# CONTENTS

# LIST OF FIGURES

No figures were included in this chapter.

# LIST OF TABLES

# 2 SITE CHARACTERISTICS

Chapter 2 of this report describes the U.S. Nuclear Regulatory Commission (NRC) staff's review of the geography and demography, nearby facilities, and postulated site parameters for the U.S. EPR design, including meteorology, hydrology, geology, seismology, and geotechnical parameters. This information is included in AREVA NP's (the applicant's) U.S. EPR Final Safety Analysis Report (FSAR), Chapter 2, "Site Characteristics." The review is focused on the site parameters and site-related design characteristics needed to enable the staff to reach a conclusion on safety matters related to siting.

## 2.0 Site Characteristics

This chapter discusses the site envelope for the U.S. EPR design and focuses on the geography and demography, nearby facilities, and postulated site parameters for the design, including meteorology, hydrology, geology, seismology, and geotechnical parameters.

An applicant for a combined license (COL) that references the U.S. EPR design will compare actual site characteristics, which are based on site-specific data, to the site parameter values identified in FSAR Tier 1, Table 5.0-1, "Site Parameters for the U.S. EPR Design," and FSAR Tier 2, Table 2.1-1, "U.S. EPR Site Design Envelope." As listed in FSAR Tier 2, Table 1.8-1, "Summary of U.S. EPR Plant Interfaces with Remainder of Plant," the envelope of U.S. EPR site-related design is Plant Interface Item 2-1 (FSAR Tier 2, Section 2.0, Table 2.1-1). In FSAR Tier 2, Chapter 2, the applicant presented the envelope of site-related parameters that the U.S. EPR standard plant is designed to accommodate. FSAR Tier 2, Table 2.1-1 lists the site parameters and 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), Subsection II, "Acceptance Criteria," by (1) the envelope of site-related parameters that the U.S EPR plant is designed to accommodate, and (2) the other site-related assumptions, both implicit and explicit, used in the evaluation of the U.S. EPR design.

If the site characteristics for the site fall within the assumed site parameter values in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. Should the site characteristics fall outside the assumed site-parameter values presented in FSAR Tier 2, Table 2.1-1, the COL applicant will need to demonstrate by some other means that the design of the proposed facility is acceptable at the proposed site. This might be done by reanalyzing or redesigning the proposed facility. FSAR Tier 2, Table 1.8.2, "U.S. EPR Combined License Information Items," includes this as COL Information Item 2.0-1 and specifies that it will be addressed by the COL applicant. COL Information Item 2.0-1, Revision 0, however, did not clearly distinguish between site characteristics and postulated site parameters in accordance with the definitions provided in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 52.1(a). Therefore, in Request for Additional Information (RAI) 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2, the staff requested that the applicant use the terms "site characteristics" and "site parameters" in COL Information Item 2.0-1 in accordance with the definitions provided in 10 CFR 52.1(a). RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2 were being tracked as open items.

In April 1, 2010, responses to RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2 the applicant agreed that the term "site parameter" should be used for the assumed site of the U.S. EPR FSAR and the term "site characteristic" should be used for a site-specific COL FSAR.

The applicant subsequently committed to revising a number of the COL information Items listed in FSAR Tier 2, Table 1.8-2 (including COL Information Item 2.3-1) to reflect this distinction.

The staff reviewed the applicant's April 1, 2010, responses to RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2 and finds the responses acceptable because the applicant committed to revising the FSAR to appropriately address the distinction between site parameters and site characteristics. The staff confirmed that FSAR Tier 2, dated August 31, 2010, was revised as committed in the responses to RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2. Accordingly, the staff considers RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2 resolved.

The staff based its evaluation of the site envelope on a thorough review of the FSAR Tier 2, Chapter 2, "Site Characteristics," as well as the applicant's responses to the staff's RAIs.

The applicant selected the site parameters referenced above for plant design inputs (a subset of which is included as FSAR Tier 1 information), and the staff agrees that they are representative of a reasonable number of sites that have been or may be considered for a COL application. Accordingly, the staff concludes that the site parameters meet the requirements of 10 CFR 52.47(a)(1)(iii).

### 2.0.1 Summary of Application

A COL applicant that references the U.S. EPR design certification will compare the characteristics of its proposed site to the site parameter values in FSAR Tier 2, Table 2.1-1. If the specific characteristics for the site fall within the assumed site parameter values in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific characteristics that are outside the bounds of the assumptions presented in FSAR Tier 2, Table 2.1-1, the COL applicant will demonstrate that the U.S. EPR design meets all applicable regulatory requirements, given the more limiting site-specific characteristics, and that the design commitments and acceptance criteria described in the U.S. EPR FSAR continue to be acceptable.

The U.S. EPR FSAR Tier 2 addresses the site parameters in Section 2.0.

### 2.0.2 Regulatory Basis

The applicable regulatory requirements for site parameters are as follows:

1. 10 CFR 52.47(a)(1), as it relates to providing the postulated site parameters for the U.S. EPR design

2. 10 CFR 52.47(a), as it relates to providing technical information sufficient to demonstrate the design bases, and the limits on plant operation, and presents a safety analysis of the structures, systems, and components (SSCs) and of the facility as a whole

Acceptance criteria adequate to confirm the above requirements are met include:

1. The acceptance criteria associated with specific site parameters are contained in the related SRP Chapter 2 or other referenced SRP sections.

2. The acceptance criteria associated with specific site parameters are based on the COL applicant's demonstration that the characteristics of the site fall within the site

parameters of the certified design. If the actual site characteristics do not fall within the certified standard design site parameters, the COL applicant provides sufficient justification that the proposed facility is acceptable at the proposed site.

### 2.0.3 Technical Evaluation

The staff reviewed the FSAR using the review procedures described in SRP Section 2.0. The staff based its finding on the U.S. EPR site parameters described in FSAR Tier 2, Chapter 2, "Site Characteristics." The application addresses each of the pertinent site parameters. The adequacy of each site parameter is discussed in the individual safety-evaluation sections throughout this report.

### 2.0.4 Conclusions

As set forth above, the staff reviewed the application to ensure that sufficient information was presented with respect to the site parameters in the FSAR. Accordingly, the staff concludes that the applicant has established the site parameters in the design certification application and, thus, meets the requirements of 10 CFR 52.47(a)(1).

