbine building, fuel building, radwaste building) whose exhaust may be discharged to the main plant stack. The applicant should identify these infrequent event and accident scenarios and state in the DCD that the COL applicant should calculate and compare the main plant stack control room χ/Q values to the control room χ/Q values for all the other possible release pathways to ensure the bounding control room χ/Q values are identified.

f. The applicant's response to RAI 2.3-9 states that the instrument line break release location is assumed to be the turbine building, whereas DCD Tier 2, Section 15.4.8.5.1 and Table 15.4-7, state that the release location for the instrument line break is assumed to be via the reactor building. The applicant should clarify this apparent discrepancy.

g. [[

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h. One of the three potential unfiltered inleakage locations identified in the response to RAI 2.3-9 is the closest point from the turbine building and condenser to the CB (e.g., point "B" or the northwest corner of the CB). The applicant should explain why it did not use this receptor location to define the source/receptor configuration information presented in Table 1 of the response to RAI 2.3-9 for the turbine building condenser and turbine building leakage release pathways.

i. DCD Tier 2, Section 6.4.4, states that the initiation of the emergency mode of operation of the control room habitability area HVAC subsystem consists of (1) isolating the normal outside air intake and restroom exhaust and (2) starting one of the two emergency filter units that delivers filtered air from one of the two unique safety-related outside air intake locations. The applicant should describe the relative location of these three outside air intakes (i.e., the normal mode air intake and the two emergency mode air intakes) to determine if they should be modeled as one or more separate receptors. The applicant should also discuss whether the isolated normal outside air intake and restroom exhaust can serve as potential inleakage locations during the emergency mode of operation.

The information requested in paragraphs 2.3.4.3.2.a through 2.3.4.3.2.i above are identified as part of **Open Item 2.3-9.**

GESTAR II Amendment 28 gives the control room radiological analysis for the mislocated and misoriented fuel assembly loading error events. A bounding control room χ/Q value of 1.25×10^{-2} s/m^3 was back-calculated using the AST regulatory dose criteria for the control room.

This means that any site with control room χ/Q site characteristics of less than 1.25×10^{-2} s/m^3 will result in doses less than the regulatory criteria. Since the GESTAR II control χ/Q value of 1.25×10^{-2} s/m^3 is greater than any of the ESBWR standard plant site design parameter control room χ/Q values listed in SER Table 2.3.4-1, the ESBWR standard plant site design parameter control room χ/Q values are more limiting.

2.3.4.4 Conclusion

Due to the open items that remain to be resolved (Open Items 2.3-8 and 2.3-9, and Confirmatory Item 15.3-1)), the staff was unable to finalize its conclusion regarding acceptability. The staff acknowledges that the applicant has selected the short-term (postaccident) standard plant site design parameters for plant design inputs but does not claim that they are representative of any particular percentile of possible sites in the United States and does not assert the acceptability of the basis for the choice of values with respect to siting. The short-term atmospheric dispersion characteristics for accidental releases are site specific and will be addressed by the COL applicant. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in the COL or CP application.

Table 2.3.4-1 Short-Term (Accident Release) Atmospheric Dispersion Standard Plant Site Design Parameters

a. Offsite χ/Q Values:

Receptor	Time Interval	χ/Q Value
EAB	0–2 hours	2.00×10^{-3} s/m^3
LPZ	0–8 hours	1.90×10^{-4} s/m^3
	8–24 hours	1.40×10^{-4} s/m^3
	1–4 days	7.50×10^{-5} s/m^3
	4–30 days	3.00×10^{-5} s/m^3

b. Control Room χ/Q Values:

Release Point	Time Interval	χ/Q Value	
		Unfiltered Inleakage	Filtered Air Intake
Reactor Building	0–2 hours	1.90×10^{-3} s/m^3	1.50×10^{-3} s/m^3
	2–8 hours	1.30×10^{-3} s/m^3	1.10×10^{-3} s/m^3
	8–24 hours	5.90×10^{-4} s/m^3	5.00×10^{-4} s/m^3
	1–4 days	5.00×10^{-4} s/m^3	4.20×10^{-4} s/m^3
	4–30 days	4.40×10^{-4} s/m^3	3.80×10^{-4} s/m^3
PCCS/Reactor Building Roof	0–2 hours	3.40×10^{-3} s/m^3	3.00×10^{-3} s/m^3
	2–8 hours	2.70×10^{-3} s/m^3	2.50×10^{-3} s/m^3
	8–24 hours	1.40×10^{-3} s/m^3	1.20×10^{-3} s/m^3
	1–4 days	1.10×10^{-3} s/m^3	9.00×10^{-4} s/m^3
	4–30 days	7.90×10^{-4} s/m^3	7.00×10^{-4} s/m^3
Turbine Building	0–2 hours	1.20×10^{-3} s/m^3	1.20×10^{-3} s/m^3
	2–8 hours	9.80×10^{-4} s/m^3	9.80×10^{-4} s/m^3
	8–24 hours	3.90×10^{-4} s/m^3	3.90×10^{-4} s/m^3
	1–4 days	3.80×10^{-4} s/m^3	3.80×10^{-4} s/m^3
	4–30 days	3.20×10^{-4} s/m^3	3.20×10^{-4} s/m^3

Table 2.3.4-2 Source/Receptor Inputs to the ARCON96 Computer Code for Determining Control Room Atmospheric Dispersion Factors[6]