## 2.1 Geography and Demography

### 2.1.1 Site Location and Description

The descriptions of the site area and reactor location are used to assess the acceptability of the reactor site. The review covers the following specific areas: (1) Specification of reactor location with respect to latitude and longitude, political subdivisions, and prominent natural and manmade features of the area; (2) site area map to determine the distance from the reactor to the boundary lines of the exclusion area, including consideration of the location, distance, and orientation of plant structures with respect to highways, railroads, and waterways that traverse or lie adjacent to the exclusion area; and (3) any additional information requirements prescribed within the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The purpose of the review is to ascertain the accuracy of the applicant's description for use in independent evaluations of the exclusion area authority and control, surrounding population, and nearby manmade hazards.

#### 2.1.1.1 *Summary of Application*

FSAR Tier 2, Section 2.1 addresses the need for site location and description with a statement that a COL applicant that references the U.S. EPR design certification will provide site-specific information related to site location and description, exclusion area authority and control, and population distribution.

#### 2.1.1.2 *Regulatory Basis*

The applicable regulatory requirements for identifying site location and description are as follows:

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, as they relate to the inclusion in the Safety Analysis Report (SAR) of a

detailed description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design (10 CFR 50.34(a)(1), 10 CFR 52.47(a)(1), and 10 CFR 52.47(a)(2)(iv), and 10 CFR 52.79(a)(1)(vi)).

2. 10 CFR Part 100, "Reactor Site Criteria," as it relates to the following: (1) Defining an exclusion area and setting forth requirements regarding activities in that area (10 CFR 100.3, "Definitions"); (2) addressing and evaluating factors that are used in determining the acceptability of the site as identified in 10 CFR100.20(b); (3) determining an exclusion area such that certain dose limits would not be exceeded in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1) as it relates to site-evaluation factors identified in 10 CFR Part 100; and (4) requiring that the site location and the engineered features included as safeguards against the hazardous consequences of an accident, should one occur, should ensure a low risk of public exposure.

Acceptance criteria adequate to meet the above requirements are as follows:

1. Specification of Location: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.34(a)(1) as it relates to site evaluation factors identified in 10 CFR Part 100 and 10 CFR 52.79(a)(1) if it describes highways, railroads, and waterways that traverse the exclusion area in sufficient detail to allow the reviewer to determine that the applicant has met the requirements in 10 CFR 100.3.

2. Site Area Map: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.34(a)(1) as it relates to site-evaluation factors identified in 10 CFR Part 100 and 10 CFR 52.79(a)(1) if it describes the site location, including the exclusion area and the location of the plant within the area, in sufficient detail to enable the reviewer to evaluate the applicant's analysis of a postulated fission product release. This would allow the reviewer to determine (in SRP Sections 2.1.2 and 2.1.3 and Chapter 15, "Transient and Accident Analysis,") that the applicant has met the requirements of 10 CFR 50.34(a)(1) as it relates to site evaluation factors identified in 10 CFR Part 100.

### 2.1.1.3 *Technical Evaluation*

In FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," COL Information Item 2.1-1, the applicant stated that a COL applicant referencing U.S. EPR design certification will address the site-specific information pertaining to the site location and description to include the following:

- reactor location with respect to (1) latitude and longitude, and the Universal Transverse Mercator (UTM) 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 of plant accidents on these transportation routes (SRP Section 2.1.1)

The FSAR does not contain this type of information because it is site-specific.

#### 2.1.1.4 *Conclusions*

As discussed above, in FSAR Tier 2, Table 1.8-2, COL Information Item 2.1-1, the applicant stated that the COL applicant will provide the site-specific information. Since this information is site-specific, the staff finds the applicant's statement provided in the FSAR, that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.1.1 acceptable. Since this information is site-specific and for the reasons given above, the staff concludes that it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. Each COL applicant should provide information sufficient to demonstrate that the actual site characteristics specified in a COL application fall within the values of the site parameters specified in the U.S. EPR FSAR.

### 2.1.2 Exclusion Area Authority and Control

The descriptions of exclusion area authority and control are used to verify the applicant's legal authority to determine and control activities within the designated exclusion area, as provided in the application, and are sufficient to enable the reviewer to assess the acceptability of the reactor site. The review covers the following specific areas: (1) Establishment of the applicant's legal authority to determine all activities within the designated exclusion area; (2) the applicant's authority and control in regard to excluding or removing personnel and property in the event of an emergency; (3) establishment of the fact that proposed or permitted activities in the exclusion area unrelated to operation of the reactor do not result in a significant hazard to public health and safety; and (4) any additional information requirements prescribed within the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

#### 2.1.2.1 *Summary of Application*

This section of the FSAR addresses the need for exclusion area authority and control with a statement that a COL applicant that references the U.S. EPR design certification will provide site-specific information related to exclusion area authority and control.

#### 2.1.2.2 *Regulatory Basis*

The applicable regulatory requirements for verifying exclusion area authority and control are:

1. 10 CFR Part 50 and 10 CFR Part 52, as they relate to the inclusion in the SAR of a detailed description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design (10 CFR 50.34(a)(1) as it relates to site-evaluation factors identified in 10 CFR Part 100, 10 CFR 52.17(a)(1), and 10 CFR 52.79(a)(1)).

2. 10 CFR Part 100, as it relates to the following: (1) Defining an exclusion area and setting forth requirements regarding activities in that area (10 CFR 100.3, 10 CFR 100.21(a)); (2) addressing and evaluating factors that are used in determining the acceptability of the site as identified in 10 CFR 100.20(b); and (3) determining an

exclusion area in which certain dose limits would not be exceeded in the event of a postulated fission product release as identified in 10 CFR 50.34(a)(1) as it relates to site-evaluation factors identified in 10 CFR Part 100.

Acceptance criteria adequate to meet the above requirements include the following:

1. Establishment of Authority: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.33, "Contents of Applications: General Information," and 10 CFR 50.34(a)(1) as they relate to site-evaluation factors identified in 10 CFR Part 100; 10 CFR 52.17 and 10 CFR 52.47, both titled, "Contents of Applications; Technical Information"; 10 CFR 52.79, "Contents of Applications; Technical Information in Final Safety Analysis Report"; and 10 CFR Part 100 if it provides sufficient detail to enable the staff to evaluate the applicant's legal authority within the designated exclusion area.

2. Exclusion or Removal of Personnel and Property: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.33 and 10 CFR 50.34(a)(1) as they relate to site evaluation factors identified in 10 CFR Part 100, 10 CFR 52.17, 10 CFR 52.47, 10 CFR 52.79, and 10 CFR Part 100 if it provides sufficient detail to enable the staff to evaluate the applicant's legal authority for the exclusion or removal of personnel or property from the exclusion area.

3. Proposed and Permitted Activities: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.33 and 10 CFR 50.34(a)(1) as they relate to site-evaluation factors identified in 10 CFR Part 100, 10 CFR 52.17, 10 CFR 52.47, 10 CFR 52.79, and 10 CFR Part 100 if it provides sufficient detail to enable the staff to evaluate the applicant's legal authority over all activities within the designated exclusion area.

### 2.1.2.3 *Technical Evaluation*

The applicant need not postulate a location for the EAB or outer boundary of the low-population zone (LPZ) as site parameters because the points at which radiological doses are calculated pursuant 10 CFR 52.47(a)(2)(iv) for these locations are implicit in the atmospheric dispersion factors ($\chi$/Q values) discussed in Section 2.3 and Chapter 15 of this report.

In FSAR Tier 2, Table 1.8-2, COL Information Item 2.1-1, the applicant stated that a COL applicant referencing the U.S. EPR design certification will address the site-specific information pertaining to exclusion area authority and control. The specific criteria acceptable to meet the relevant requirements are addressed in SRP Section 2.1.2 which typically involves reviewing: (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.

The FSAR does not contain this type of information because it is site-specific.

### 2.1.2.4 *Conclusions*

As discussed above, in FSAR Tier 2, Table 1.8-2, COL Information Item 2.1-1, the applicant stated that the COL applicant will provide the site-specific information. Since this information is site-specific, the staff finds the applicant's statement provided in the FSAR that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.1.2 acceptable. Since this information is site-specific and for the reasons given above, the staff concludes that it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. Each COL applicant should provide information sufficient to demonstrate that the actual site characteristics specified in a COL application fall within the values of the site parameters specified in the U.S. EPR FSAR.

## 2.1.3 Population Distribution

The description of population distributions addresses the need for information about: (1) Population in the site vicinity, including transient populations; (2) population in the exclusion area; (3) whether appropriate protective measures could be taken on behalf of the populace in the specified LPZ in the event of a serious accident; (4) whether the nearest boundary of the closest population center containing 25,000 or more residents is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ; (5) whether the population density in the site vicinity is consistent with the guidelines given in Regulatory Guide (RG) 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Regulatory Position C.4; and (6) any additional information requirements prescribed within the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

### 2.1.3.1 *Summary of Application*

This section of the FSAR addresses the need for information about population distribution with a statement that a COL applicant that references the U.S. EPR design certification will provide site-specific information related to population distribution.

### 2.1.3.2 *Regulatory Basis*

The applicable regulatory requirements for identifying site location and description are as follows:

1. 10 CFR 50.34(a)(1), as it relates to consideration of the site evaluation factors identified in 10 CFR 100.3, 10 CFR Part 100 (including consideration of population density), 10 CFR 52.17, 10 CFR 52.47, and 10 CFR 52.79, as they relate to provision by the applicant in the SAR of the existing and projected future population profile of the area surrounding the site.

2. 10 CFR 100.20, "Factors To Be Considered When Evaluating Sites," and 10 CFR 100.21, "Non-Seismic Siting Criteria," as they relate to determining the acceptability of a site for a power reactor. In 10 CFR 100.3, 10 CFR 100.20(a), and 10 CFR 100.21(b), the NRC provides definitions and other requirements for determining an exclusion area, LPZ, and population center distance.

Acceptance criteria adequate to meet the above requirements include the following:

1. Population Data: The population data supplied by the applicant in the SAR is acceptable under the following conditions: (1) The SAR contains population data from the latest census and projected population at the year of plant approval and 5 years thereafter, in the geographical format given in RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Section 2.1.3, and in accordance with RG 1.206, "Combined License Applications for Nuclear Power Plants"; (2) the SAR describes the methodology and sources used to obtain the population data, including the projections; and (3) the SAR includes information on transient populations in the site vicinity.

2. Exclusion Area: The exclusion area should either not contain any residents, or such residents should be subject to ready removal if necessary.

3. Low-Population Zone: The specified LPZ is acceptable if it is determined that appropriate protective measures could be taken on behalf of the enclosed populace in the event of a serious accident.

4. Nearest Population Center Boundary: The nearest boundary of the closest population center containing 25,000 or more residents is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ.

5. Population Density: If the population density exceeds the guidelines given in RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Regulatory Position C.4, the applicant must give special attention to the consideration of alternative sites with lower population densities.

### 2.1.3.3 *Technical Evaluation*

In FSAR Tier 2, Table 1.8-2, COL Information Item 2.1-1, the applicant stated that a COL applicant referencing U.S. EPR design certification will address the site-specific information pertaining to population distribution. The specific criteria acceptable to meet the relevant requirements are addressed in SRP Section 2.1.3 which typically involves reviewing:

- data about the population in the site vicinity
- the population in the exclusion area
- the LPZ to determine if 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 if 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 if it exceeds 500 persons per square mile averaged over any radial distance out to 32.2 kilometers (km) (20 miles (mi))

The FSAR does not contain this type of information because it is site-specific.

#### 2.1.3.4 *Conclusions*

As discussed above, in FSAR Tier 2, Table 1.8-2, COL Information Item 2.1-1, the applicant stated that the COL applicant will provide the site-specific information. Since this information is site-specific, the staff finds the applicant's statement provided in the FSAR that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.1.3 acceptable. Since this information is site-specific and for the reasons given above, the staff concludes that it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. Each COL applicant should provide information sufficient to demonstrate that the actual site characteristics specified in a COL application fall within the values of the site parameters specified in the U.S. EPR FSAR.

## 2.2 Nearby Industrial, Transportation, and Military Facilities

The applicant stated that the U.S. EPR is designed to withstand the effects of external events resulting from such occurrences as earthquakes, storms, or other natural phenomena. This provides a robust design that can withstand a range of potential external hazards. A COL applicant that references the U.S. EPR design certification will provide site-specific information related to the identification of potential hazards stemming from nearby industrial, transportation, and military facilities within the site vicinity, including an evaluation of the potential effect such hazards might have on the proposed facility (such as from explosions, toxic chemicals, and fires).