Release Pathway	Infrequent Event/Accident	Receptor	Release Height (m)	Building Area (m^2)	Vertical Velocity (m/s)	Stack Flow (m^3/s)	Stack Radius (m)	Distance to Receptor (m)	Intake Height (m)	Elevation Difference (m)	Direction to Source (deg)	Initial Horiz Diff Coef (m)	Initial Vertical Diff Coef (m)
Reactor Building Leakage	• FHA • LOCA Containment Leakage • Instrument Line Break	Air Intake	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
		CB Louvers	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
		CB Chase	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
Reactor Building Roof	• LOCA Containment Leakage through PCCS	Air Intake	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
		CB Louvers	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
Turbine Building Condenser	• LOCA MSIV Leakage • 1,000 Failed Fuel Rods[7]	Air Intake	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
		CB Louvers	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
Turbine Building Leakage	• LOCA MSIV Leakage • MSLB • Instrument Line Break	Air Intake	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
		CB Louvers	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
Fuel Building Cask Door	• FHA	Air Intake	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]
		CB Louvers	[[ ]]		0.0	0.0	0.0	[[ ]]	[[ ]]	0.0		[[ ]]	[[ ]]

6 The blank entries in this table are to be provided by the applicant in response to Open Item 2.3-9.

7 The 1,000 failed fuel rod analysis was performed for those infrequent events that resulted in transitional boiling. These events, whose analyses are presented in DCD Tier 2, Section 15.3, included loss of feedwater heating with failure of selected control rod run-in, pressure regulator failure—closure of all turbine control and bypass valves, generator load rejection with total turbine bypass failure, and turbine trip with total turbine bypass failure.

Release Pathway	Infrequent Event/Accident	Receptor	Release Height (m)	Building Area (m^2)	Vertical Velocity (m/s)	Stack Flow (m^3/s)	Stack Radius (m)	Distance to Receptor (m)	Intake Height (m)	Elevation Difference (m)	Direction to Source (deg)	Initial Horiz Diff Coef (m)	Initial Vertical Diff Coef (m)
Radwaste Building	• Liquid Containing Tank Failure	Air Intake											
		CB Louvers											
Main Plant Stack[8]	• 1,000 Failed Fuel Rods	Air Intake	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
		CB Louvers	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

[8] The location of the main plant stack is site specific. The COL applicant needs to determine the source/receptor inputs to the ARCON96 computer code.

2.3.5 Long-Term Dispersion Estimates for Routine Releases

2.3.5.1 Regulatory Criteria

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

- 10 CFR Part 20, Subpart D, with respect to demonstrating compliance with dose limits for individual members of the public

- 10 CFR 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents—Nuclear Power Reactors," and Sections II.B, II.C, and II.D of Appendix I to 10 CFR Part 50, with respect to the numerical guides for design objectives and limiting conditions for operation to meet the requirements that radioactive material in effluents released to unrestricted areas be kept ALARA

- 10 CFR 100.21(c), with respect to establishing atmospheric dispersion site characteristics such that radiological effluent release limits associated with normal operation can be met for any individual located off site

Section 2.3.5 of the SRP, Revision 3, states that the DC applicant should include the maximum annual average site boundary atmospheric dispersion factors (χ/Q values) and deposition factors (D/Q values) in the list of site parameters. SRP Section 2.3.5 also states that the postulated site parameters should be representative of a reasonable number of sites that may be considered within a COL application, and a basis should be provided for each of the site parameters.

The long-term atmospheric dispersion and deposition factors are used in the calculation of offsite concentrations and dose consequences of routine airborne radioactive releases to demonstrate compliance with 10 CFR Part 20 and Appendix I to 10 CFR Part 50. RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," presents criteria for characterizing atmospheric dispersion and deposition conditions for evaluating the consequences of routine releases.

2.3.5.2 Summary of Technical Information

Both DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, specify the site parameters used in the ESBWR standard plant design. The standard plant site design parameters specified as Tier 1 are the same as those specified as Tier 2. The long-term (routine release) χ/Q and D/Q values identified by GEH as standard plant site design parameters in DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, are 2.0×10^{-6} s/m^3 and 4.0×10^{-9} per meter squared (m^{-2}), respectively. GEH used these standard plant site design parameters to calculate (1) annual average site boundary airborne concentrations to demonstrate compliance with Subpart D to 10 CFR Part 20 and (2) doses from routine airborne releases to demonstrate compliance with Appendix I to 10 CFR Part 50. DCD Tier 2, Section 12.2, describes these calculations.

DCD Tier 2, Section 12.2.2.1, discusses the generation of the ESBWR long-term χ/Q and D/Q standard plant site design parameters. GEH stated that it considered multiple sites in

determining these standard plant site design parameters. Data used were derived from 27 U.S. sites and one fictitious site, assuming an 800-m (2625-ft) EAB. The χ/Q value was determined using the NRC computer code XOQDOQ (NUREG/CR-2919) for these sites, and the resulting χ/Q value for the worst (most conservative) sector was chosen. The D/Q value was taken from a table of annual average meteorological coefficients prepared by the GE REFAE computer code. The applicant stated that the χ/Q and D/Q standard plant site design parameters bound all 28 sites and are obtained following the methodology of SRP Section 2.3.5.

DCD Tier 2, Section 2.0.1.1, states that a COL applicant referencing the ESBWR DCD should demonstrate that the site characteristics for a given site fall within the ESBWR DCD site parameter values. DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1, list the ESBWR standard plant site design parameters. A number of these site design parameters (i.e., long-term χ/Q and D/Q dispersion estimates) are related to regional climatology. Footnote 12 to DCD Tier 1, Table 5.1-1, and Footnote 12 to DCD Tier 2, Table 2.0-1, state that if a selected site has a long-term χ/Q value that exceeds the ESBWR reference site value, then the COL applicant will need to adjust the release concentrations in DCD Tier 2, Table 12.2-17, proportionate to the change in the χ/Q value. In addition, for a site selected that exceeds the bounding long-term χ/Q or D/Q values, the COL applicant will address how the resulting annual average doses (listed in DCD Tier 2, Table 12.2-18b) continue to meet the dose reference values provided in Appendix I to 10 CFR Part 50, using site-specific χ/Q and D/Q values. Similarly, DCD Tier 2, Section 12.2.4, states that the COL applicant is responsible for ensuring that offsite dose (using site-specific parameters) related to radioactive airborne effluents complies with the regulatory dose limits in Appendix I to 10 CFR Part 50. This is a **COL Action Item.**