### 2.2.1 Location and Routes

The description of locations and routes refers to potential external hazards or hazardous materials that are present or may reasonably be expected to be present during the projected lifetime of the proposed plant. The purpose is to evaluate the sufficiency of information concerning the presence and magnitude of potential external hazards so that the reviews and evaluations described in SRP Sections 2.2.3, 3.5.1.5, and 3.5.1.6 can be performed. The review covers the following specific areas: (1) The locations of, and separation distances to, transportation facilities and routes, including airports and airways, roadways, railways, pipelines, and navigable bodies of water; (2) the presence of military and industrial facilities, such as fixed manufacturing, processing, and storage facilities; and (3) any additional information requirements prescribed within the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52.

### 2.2.2 Descriptions

As referred to in Section 2.2 above, the industrial, transportation, and military facilities are site-specific information and will be addressed by the COL applicant as stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.2-1. This information will describe the primary function of each facility and the nature of the hazards it presents.

#### 2.2.2.1 *Summary of Application*

This section of the FSAR addresses the need for identification of potential hazards in the site vicinity with a statement that a COL applicant that references the U.S. EPR design certification will provide site-specific information related to the location and routes for nearby industrial, transportation, and military facilities.

### 2.2.2.2 *Regulatory Basis*

The applicable regulatory requirements for identifying locations and routes are as follows:

1. 10 CFR 52.17(a)(1)(vii) and 10 CFR 52.79(a)(1)(iv), as they relate to the factors to be considered in the evaluation of sites which require the location and description of industrial, military, or transportation facilities and routes, and 10 CFR 52.79(a)(1)(vi) as it relates to the compliance with 10 CFR Part 100.

2. 10 CFR 100.20(b), as it relates to the requirement that the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, and military and chemical facilities) be evaluated to establish site parameters for use in determining whether plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.

Acceptance criteria adequate to meet the above requirements include the following:

1. Data in the FSAR adequately describe the locations and distances from the plant of nearby industrial, military, and transportation facilities; these data are in agreement with data obtained from other sources, when available.

2. Descriptions of the nature and extent of activities conducted at the site and in its vicinity, including the products and materials likely to be processed, stored, used, or transported, are adequate to permit identification of the possible hazards cited in NUREG-0800, Section 2.2.1-2.2.2, Subsection III.

3. Sufficient statistical data with respect to hazardous materials are provided to establish a basis for evaluating the potential hazards to the plant or plants considered at the site.

### 2.2.2.3 *Technical Evaluation*

In FSAR Tier 2, Table 1.8-2, COL Information Item 2.2-1, the applicant stated that a COL applicant referencing U.S. EPR design certification will address the site-specific information pertaining to the identification of potential hazards stemming from the nearby industrial, transportation, and military facilities within the site vicinity. The specific criteria acceptable to meet the relevant requirements are addressed in SRP Sections 2.2.1 and 2.2.2, which typically involve reviewing:

- the locations of and distances to 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 considered for the site

The FSAR does not contain this type of information because it is site-specific.

### 2.2.2.4 *Conclusions*

As discussed above, in FSAR Tier 2, Table 1.8-2, COL Information Item 2.2-1, the applicant stated that the COL applicant will provide the site-specific information. Since this information is site-specific, the staff finds the applicant's statement provided in the FSAR that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.2.1 and 2.2.2 acceptable. Since this information is site-specific and for the reasons given above, the staff concludes that it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. Each COL applicant should provide information sufficient to demonstrate that the actual site characteristics specified in a COL application fall within the values of the site parameters specified in the U.S. EPR FSAR.

## 2.2.3 Evaluation of Potential Accidents

The evaluation of potential accidents considers the applicant's probability analyses of potential accidents involving hazardous materials or activities onsite and in the vicinity of the proposed site to confirm that appropriate data and analytical models have been used. The staff's review covers the following specific areas: (1) Hazards associated with nearby industrial activities, such as manufacturing, processing, or storage facilities; (2) hazards associated with nearby military activities, such as military bases, training areas, or aircraft flights; and (3) hazards associated with nearby transportation routes (aircraft routes, highways, railways, navigable waters, and pipelines). Each hazard review area includes consideration of the following principal types of hazards: (1) Toxic vapors or gases and their potential for incapacitating nuclear plant control room operators; (2) overpressure resulting from explosions or detonations involving materials such as munitions, industrial explosives, or explosive vapor clouds resulting from the atmospheric release of gases (such as propane and natural gas or any other gas) with a potential for ignition and explosion; (3) missile effects attributable to mechanical impacts, such as aircraft impacts, explosion debris, and impacts from waterborne items such as barges; and (4) thermal effects attributable to fires.

### 2.2.3.1 *Summary of Application*

This section of the FSAR addresses the need for evaluation of potential accidents in the plant vicinity with a statement that a COL applicant that references the U.S. EPR design certification will provide site-specific information related to the evaluation of accidents in the vicinity of the plant.

### 2.2.3.2 *Regulatory Basis*

The applicable regulatory requirements for identifying evaluation of potential accidents are:

- 10 CFR 52.17(a)(1)(vii) and 10 CFR 52.79(a)(1)(iv), as they relate to the factors to be considered in the evaluation of sites, which require the location and description of industrial, military, or transportation facilities and routes, and the requirements of 10 CFR 52.17(a)(1)(vii) and 10 CFR 52.79(a)(1)(vi) as they relate to compliance with 10 CFR Part 100.

Acceptance criteria adequate to meet the above requirements include the following:

1. Event Probability: The identification of design-basis events (DBEs) resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants of

specified type is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the 10 CFR 50.34(a)(1) limits as it relates to the requirements of 10 CFR Part 100 is estimated to exceed the staff objective of an order of magnitude of $10^{-7}$ per year.

2. Design-Basis Events: The effects of design-basis events have been adequately considered, in accordance with 10 CFR 100.20(b), if analyses of the effects of those accidents on the safety-related features of the plant or plants of specified type have been performed and measures have been taken (e.g., hardening/fire protection) to mitigate the consequences of such events.

3. 10 CFR 100.20(b), which states the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, and 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.

4. 10 CFR 100.21(e), which states 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.

### 2.2.3.3 *Technical Evaluation*

In FSAR Tier 2, Table 1.8-2, COL Information Item 2.2-2, the applicant stated that a COL applicant referencing U.S. EPR design certification will address the site-specific information pertaining to the evaluation of potential accidents within the plant vicinity. This includes hazards associated with: Nearby industrial activities (e.g., manufacturing, processing, or storage facilities); nearby military activities (e.g., military bases, training areas, or aircraft flights); and nearby transportation routes (e.g., aircraft routes, highways, railways, navigable waters, and pipelines). The following principal types of hazards will be considered with respect to each of the above areas of review, if they have a probability of occurrence greater than $10^{-7}$ per year.

- 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

The FSAR does not contain this type of information as it is site-specific.

#### 2.2.3.4 *Conclusions*

As discussed above, in FSAR Tier 2, Table 1.8-2, COL Information Item 2.2-2, the applicant stated that the COL applicant will provide the site-specific information. Since this information is site-specific, the staff finds the applicant's statement provided in the FSAR that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.2.3 acceptable. Since this information is site-specific and for the reasons given above, the staff concludes that it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. Each COL applicant should provide information sufficient to demonstrate that the actual site characteristics specified in a COL application fall within the values of the site parameters specified in the U.S. EPR FSAR.

## 2.3 Meteorology

Pursuant to 10 CFR 52.47(a)(1), a design certification applicant must provide site parameters postulated for the design. As stated in 10 CFR 52.1(a), site parameters are the postulated physical, environmental, and demographic features of an assumed site specified in a standard design certification. As stated in 10 CFR 52.79(c)(1), a COL application references an approved standard design; the COL FSAR 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 NRC regulations, the 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 parameters, to ensure that they are representative of a reasonable number of sites that may be considered for a COL application. The staff prepared Sections 2.3.1 through 2.3.5 of this report in accordance with the review procedures described in the SRP using information presented in the FSAR, and responses to staff RAIs.

### 2.3.1 Regional Climatology

#### 2.3.1.1 *Summary of Application*

**COL Information Items**

The following COL Information Items presented in FSAR Tier 2, Table 1.8-2 are related to this section:

- COL Information Item 2.0-1: A COL applicant that references the U.S. EPR design certification will compare the characteristics of its proposed site to the site parameters in FSAR Tier 2, Table 2.1-1. If the characteristics of the site fall within the assumed site parameters in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific characteristics that are outside the bounds of the assumptions presented in FSAR Tier 2, Table 2.1-1, the COL applicant will demonstrate that the U.S. EPR design acceptably meets the regulatory requirements given the more limiting site-specific characteristics. In such an instance, the COL applicant will also demonstrate that the design commitments and acceptance criteria described in the FSAR do not need to be changed, or will propose new design commitments or acceptance criteria, or both.

- COL Information Item 2.3-1: If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the site parameters in FSAR Tier 2, Table 2.1-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the COL application.

- COL Information Item 2.3-2: A COL applicant that references the U.S. EPR design certification will provide site-specific characteristics for regional climatology.

**Site Parameters**

The list of U.S. EPR site parameters presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 will include climatic site parameters related to winter precipitation (for roof loading), maximum wind speed (other than tornado and hurricane), tornado, hurricane, and ambient air temperature.

1. Winter Precipitation (for Roof Loading)

   The site parameter for winter precipitation roof loading (e.g., snow and ice loads), as presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, is as follows:

   - The sum of normal winter precipitation event and extreme frozen winter precipitation event ground load is equal to or less than 6.85 kilo-newtons per square meter or kilo-Pascals ($kN/m^2$ or kPa) (143 pounds per square foot ($lb/ft^2$)).

   Footnote 1 to FSAR Tier 1, Table 5.0-1, and Footnote 1 to FSAR Tier 2, Table 2.1-1, state that the effect of extreme liquid winter precipitation event on roof loads is negligible due to the lack of parapets.

   FSAR Tier 2, Section 2.3.1.1 further states the prescribed loads included in the combination of normal live loads are based on the weight of the normal winter precipitation event recorded at ground level. Winter precipitation loads to be included in the combination of extreme live loads are based on the addition of the weight of the extreme frozen or liquid precipitation event, whichever is greater. Snow pack and snowfall are adjusted for density differences and ground level values are adjusted to represent appropriate weights on roofs.

2. Maximum Wind Speed (Other Than Tornado and Hurricane)

   The site parameter for maximum wind speed (other than tornado and hurricane), as presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, is 65 meters per second (m/s) (145 miles per hour (mph)). FSAR Tier 2, Table 2.1-1 further states the 65 m/s (145 mph) value is based on a 3-second gust at 10 m (33 feet (ft)) above ground level and is factored for a 50-year mean recurrence interval. FSAR Tier 2, Table 2.1-1 also provides an importance factor site parameter value of 1.15 for safety-related structures. FSAR Tier 2, Section 3.3.1 describes how the 1.15 importance factor is used to convert the velocity pressure associated with the 50-year mean recurrence interval wind speed to a 100-year mean recurrence interval for the design of safety-related and quality-related structures.

3. Tornado

The site parameters for tornadoes, as presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, are as follows:

- The maximum wind speed is 103 m/s (230 mph)
- The maximum rotational speed is 82 m/s (184 mph)
- The maximum translational speed is 21 m/s (46 mph)
- The radius of maximum rotational speed is 45.7 m (150 ft)
- The maximum pressure drop is 83 millibars (mb) (1.2 pounds per square inch ($lb/in^2$)) at a rate of 34.5 mb per second (0.5 $lb/in^2$ per second)

FSAR Tier 2, Section 3.3.2.1 states the tornado site parameters were determined to conform to RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants."

4. Hurricane

The site parameters for hurricanes, as presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, include the following:

- The maximum wind speed is 103 meters per second (m/s) (230 mph)

FSAR Tier 2, Section 3.3.2.1 states the hurricane site parameter was determined to conform to RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants."

5. Ambient Air Temperature

The site parameters for ambient air temperature, as presented by the applicant in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, are as follows:

- The zero percent exceedance maximum ambient air temperature is 46.1 °C (115 °F) dry bulb and 26.7 °C (80 °F) wet bulb (mean coincident)
- The zero percent exceedance minimum ambient air temperature is -40 °C (-40 °F)
- The one percent exceedance (seasonal basis) maximum ambient air temperature is 37.8 °C (100 °F) dry bulb and 25 °C (77 °F) wet bulb (mean coincident)
- The one percent exceedance (seasonal basis) minimum ambient air temperature is -23.3 °C (-10 °F)

FSAR Tier 2, Table 2.1-1 provides the following additional ambient air temperature site parameter:

- The one percent exceedance (seasonal basis) maximum wet bulb (non-coincident) temperature is 26.7 °C (80 °F)

Footnote 2 to FSAR Tier 1, Table 5.0-1 and Footnote 3 to FSAR Tier 2, Table 2.1-1 state that, by definition, the zero percent exceedance ambient air temperature values exclude peaks of temperature that last less than 2 hours in duration and are based on conservative estimates of 100-year return period values and historic values, whichever is bounding.