DCD Tier 2, Section 2.0.1.2, states that a COL application is to provide information on site characteristics as described in DCD Tier 2, Table 2.0-2. This information may be contained in an ESP if the COL applicant is referencing such a permit. DCD Tier 2, Table 2.0-2, Section 2.3.5, states that the COL applicant is to supply site-specific information in accordance with the SRP Section 2.3.5. This is also a **COL Action Item.**

2.3.5.3 Staff Evaluation

SRP Section 2.3.5 states that the DC applicant should include the maximum annual average site boundary χ/Q and D/Q values in the list of site parameters. Revision 0 to the DCD did not list the long-term χ/Q and D/Q values used in the Chapter 12 radiological consequence analyses as standard plant site design parameters. In RAI 2.3-10, the staff asked GEH to list the long-term χ/Q and D/Q values as site design parameters in DCD Tier 2, Table 2.0-1. In its response to RAI 2.3-10 dated October 20, 2006, GEH agreed to list the requested long-term χ/Q and D/Q values as site design parameters in DCD Tier 2, Table 2.0-1. GEH included the requested long-term χ/Q and D/Q values as site design parameters in Revision 2 of DCD Tier 1, Table 5.1-1, and DCD Tier 2, Table 2.0-1.

To determine whether the ESBWR long-term χ/Q and D/Q standard plant site design parameters bound a reasonable number of sites that may be considered within a COL application, the staff compared the ESBWR long-term χ/Q and D/Q standard plant site design parameters to the annual average EAB χ/Q and D/Q site characteristics identified in the first three docketed ESP applications (e.g., NUREG-1835, NUREG-1840, and NUREG-1844). This

comparison, presented in SER Table 2.3.5-1, shows that the ESBWR long-term EAB χ/Q and D/Q standard plant site design parameters were lower than the annual average EAB χ/Q and D/Q site characteristics presented in the three ESP applications. This is despite the fact that the ESBWR DC assumes a shorter distance to the EAB than the three ESP applicants.

Table 2.3.5-1 Comparison of Long Term χ/Q and D/Q Values

Document	EAB Distance	χ/Q Value	D/Q Value
North Anna ESP SER	1416 m (4646 ft)	3.7×10^{-6} s/m^3	1.2×10^{-8} m^{-2}
Grand Gulf ESP SER	1368 m (4488 ft)	8.8×10^{-6} s/m^3	1.5×10^{-8} m^{-2}
Clinton ESP SER	1025 m (3363 ft)	2.0×10^{-5} s/m^3	1.2×10^{-8} m^{-2}
ESBWR DCD	800 m (2625 ft)	2.0×10^{-6} s/m^3	4.0×10^{-9} m^{-2}

Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing site design parameter χ/Q and D/Q values with site characteristic χ/Q and D/Q values, the site is acceptable for the design if the site characteristic χ/Q and D/Q values are smaller than the site design parameter χ/Q and D/Q values. Such a comparison shows that the site has better dispersion characteristics than that required by the reactor design. Because the three ESP sites have higher long-term χ/Q and D/Q site characteristic values as compared to the ESBWR long-term χ/Q and D/Q standard plant site design parameters, the COL applicants for these three ESP sites would need to provide additional analyses demonstrating that concentrations and dose consequences of routine airborne releases will be in compliance with 10 CFR Part 20 and Appendix I to 10 CFR Part 50 criteria if they choose the ESBWR design for their sites.

The staff believes that the reason the three ESP sites may have higher long-term χ/Q and D/Q site characteristic values as compared to the ESBWR long-term χ/Q and D/Q standard plant site design parameters is because the ESP applicants used bounding conservative assumptions in generating their site characteristic values (e.g., all three ESP applicants assumed ground level releases). To confirm this assumption, GEH should describe (1) the input assumptions used in executing the XOQDOQ computer code to derive the ESBWR DCD long-term χ/Q site design parameter value of 2.0×10^{-6} s/m^3 and (2) the technical bases for the GE REFAE computer code and the input assumptions used in executing the GE REFAE computer code to derive the ESBWR DCD long-term D/Q site design parameter value of 4.0×10^{-9} m^{-2}. This is **Open Item 2.3-10.**

2.3.5.4 Conclusion

Due to Open Item 2.3-10 that remains to be resolved, the staff was unable to finalize its conclusions regarding acceptability. The staff acknowledges that the applicant has selected the long-term (routine release) standard plant site design parameters referenced above for plant design inputs but does not claim that they are representative of any particular percentile of possible sites in the United States and does not assert the acceptability of the basis for the choice of values with respect to siting. The long-term atmospheric dispersion and deposition

characteristics are site specific and will be addressed by the COL applicant. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL or CP application.

2.4 Hydrologic Engineering

In this section of the DCD Tier 2, applicants provide information to allow an independent hydrologic engineering review to be made of all hydrologically related design bases, performance requirements, and bases for operation of SSCs important to safety, to be conducted consistent with the guidance gleaned from the SRP. This safety evaluation is based on the review of Revision 3 of GEH's application dated February 2007. Table 2.0-2 of Revision 3 includes COL action item and the staff used it to determine the adequacy of the application. The review areas include the hydrological description, floods, probable maximum flood (PMF) on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami flooding, ice effects, cooling water channels and reservoirs, channel diversion, flooding protection requirements, low water considerations, ground water, accidental release of liquid effluents in ground and surface waters, and technical specification and emergency operation requirements. For the DC review, site-specific issues will be deferred to the COL applicant. This section of the SER reviews the hydrological parameters that constitute the ESBWR standard plant design bases for siting suitability by a COL applicant under 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," or an application under 10 CFR Part 50.