Footnote 3 to FSAR Tier 1, Table 5.0-1 and Footnote 4 to FSAR Tier 2, Table 2.1-1 state that the one percent exceedance (seasonal basis) maximum ambient air temperature values are based on data from the summer months of June, July, and August and the one percent exceedance (seasonal basis) minimum ambient air temperature value is based on data from the winter months of December, January, and February.

FSAR Tier 2, Section 2.3.1.1 states the dry bulb and wet bulb temperature site parameters were based on the EPRI Advanced Light Water Reactors (ALWR) Utility Requirements Document (URD) and available early site permit (ESP) applications. The zero percent exceedance values were based on conservative estimates of 100-year return period values and historic extreme values, whichever were bounding.

**Ultimate Heat Sink Meteorological Conditions**

FSAR Tier 2, Section 9.2.5 describes the ultimate heat sink (UHS) as four separated divisions with each division consisting of one mechanical draft cooling tower with two cells.

FSAR Tier 2, Section 2.3.1.2 states that, as described in FSAR Tier 2, Section 9.2.5, the UHS is designed to operate for a nominal 30 days following a loss-of-coolant accident (LOCA) without the addition of any makeup water to the source, or it must be demonstrated that replenishment or use of an alternative or additional water supply can provide continuous capability of the heat sink to perform its safety-related functions (this is COL Information Item 9.2-8). The applicant also states the UHS tower basin contains a minimum 72-hour supply of water.

FSAR Tier 2, Section 2.3.1.2 states the meteorological conditions resulting in maximum evaporation and drift loss of water from the UHS for a 72-hour period are presented in FSAR Tier 2, Table 9.2.5.3, “Design Values for Maximum Evaporation and Drift Loss of Water from the UHS.” The applicant stated that the UHS cooling tower basin is designed considering the wet bulb temperature in FSAR Tier 2, Table 9.2.5-2, “Ultimate Heat Sink Design Parameters” (i.e., a design inlet wet bulb temperature of 27.2 °C (81 °F), which represents a non-coincident zero percent exceedance value) and maintains its cooling function for the FSAR Tier 2, Table 9.2.5-3 meteorological conditions. Water makeup to the UHS cooling tower basin beyond 72 hours is site-specific. As described in FSAR Tier 2, Section 9.2.5.3, the COL applicant is to describe the means for providing UHS makeup sufficient to meet the maximum evaporative and drift water loss after 72 hours through the remainder of the 30-day period consistent with RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants” (see COL Information Item 9.2-8).

FSAR Tier 2, Section 2.3.1.2 further states the meteorological conditions resulting in minimum water cooling in the UHS are presented in FSAR Tier 2, Table 9.2.5-4, “Design Values for Minimum Water Cooling in the UHS.” The meteorological conditions presented in FSAR Tier 2, Table 9.2.5-4 reflect a 1-day period during which evaporative cooling is at a minimum. The applicant also states the UHS heat loads peak and decline within the first day, such that extending the 1-day meteorological profile for 5 consecutive days does not cause the UHS

cooling tower basin water temperature to exceed the maximum design cold (outlet) water temperature of 35 °C (95 °F) listed as a UHS design parameter in FSAR Tier 2, Table 9.2.5-2.

### 2.3.1.2 *Regulatory Basis*

The acceptance criteria for the climatological site parameters selected as the design bases for the U.S. EPR are based on meeting the relevant requirements of the following NRC regulations:

1. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," as it relates to 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

2. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to information on tornadoes that could generate missiles

3. 10 CFR Part 50, Appendix A, GDC 44, "Cooling Water," as it relates to meteorological data used to evaluate the design of the UHS

4. 10 CFR 52.47(a)(1) with respect to the site parameters that a design certification applicant postulated for the design

SRP Section 2.3.1 states that the regional climatic conditions identified as site parameters for design certification applications should include the following:

1. 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

2. The 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

3. 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

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

5. Ambient air temperature and humidity statistics for use in establishing heat loads for the design of normal plant heat sink systems, post-accident containment heat removal systems, and plant heating, ventilating, and air conditioning systems

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

Subsequent to publication of SRP Section 2.3.1, the staff issued proposed interim staff guidance (ISG) document DC/COL-ISG-7, "Interim Staff Guidance on Assessment of Normal

and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," for public comment in the *Federal Register* on August 22, 2008 (73 FR 49712), to clarify the staff's position on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of Seismic Category I structures. The final version of DC/COL-ISG-7 was issued on July 1, 2009 (74 FR 31470).

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 undue risk to the facility. Examples include:

- RG 1.76, "Design Basis Tornado for Nuclear Power Plants," which 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.

- RG 1.221, which provides guidance in selecting the design-basis hurricane and design-basis hurricane generated missiles that a nuclear power plant should be designed to withstand to prevent undue risk to the health and safety of the public.

- RG 1.27, which states the meteorological conditions resulting in the maximum evaporative and drift loss of water from the UHS, as well as the meteorological conditions, resulting in minimum water cooling that should be considered to ensure the UHS is able to perform its safety functions.

### 2.3.1.3 *Technical Evaluation*

**COL Information Items**

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in FSAR Tier 2, Table 1.8-2.

The staff determined that COL Information Item 2.3-1 in Revision 0 to the FSAR did not distinguish between site parameters and site characteristics as defined in 10 CFR 52.1(a). Further, COL Information Item 2.3-1 did not clearly describe how the actual site characteristics will be compared to the postulated site parameters set forth in the FSAR. Therefore, in RAI 288, Question 02.03.01-16, the staff requested that the applicant address this issue. RAI 288, Question 02.03.01-16 was being tracked as an open item. (This open item addresses issues similar to the concerns identified in RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2.)

In an April 1, 2010, response to RAI 274, Question 02.00.00-1, the applicant agreed that the term "site parameter" should be used for the assumed site of the U.S. EPR FSAR and the term "site characteristic" should be used for a site-specific COL FSAR. The applicant subsequently committed to revising a number of the COL information items listed in FSAR Tier 2, Table 1.8-2 (including COL Information Item 2.3-1) to reflect this distinction.

The staff reviewed the applicant's April 1, 2010, response to RAI 274, Question 02.00.00-1 and finds it addressed RAI 288, Question 02.03.01-16 by committing to revise the FSAR to appropriately address the distinction between site parameters and site characteristics. The staff confirmed that FSAR Tier 2, Revision 2, dated August 31, 2010, was revised as committed in the April 1, 2010, response to RAI 274, Question 02.00.00-1. Accordingly, the staff considers RAI 288, Question 02.03.01-16 resolved.