2.4.1 Hydrologic Description

2.4.1.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.1, "Hydrological Description," using guidance provided in SRP Section 2.4.1, "Hydrological Description." The applicant's hydrological description will be considered adequate if it meets the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 2 in Appendix A to 10 CFR Part 50 states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

- GDC 44, "Cooling Water," states that a system to transfer heat from SSCs important to safety, to a UHS shall be provided. The system safety function shall be to transfer the combined heat load of these SSCs under normal operating and accident conditions.

- GDC 60, "Control of Releases of Radioactive Material to the Environment," states that the nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for the retention of gaseous

and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.

- According to 10 CFR 52.79(a) and 10 CFR 100.20(2)(c), the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology.

- According to 10 CFR 100.23(d)(3), in establishing the design-basis flood, seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined.

2.4.1.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum ground water level considered in the plant design is 0.61 m (2 ft) below grade. DCD Tier 2, Table 2.0-2 defers the presentation of the required site specific hydrologic information to the COL applicant.

2.4.1.3 Staff Evaluation

The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100, which form the basis of the hydrologic engineering design. This is a **COL Action Item.** DCD Tier 1, Table 5.1-1, captures this basic design-basis site parameter. The staff finds this acceptable.

2.4.1.4 Conclusion

As the hydrologic description information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.2 Floods

2.4.2.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.2, "Floods," using guidance provided in SRP Section 2.4.2, "Floods." The applicant's flood design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- 10 CFR 52.79(a) and 10 CFR 100.20(c), which states that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

- 10 CFR 100.20 (c)(3), which states that factors important to hydrological radionuclide transport that may affect the consequences of an escape of radioactive material from a plant will be obtained from onsite measurements

- 10 CFR 100.23(d)(3), which states that in establishing the design-basis flood, seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined

2.4.2.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the standard plant design is 0.3 m (1 ft) below grade. DCD Tier 2, Table 2.0-2 defers the presentation of the required site specific hydrologic information to the COL applicant.

2.4.2.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.2, in light of the regulatory criteria cited in SER Section 2.4.2.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that the standard plant design-basis flood is not exceeded. This is a **COL Action Item.**
DCD Tier 1, Table 5.1-1, captures this is basic design-basis site parameter. The staff finds this acceptable.

2.4.2.4 Conclusion

As the flood information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.3 Probable Maximum Flood on Streams and Rivers

2.4.3.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.3, “Probable Maximum Flood (PMF) on Streams and Rivers,” in accordance with SRP Section 2.4.3, “Probable Maximum Flood (PMF) on Streams and Rivers.” The applicant’s flood design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

- 10 CFR 100.23(d)(3), which states that in establishing the design-basis flood, seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined

2.4.3.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the plant design is 0.3 m (1 ft) below grade. DCD Tier 2, Table 2.0-1 also indicates a maximum rainfall rate of 19.4 in/hr and a maximum short term (5 minute) rainfall rate of 6.2 in/hr. DCD Tier 2, Table 2.0-2 defers the presentation of the required site specific hydrologic information to the COL applicant.

2.4.3.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.3, in light of the regulatory criteria cited in SER Section 2.4.3.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from the overflow of streams and rivers will not exceed the standard plant design-basis flood. This is a **COL Action Item.** DCD Tier 1, Table 5.1-1 captures this basic design-basis site parameter. The staff finds this acceptable.

2.4.3.4 Conclusion

As this information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.4 Potential Dam Failures

2.4.4.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.4, “Potential Dam Failures,” in accordance with SRP Section 2.4.4, “Potential Dam Failures.” The applicant’s flood design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

- 10 CFR 100.20(c)(3), which states that factors important to hydrological radionuclide transport that may affect the consequences of an escape of radioactive material from a plant will be obtained from onsite measurements

- 10 CFR 100.23(d)(3), which states that in establishing the design-basis flood, seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined

2.4.4.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the plant design is 0.3 m (1 ft) below grade, and DCD Tier 2, Table 2.0-2, defers the presentation of the required site-specific information to the COL applicant.

2.4.4.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.4, in light of the regulatory criteria cited in SER Section 2.4.4.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from seismic dam failure will not exceed the standard plant design-basis flood. This is a **COL Action Item.** The staff finds this acceptable.

2.4.4.4 Conclusion

As this information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.5 Probable Maximum Surge and Seiche Flooding

2.4.5.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.5, “Probable Maximum Surge and Seiche Flooding,” in accordance with SRP Section 2.4.5, “Probable Maximum Surge and Seiche Flooding.” The applicant’s flood design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

- 10 CFR 100.23(d)(3), which states that in establishing the design-basis flood, seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined

2.4.5.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the plant design is 0.3 m (1 ft) below grade, and DCD Tier 2, Table 2.0-2, defers the presentation of the required site specific information to the COL applicant.

2.4.5.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.5, in light of the regulatory criteria cited in SER Section 2.4.5.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from maximum surge and seiche flooding will not exceed the standard plant design-basis flood. This is a **COL Action Item.** The staff finds this acceptable.

2.4.5.4 Conclusion

As the information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.6 Probable Maximum Tsunami Flooding

2.4.6.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.6, "Probable Maximum Tsunami Flooding," in accordance with SRP Section 2.4.6, "Probable Maximum Tsunami Flooding." The applicant's flood design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

- 10 CFR 100.23(d)(3), which state that in establishing the design-basis flood, seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined

2.4.6.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the plant design is 0.3 m (1 ft) below grade. Because the standard plant design basis is intended to be suitable for varied site conditions and therefore site independent, DCD Tier 2, Table 2.0-2, defers the presentation of the required site-specific information to the COL applicant.

2.4.6.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.6, in light of the regulatory criteria cited in SER Section 2.4.6.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from tsunami flooding will not exceed the standard plant design-basis flood. This is a **COL Action Item.** The staff finds this acceptable.