COL Information Item 2.3-10 in FSAR Tier 2, Revision 0, Table 1.8-2 stated that a COL applicant referencing the U.S. EPR design certification will need to describe the means for providing UHS makeup water sufficient to meet the maximum evaporative and drift water loss after 72 hours through a 30-day period, as specified by RG 1.27. Therefore, in RAI 453, Question 02.03.01-19, the staff requested that the applicant consider moving this COL information item from FSAR Tier 2, Section 2.3.1 to FSAR Tier 2, Section 2.4.8 because FSAR Tier 2, Section 2.4.8 is the FSAR section that is concerned with evaluating the design basis for cooling water canals and reservoirs used for makeup to the UHS cooling tower basins.

In a December 16, 2010, response to RAI 453, Question 02.03.01-19, the applicant stated that it has already committed to deleting COL Information Item 2.3-10 from FSAR Tier 2, Section 2.3.1 and moving it to FSAR Tier 2, Section 9.2.5.3 as COL Information Item 9.2-8 in its November 4, 2010, response to RAI 351, Question 09.02.05-29. The staff reviewed the applicant's responses to RAI 453, Question 02.03.01-19 and RAI 351, Question 09.02.05-29 and finds the responses acceptable because the applicant has proposed moving COL Information Item 2.3-10 to a section of the FSAR that discusses UHS water makeup capacity. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the December 16, 2010, response to RAI 453, Question 02.03.01-19. Accordingly, the staff considers RAI 453, Question 02.03.01-19 resolved.

**Site Parameters**

Pursuant to SRP Section 2.3.1, the staff verified that the postulated site parameters are representative of a reasonable number of sites that have been or may be considered for a COL application and that a technical basis has been provided for each site parameter.

1. Winter Precipitation (for Roof Loading)

   FSAR Tier 1, Revision 0, Table 5.0-1 and FSAR Tier 2, Revision 0, Table 2.1-1 present one site parameter related to winter precipitation: An extreme live load of 4.8 kPa (100 lb/ft$^2$), which includes the 48-hour PMWP. In RAI 93, Question 02.03.01-12, the staff requested that the applicant specify and identify the normal and extreme liquid and frozen precipitation events used in the design of the roofs of safety-related structures in accordance with ISG-7. The staff stated these events should be identified as site parameters in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1. The staff also requested that the applicant provide a basis for the chosen site parameter values, including ensuring the postulated site parameter values are representative of a reasonable number of sites that have been or may be considered for a COL application.

   In a December 8, 2008, response to RAI 93, Question 02.03.01-12, the applicant stated that the roof design of the U.S. EPR standard plant structures accommodates both the normal and extreme winter precipitation events in accordance with the recommendations of ISG-7. The applicant also committed to revising FSAR Tier 1, Table 5.0-1, and FSAR Tier 2, Table 2.1-1, to include the following site parameters.

   - normal ground precipitation load of 4.8 kPa (100 lb/ft$^2$)
   - normal roof precipitation load of 3.35 kPa (70 lb/ft$^2$)
   - 48-hour probable maximum winter precipitation (PMWP) liquid roof load of 0 kPa (0 lb/ft$^2$)

- 48-hour PMWP frozen ground load of 2.06 kPa (43 lb/ft$^2$) (based on 1.4 m (55 in.)
- 48-hour PMWP frozen roof load of 1.44 kPa (30 lb/ft$^2$)
- extreme winter precipitation roof load of 4.8 kPa (100 lb/ft$^2$) (100-year mean recurrence interval (MRI))

The applicant identified a normal ground precipitation load (resulting from a normal winter precipitation event) of 4.8 kPa (100 lb/ft$^2$) representing a MRI of 100 years as a site parameter. ISG-7 states the normal winter precipitation event should be the highest ground-level weight (in lb/ft$^2$) among the 100-year return period snowpack, the historical maximum snowpack, the 100-year return period snowfall event, or the historical maximum snowfall event. The applicant stated that it reviewed a map of ground snow loads for the contiguous U.S. presented in Chapter 7 of American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) Standard ASCE/SEI 7-05, "Minimum Design Loads for Buildings and Other Structures," and concluded that a 100-year snowpack of 4.8 kPa (100 lb/ft$^2$) occurs in limited areas of the U.S.

To independently confirm whether the U.S. EPR normal ground precipitation load site parameter value of 4.8 kPa (100 lb/ft$^2$) bounds a reasonable number of sites that may be considered within a COL application, the staff compared this value against the maximum observed ground snow load recorded at 204 National Weather Service (NWS) locations throughout the contiguous U.S. as reported in ASCE/SEI 7-05, Table C7-1. The staff noted that only two stations had maximum observed ground snow loads exceeding 4.8 kPa (100 lb/ft$^2$). Consequently, the staff finds that the applicant has provided a normal ground precipitation load site parameter value that should bound a reasonable number of sites that may be considered within a COL application, and is therefore acceptable.

The applicant also identified a 48-hour PMWP liquid event (i.e., the extreme liquid winter precipitation event as defined in ISG-7) as 0.81 m (32 in.) of liquid water and a 48-hour PMWP frozen event (i.e., the extreme frozen winter precipitation event as defined in ISG-7) as 1.4 m (55 in.) of snow. The applicant also identified the 48-hour PMWP frozen event of 1.4 m (55 in.) of snow as being equivalent to a 48-hour PMWP frozen ground load of 2.06 kPa (43 lb/ft$^2$).

ISG-7 states the extreme liquid winter precipitation event is defined as the theoretically greatest depth of precipitation (in inches of water) for a 48-hour period that is physically possible over a 25.9-square-kilometer (10-square-mile) area at a particular geographical location during those months with the historically highest snowpacks. ISG-7 also states the extreme liquid winter precipitation event should be determined in accordance with the hydrometeorological report (HMRs) published by National Oceanographic Atmospheric Administration's (NOAA's) Hydrometeorological Design Studies Center. The applicant stated that the 48-hour liquid PMWP event of 0.81 m (32 in.) of liquid water was obtained from HMR No. 53 for the three climatological winter months of December-February. However, since the U.S. EPR standard plant structures have no parapets, the liquid precipitation events have no significant effect on roof loading. Therefore, the applicant identified a 48-hour PMWP liquid roof load site parameter value of 0 kPa (0 lb/ft$^2$).