2.4.6.4 Conclusion

As the information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.7 Ice Effects

2.4.7.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.7, "Ice Effects," in accordance with SRP Section 2.4.7, "Ice Effects." The applicant's design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 44, which states that a system to transfer heat from SSCs important to safety to a UHS shall be provided, and the system's safety function shall be to transfer the combined heat load of these SSCs under normal operating and accident conditions

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

2.4.7.2 Summary of Technical Information

DCD Tier 2, Table 2.0-2, indicates that the specific plant design has no safety-related service water system to be affected by ice flooding or blockage and defers the presentation of site-specific information to the COL applicant.

2.4.7.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.7, in light of the regulatory criteria cited in SER Section 2.4.7.1. Regarding the applicability of the relevant requirements of GDC 44, the staff considered the information from Table 2.0-1 that indicated that no safety-related service water systems exist that can be subjected to ice flooding or blockage. The staff issued RAI 2.4-14 and RAI 2.4-15, which noted that water storage in the reactor building itself

for the Isolation Condenser System (ICS), PCCS, and other pools for safety-related use is located near the top of the reactor building. For a plant location in a very cold climate, ice formation caused by freezing in the safety-related pools during an extended outage can reduce the quantity of available liquid water. For a postulated accident scenario following an extended period of plant shutdown, it would be prudent to include a margin in the liquid water volume to accommodate the effects of ice formation. The initial GEH response was that since the pools were located indoors, and their function was achieved by boiling, there were no low water considerations regarding ice formation. On May 18, 2007, GEH revised its response to RAI 2.4-14 and 2.4-15 to indicate that the water stored inside the containment would be heated following a design-basis accident and will be available for passive cooling function. However, water needed for post-72-hour cooling is stored in fire water tanks and may be subjected to freezing depending on site characteristics. GEH committed to include this information in the DCD. These comprise **Confirmatory Items 2.4-14 and 2.4-15.**

If an external water source is used to meet the requirements of GDC 44, the COL applicant will need to provide the site-specific information to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 related to flooding, low water, or ice damage to safety-related SSCs. This is a **COL Action Item.**

2.4.7.4 Conclusion

As the information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable, pending resolution of Confirmatory Items 2.4-14 and 2.4-15.

2.4.8 Cooling Water Channels and Reservoirs

2.4.8.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.8, “Cooling Water Channels and Reservoirs,” in accordance with SRP Section 2.4.8, “Cooling Water Channels and Reservoirs.” The applicant’s design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 1, “Quality Standards and Records,” which states that SSCs important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed

- GDC 2, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions

- GDC 44, which states that a system to transfer heat from SSCs important to safety to a UHS shall be provided, and the system's safety function shall be to transfer the combined heat load of these SSCs under normal operating and accident conditions

- 10 CFR 52.17(a) and 10 CFR 100.20, which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

2.4.8.2 Summary of Technical Information

DCD Tier 2, Table 2.0-2, indicates that the plant design has no safety-related service water system that would require transport and impoundment of plant cooling water and defers the presentation of site-specific information to the COL applicant.

2.4.8.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.8, in light of the regulatory criteria cited in SER Section 2.4.8.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that the capacities of cooling water canals and reservoirs are adequate. This information is not available at the COL stage. In view of the relevant requirements of GDC 1, GDC 2, and 10 CFR Part 100, the staff considered the fact that the regulations regarding safety-related service water systems require transport and impoundment of plant cooling water (see Section 4.1 of Tier 1). This is a **COL Action Item.** The staff finds this acceptable.

2.4.8.4 Conclusion

As this information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.9 Channel Diversion

2.4.9.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.9, "Channel Diversion," in accordance with SRP Section 2.4.9, "Channel Diversion." The applicant's design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 1, which states that SSCs important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed

- GDC 2, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions

- GDC 44, which states that a system to transfer heat from SSCs important to safety to a UHS shall be provided, and that the system's safety function shall be to transfer the combined heat load of these SSCs under normal operating and accident conditions

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which states that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

2.4.9.2 Summary of Technical Information

DCD Tier 2, Table 2.0-2, indicates that the plant design has no safety-related service water system that would be adversely affected by natural stream channel diversion and defers the presentation of site-specific information to the COL applicant.

2.4.9.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.9, in light of the regulatory criteria cited in SER Section 2.4.9.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that the capacities of cooling water canals and reservoirs are adequate. This site-specific information is not available at the DC stage. In view of the relevant requirements of GDC 1, GDC 2, and GDC 44, the staff considered the fact that the regulations regarding safety-related service water systems require transport of plant cooling water that would be affected by natural stream channel diversion. This is a **COL Action Item.** The staff finds this acceptable.

2.4.9.4 Conclusion

As the information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.10 Flooding Protection Requirements

2.4.10.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.10, "Flooding Protection Requirements," in accordance with SRP Section 2.4.10, "Flooding Protection Requirements." The applicant's flood design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 1, which states that SSCs important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed

- GDC 2, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions

- GDC 44, which states that a system to transfer heat from SSCs important to safety to a UHS shall be provided, and the system's safety function shall be to transfer the combined heat load of these SSCs under normal operating and accident conditions

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

2.4.10.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the plant design is 0.3 m (1 ft) below grade. DCD Tier 2, Table 2.0-2, defers the presentation of the required site-specific information to the COL applicant.

2.4.10.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.10, in light of the regulatory criteria cited in SER Section 2.4.10.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate the topography and geology of the site and their applicability to damage as a result of flooding. Flooding protection requirements for the standard design have two parts—one is based on site-specific conditions, and the other is based on the measures taken by the standard plant design features, such as water-tight access doors, qualification of equipment that may be subject to inundation caused by external flooding, and flood elevation warning systems, if any. The first part relates to the criteria of GDC 1, GDC 2, and GDC 44, and the applicant has specified its design-basis flood elevation. This is a **COL Action Item.**

In RAI 2.4-32, the staff asked the applicant to address potential accidental flooding of safety-related compartments located well below grade resulting from unanticipated defects or other non-mechanistic causes, and to identify what provisions are there in the standard design to detect and mitigate flooding of lower compartments. GEH responses are under staff review and thus the issue of internal flooding is discussed SER Section 3.4.1.

2.4.10.4 Conclusion

As this information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that

the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.11 Low Water Considerations

2.4.11.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.11, "Cooling Water Supply," in accordance with SRP Section 2.4.11, "Low Water Considerations." The applicant's design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements of GDC 44, 10 CFR Part 52, and 10 CFR Part 100 are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 44, which states that a system to transfer heat from SSCs important to safety to a UHS shall be provided, and the system's safety function shall be to transfer the combined heat load of these SSCs under normal operating and accident conditions

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

2.4.11.2 Summary of Technical Information

DCD Tier 2, Table 2.0-2, indicates that the plant design has no safety-related service water system that would require that a water supply exist to operate the plant or maintain safe shutdown under normal and emergency conditions and defers the presentation of site-specific information to the COL applicant.

2.4.11.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.11, in light of the regulatory criteria cited in SER Section 2.4.11.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 that are associated with likely land-use changes and changes in water demand that could alter the frequency of low-flow conditions and the related minimum water elevation for the safety-related water use at a plant. In view of the relevant requirements of GDC 44 and in view of the information provided in DCD Tier 1, Section 4.1, the staff considered the fact that the site-specific safety-related service water system would require transport or impoundment of plant cooling water and determined that the COL applicant is responsible for this issue. This is a **COL Action Item.** The staff finds this acceptable.

2.4.11.4 Conclusion

As the information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that

the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.12 Ground Water

2.4.12.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.12, "Groundwater," in accordance with SRP Section 2.4.12, "Groundwater." The applicant's design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which states that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

- 10 CFR 100.20(c)(3), which states that factors important to hydrological radionuclide transport that may affect the consequences of an escape of radioactive material from a plant will be obtained from onsite measurements

- 10 CFR 100.23, "Geologic and Seismic Siting Criteria," which requires that siting factors, including the cooling water supply, be evaluated, taking into account information concerning the physical, including hydrological, properties of the materials underlying the site

2.4.12.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, indicates that the maximum ground water level considered in the plant design is 0.61 m (2 ft) below grade and DCD Tier 2, Table 2.0-2 defers the presentation of the required site specific hydrologic information to the COL applicant.

2.4.12.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.12, in light of the regulatory criteria cited in SER Section 2.4.12.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100, which includes site-specific local hydrogeological information and hydraulic parameters that govern contaminant transport. This is a **COL Action Item.** The staff finds this acceptable.

2.4.12.4 Conclusion

As the information is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.4.13 Accidental Releases of Liquid Effluent in Ground and Surface Water

2.4.13.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.13, "Accidental Releases of Liquid Effluent in Ground and Surface Water," in accordance with SRP Section 2.4.13, "Accidental Releases of Liquid Effluent in Ground and Surface Water." The applicant's design basis for safety-related plant features will be considered adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that the consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

- 10 CFR 100.20 (c)(3), which states that factors important to hydrological radionuclide transport that may affect the consequences of an escape of radioactive material from a plant will be obtained from onsite measurements

- 10 CFR 100.21, "Non-Seismic Site Criteria," which provides nonseismic siting criteria

- GDC 60, "Control of Releases of Radioactive Material to the Environment," of Appendix A to 10 CFR Part 50, which states that the nuclear power unit design shall include a means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences, and that sufficient holdup capacity shall be provided for the retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment

2.4.13.2 Summary of Technical Information

DCD Tier 2, Table 2.0-2, and Section 15.3.16, "Liquid Containing Tank Failure," demonstrate that the ESBWR design precludes accidental release of radioactive liquid effluent and that SRP Section 2.4.13 is not applicable to a site with an ESBWR.

2.4.13.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.13, in light of the regulatory criteria cited in SER Section 2.4.13.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to describe the radionuclide transport characteristic of ground and surface water with respect to existing and future users.

In Revision 3 to DCD Tier 2, Table 2.0-2, the applicant stated that SRP Section 2.4.13 does not apply to an ESBWR because of its mitigation capabilities. This does not conform with the staff guidance in SRP Section 11.2 and Branch Technical Position (BTP) 11-6, "Guidance on the Level of Detail Required for Design Certification Applications Under 10 CFR Part 52," issued March 2007. The applicant needs to add a COL action item for evaluating the effects of an accidental release of radioactive liquid waste on surface and ground water, as is necessary to address SRP Section 2.4.13 for a future site suitability assessment. In addition, the applicant needs to provide in the DCD the source term from the single tank (in accordance with the assumptions in BTP 11-6) that the COL applicant would use for a future site evaluation to address SRP Section 2.4.13. This is the postulated inventory to be used for site safety assessments. The staff requested this information from the applicant in RAI 2.4.1-2 and Supplemental RAI 2.4.1-2.

On July 5, 2007, GEH committed to revise its response in MFN letter 06-226. Specifically, GEH committed to adding a **COL Action Item** for evaluating the effects of an accidental release of radioactive liquid waste on surface and ground water, providing the source term for the postulated single tank failure (Table 12.2-13a), and to incorporate steel liners in the liquid waste management system tank cubicles to prevent accidental releases to the environment. With GEH's commitment, Open Item 2.4.1-2 is now **Confirmatory Item 2.4.1-2.**

2.4.13.4 Conclusion

The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable, pending resolution of the confirmatory item described above.

2.4.14 Technical Specification and Emergency Operation Requirements

2.4.14.1 Regulatory Criteria

The staff reviewed DCD Tier 2, Table 2.0-2, Section 2.4.14, "Technical Specification and Emergency Operation Requirements," in accordance with SRP Section 2.4.14, "Technical Specification and Emergency Operation Requirements." The applicant's safety analysis report will be considered adequate if the features meet the regulatory guidance commensurate with the safety function to be performed. This will ensure that the following relevant requirements are met as they relate to identifying technical specifications and emergency procedures required to implement flood protection for safety-related structures and an adequate water supply for shutdown and cooldown purposes:

- GDC 2, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions

- 10 CFR 50.36(c)(ii)(B)(2), which states the lowest functional capability or performance of equipment required for safe operation of the facility

2.4.14.2 Summary of Technical Information

DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 5.1-1, indicate the basic hydrologic design bases related to the maximum ground water level considered in the plant design. Since the site-specific hazards related to any emergency condition for plant operation or limiting conditions of operation are not available at the DC stage, DCD Tier 2, Table 2.0-2 defers the presentation of the required site specific hydrologic information to the COL applicant.

2.4.14.3 Staff Evaluation

The staff evaluated DCD Tier 2, Table 2.0-2, Section 2.4.12, in light of the regulatory criteria cited in SER Section 2.4.14.1. The COL applicant will provide the site-specific information used to satisfy the requirements of 10 CFR Part 52 and 10 CFR Part 100 and to describe the site-specific emergency conditions of operation. This is a **COL Action Item.** The staff finds this acceptable.

2.4.14.4 Conclusion

As the information related to emergency operation requirements due to flooding is site specific, the COL applicant will address it and the NRC will review it at the COL stage. The COL applicant should provide information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. Therefore, the requirement that the COL applicant address these issues is acceptable.

2.5 Geological, Seismological, and Geotechnical Engineering

The following regulatory requirements apply to the review of geological, seismological, and geotechnical engineering:

- 10 CFR 52.47, “Contents of Applications”

- Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” to 10 CFR Part 50

- 10 CFR 100.23(d)(4)

- GDC 2 in Appendix A to 10 CFR Part 50

2.5.1 Summary of Technical Information

DCD Tier 2, Section 2.0, describes the envelope of site-related parameters that the ESBWR standard plant is designed to accommodate. The applicant stated that these parameters envelop most potential sites in the United States and that both DCD Tier 1 and DCD Tier 2, Section 2.0, specify these parameters. DCD Tier 2, Section 2.0, Table 2.0-1, specifies the following site parameters that relate to soil parameters, seismology, and site stability:

- minimum static bearing capacity (greater than 718 kPa or 15 tsf)
- minimum shear wave velocity (300 m/s or 1,000 fps)
- liquefaction potential (none under footprint of seismic Category I or II structures)
- angle of internal friction (greater than 30 degrees)
- safe-shutdown earthquake (SSE) horizontal and vertical (as shown in DCD Tier 2, Figures 2.0-1 and 2.0-2)
- maximum settlement and differential settlement (values specified for various structures)

Notes accompanying DCD Tier 2, Section 2.0, Table 2.0-1, state (1) that the minimum static bearing capacity is specified at the foundation level of seismic Category I structures, (2) that the minimum shear wave velocity is the equivalent uniform shear wave velocity (V_{eq}) at seismic strains after the soil property uncertainties have been applied, and (3) that the SSE design ground response spectra are defined as free-field outcrop spectra at the foundation level of seismic Category I structures. DCD Tier 2, Section 2.0, Table 2.0-2, adds one additional geologic criterion that the ESBWR design assumes no permanent ground deformation from tectonic or nontectonic faulting.

2.5.2 Staff Evaluation

The staff reviewed the geologic and seismic information presented in DCD Tier 2, Section 2.0, to ensure that the relevant requirements of 10 CFR 52.47 were met. Accordingly, the staff reviewed DCD Tier 2, Section 2.0, Table 2.0-1, to ensure that the applicant included the key geological and seismological site parameters. The staff also reviewed the COL action item specified in DCD Tier 2, Section 2.0, Table 2.0-2 to verify that it completely describes the information that COL applicants should provide in order satisfy 10 CFR Part 100.

For the ESBWR standard plant design SSE, the applicant used a combination of two spectra. The lower frequency portion of the SSE spectrum is the RG 1.60 spectrum anchored at 0.3g. At frequencies above 9 hertz (Hz), the ESBWR SSE is the site SSE developed by Dominion for the North Anna, Virginia, site. In RAI 2.5-1, the staff asked the applicant to explain the differences between the high-frequency portion (9 Hz and above) of the ESBWR SSE (shown in Figure 2.0-1) and the North Anna SSE for the ESP site. In particular, the staff noted that the actual North Anna ESP SSE is slightly larger than the high-frequency portion of the ESBWR SSE. In response, the applicant stated that the spectra shown in DCD Tier 2, Figures 2.0-1 and 2.0-2, are the high-frequency spectra computed exactly as they were for the North Anna

ESP SSE but defined at deeper control points corresponding to the CB and reactor/fuel building bases, whereas the North Anna ESP SSE spectrum is from a higher control point at the top of competent rock. Based on the applicant's explanation of different control points or depths for the North Anna SSE, the staff finds that the slight differences between the North Anna ESP site-specific SSE shown in DCD Tier 2, Figures 2.5-1 and 2.5-2, and the North Anna ESP SSE presented in Dominion's ESP application for North Anna are acceptable. The staff finds that it is acceptable for the applicant to specify the ESBWR standard plant design SSE at the foundation level as this enables an easy comparison to the minimum design requirements for the SSE covered in Appendix S to 10 CFR Part 50. Appendix S to 10 CFR Part 50 states, "the horizontal component of the Safe Shutdown Earthquake Ground Motion in the free-field at the foundation level of the structures must be an appropriate response spectrum with a peak ground acceleration of at least 0.1g." COL applicants referencing the ESBWR standard plant design must ensure that the comparison between the site-specific SSE and the standard plant design SSE are made at the same control point. The development of the site-specific SSE by COL applicants, in accordance with SRP Section 2.5.2, is a **COL Action Item.**

With regard to the minimum shear wave velocity (300 m/s or 1,000 fps) specified in DCD Tier 2, Section 2.0, Table 2.0-1 the staff asked the applicant in RAI 2.5-5 to specify if this minimum shear wave velocity is applicable to each soil layer in the soil profile or if is a value that is representative of some averaged value for the entire soil column. In response to RAI 2.5-5, the applicant revised Table 2.0-1 to read "minimum shear wave velocity: 300 m/s (1,000 fps)" with a footnote that specifies the use of V_{eq} as the shear wave velocity. Specifically, the footnote states the following:

> This is the equivalent uniform shear wave velocity (V_{eq}) at seismic strains after the soil property uncertainties have been applied. V_{eq} is calculated to achieve the same wave traveling time over the depth equal to the embedment depth plus 2 times the largest foundation plan dimension below the foundation as follows:
>
> $$V_{eq} = \frac{\sum d_i}{\sum \frac{d_i}{V_i}}$$
>
> where d_i and V_i are the depth and shear wave velocity, respectively, of the ith layer. The ratio of the largest to the smallest shear wave velocity over the mat foundation width at the foundation level does not exceed 1.7.

The staff finds that the applicant's revision of DCD Tier 2, Table 2.0-1, is acceptable since it references a more complete and detailed explanation of the minimum shear wave velocity criterion. SER Section 3.7.5 provides the staff's evaluation of the applicant's use and definition of V_{eq}.

In RAI 2.5-6, the staff asked the applicant to clarify its restrictions with regard to soil liquefaction specified in DCD Tier 2, Table 2.0-1, which states only "no liquefaction potential." In response

to RAI 2.5-6, the applicant revised DCD Tier 2, Table 2.0-1, to read, "None under footprint of seismic Category I or II structures." In addition, the applicant added a paragraph to DCD Tier 2, Section 2.0, that states the following:

> The site parameters include a requirement that liquefaction not occur underneath seismic Category I and II structures, systems, and components (SSCs) resulting from a site-specific SSE. In addition, although the ESBWR design is independent of a particular site and takes into consideration the 0.3g Regulatory Guide spectra, the evaluation of each site for liquefaction potential under seismic Category I and II SSCs uses the site-specific SSE with acceptance criteria demonstrating adequate margin for no liquefaction.

The staff finds that the applicant's modifications to Table 2.0-1 are acceptable since they explicitly specify the site-related requirements with respect to liquefaction. In addition, the applicant's revision of DCD Tier 2, Table 2.0-1, to specify no liquefaction potential under the footprint of safety-related structures, meets the requirements of 10 CFR 100.23(d)(4), which states that liquefaction potential must be evaluated for the design of nuclear power plants. Furthermore, the staff concurs with the applicant's specification that liquefaction potential be evaluated using the site-specific SSE rather than the ESBWR standard plant SSE. The use of the site-specific SSE to evaluate liquefaction potential is consistent with the requirements of GDC 2 in Appendix A to 10 CFR Part 50, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes. Furthermore, GDC 2 states that the design bases for these SSCs shall reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The GDC 2 requirement that "the most severe of the natural phenomena that have been historically reported for the site and surrounding area" be considered clearly indicates that the site-specific SSE should be used to evaluate the potential for liquefaction. DCD Tier 2, Table 2.0-2 specifies that COL applicants describe the static and dynamic stability of the subsurface materials and foundations. This is a **COL Action Item.**

In RAI 2.5-7, the staff asked the applicant to clarify its restrictions with regard to soil stability specified in DCD Tier 2, Table 2.0-1, which states only "assumes stable slopes." In response to RAI 2.5-7, the applicant revised DCD Tier 2, Table 2.0-1 to provide a slope stability factor of safety of 1.5 for static (nonseismic) loading and 1.1 for dynamic (seismic) loading. The staff finds the applicant's specification of factors of safety for static and dynamic loading conditions to be an adequate description of slope stability and, in particular, the factor of safety values are compatible with previously accepted values (see NUREG-1835, "Safety Evaluation Report for an Early Site Permit (ESP) at the North Anna ESP Site," issued September 2005). However, the factor of safety values are highly dependent upon the type of analysis used to determine slope stability. Therefore, the staff will evaluate slope stability analyses on a case-by-case basis to ensure that the analysis methodology adequately characterizes the engineering properties of the soil and rock materials comprising the slopes as well as the static and dynamic loading conditions. **This is a COL Action Item.**

RAIs 2.5-2, 2.5-3, and 2.5-4 pointed out minor errors and inconsistencies in DCD Tier 2, Section 2.5. Revision 3 of DCD Tier 2 eliminated Section 2.5 and instead consolidated all of the relevant ESBWR standard plant site design parameters into Section 2.0. As such, these three RAIs are no longer relevant.

2.5.3 Conclusion

The ESBWR standard plant is designed to accommodate the following geological, seismological, and geotechnical site-related parameters:

- minimum static bearing capacity (greater than 718 kPa or 15 tsf)
- minimum shear wave velocity (300 m/s or 1,000 fps)
- liquefaction potential (none under footprint of seismic Category I or II structures)
- angle of internal friction (greater than 30 degrees)
- SSE horizontal and vertical (as shown in DCD Tier 2, Figures 2.0-1 and 2.0-2)
- maximum settlement and differential settlement (values specified for various structures)

Notes accompanying DCD Tier 2, Section 2.0, Table 2.0-1, cover specific details with regard to these parameters and are described above in Sections 2.5.1 and 2.5.2. In addition, DCD Tier 2, Section 2.0, Table 2.0-2, adds one additional geologic criterion that the ESBWR design assumes no permanent ground deformation from tectonic or nontectonic faulting.

The applicant has selected the site-related design characteristics and site parameters referenced above for plant design inputs (a subset of which is included as Tier 1 information), but the staff does not claim that they are representative of any particular percentile of possible sites in the United States and does not assert the acceptability of the basis for the choice of values with respect to siting. Accordingly, the staff concludes that the site parameters meet the requirements of 10 CFR 52.47(a)(1)(iii).

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