ISG-7 states the extreme frozen winter precipitation event should be the higher ground-level weight between; (1) the 100-year return period 2-day snowfall event and

(2) the historical maximum 2-day snowfall event in the site region. The applicant stated the 48-hour frozen PMWP event of 1.4 m (55 in.) of snow was determined from a review of NOAA data for the maximum 2-day snowfall for all available stations in the lower 48 states and Alaska. To confirm whether the U.S. EPR 48-hour PMWP frozen ground load site parameter value of 2.06 kPa (43 lb/ft$^2$) (based on 1.4 m (55 in.) of snow) bounds a reasonable number of sites that may be considered within a COL application, the staff compared the 1.4 m (55 in.) of snow value against the 2-day record snowfall events at over 9000 NWS locations throughout the contiguous U.S. as reported by the National Climatic Data Center's (NCDC's) Snow Climatology website (http://www.ncdc.noaa.gov/ussc/index.jsp, accessed on October 20, 2008). The staff noted that less than one percent had maximum observed 2-day record snowfall events exceeding 1.4 m (55 in.). Note that the 48-hour PMWP frozen event of 1.4 m (55 in.) of snow can be shown to be equivalent to a 48-hour PMWP frozen ground load of 2.06 kPa (43 lb/ft$^2$) by assuming a snow density (defined as the ratio of the volume of melt water that can be derived from a sample of snow) of 0.15 and the weight of one inch of water of 0.249 kPa (5.2 lb/ft$^2$). Consequently, the staff finds that the applicant has provided a 48-hour PMWP frozen ground load site parameter value that should bound a reasonable number of sites that may be considered within a COL application and is, therefore, acceptable.

The staff confirmed that FSAR Tier 2, Revision 1, dated May 29, 2009, was revised as committed in the response to RAI 93, Question 02.03.01-12. Therefore, RAI 93, Question 02.03.01-12 was closed.

In RAI 256, Question 02.03.01-15, the staff requested that the applicant change the description of some of the winter precipitation site parameters listed in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, as described in the response to RAI 93, Question 02.03.01-12 to be consistent with the terminology presented in ISG-7. For example, the staff requested that the applicant make the following changes:

- change "48-hour PMWP liquid roof load" to "extreme liquid winter precipitation event roof load"
- change "48-hour PMWP frozen ground load" to "extreme frozen winter precipitation event ground load"
- change "48-hour PMWP frozen roof load" to "extreme frozen winter precipitation event roof load"

RAI 256, Question 02.03.01-15 was being tracked as an open item.

In a February 26, 2010, response to the open item in RAI 256, Question 02.03.01-15, the applicant agreed to the changes requested by the staff. The staff confirmed that FSAR Tier 2, Revision 2, dated August 31, 2010, was revised as committed in the RAI response. Therefore, the staff considers the open item in RAI 256, Question 02.03.01-15 closed.

In RAI 417, Question 02.03.01-17, the staff requested that the applicant consider the following:

- replacing all six winter precipitation site parameters listed in FSAR Tier 1, Revision 2, Table 5.0-1 and FSAR Tier 2, Revision 2, Table 2.1-1 with one site

parameter, “sum of normal winter precipitation event and extreme frozen winter precipitation event ground load: 143 psf”

- adding a footnote to this new site parameter in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 stating that the effect of the extreme liquid winter precipitation event on roof loads is negligible due to the lack of parapets

- adding a reference to FSAR Tier 2, Section 2.3 in the precipitation section subtitle in FSAR Tier 2, Table 2.1-1

- eliminating the discussion related to rain, snow, and ice loads from FSAR Tier 2, Section 2.4 (this discussion better belongs in FSAR Tier 2, Section 2.3, as outlined in SRP Section 2.3.1 and ISG-07)

- clarifying in FSAR Tier 2, Section 3.8.4.3.1, that the design load related to rain, snow, and ice is based on a ground snow load of 143 lbs/ft$^2$ and that this corresponds to a roof load of 100 lbs/ft$^2$

The discussion in FSAR Tier 2, Section 3.8.4.3.1 states that the normal design live load due to rain, snow, and ice includes the weight of the normal winter precipitation event and the weight of the extreme winter precipitation event. Therefore, it is appropriate to include one site parameter that combines the weight of the normal winter precipitation event and the extreme winter precipitation event. Also, the intent of FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 is to list those site parameters (i.e., the postulated physical, environmental, and demographic features of an assumed site, such as ground snow loads) that are to be compared to a COL applicant’s site characteristics pursuant to 10 CFR 52.79(d)(1). FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 need not contain the design characteristics (e.g., roof loads) resulting from the assumed site parameter values (e.g., ground loads).

In a December 16, 2010, response to RAI 453, Question 02.03.01-17, the applicant committed to modifying the FSAR as suggested by the staff. The staff reviewed the applicant’s response to RAI 453, Question 02.03.01-17, and finds it acceptable because the applicant agreed to make the changes to the FSAR suggested by the staff. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the response to RAI 453, Question 02.03.01-17. Therefore, the staff considers RAI 453, Question 02.03.01-17 resolved.

Note that FSAR Tier 2, Section 3.8.4.3.1 provides details of the analysis method used to convert ground snow loads to roof snow loads. This method is reviewed by the staff in Section 3.8.4 of this report.

2. Maximum Wind Speed (Other than Tornado and Hurricane)

NUREG-0800, Section 2.3.1, recommends that the basic (straight-line) 100-year return period 3-second gust wind speed should be based on appropriate standards, such as ASCE/SEI 7-05. Since this standard was the basis for the applicant’s extreme wind site parameter, the staff finds that the applicant has provided an adequate basis for this site parameter.

ASCE/SEI 7-05, Figure 6-1 shows contours of the 50-year return period 3-second wind gust for the continental U.S. Based on ASCE/SEI 7-05, the applicant’s extreme wind

site parameter of 65 m/s (145 mph) has the potential to be exceeded in a small portion of the coastal South and Southeast U.S. Since the 3-second gust wind speed for a large majority of the country is below the applicant's proposed site parameter, the staff finds that the applicant has provided a wind speed value which should be representative of a reasonable number of potential COL sites.

FSAR Tier 2, Table 2.1-1 also identifies an importance factor of 1.15 to convert the velocity pressure associated with the 50-year return period wind speed site parameter to a 100-year return period for the design of safety-related and quality-related structures. The staff finds this acceptable as it is consistent with the importance factor value assigned to the Category IV building and structure classification (i.e., buildings and structures designated as essential facilities) in ASCE/SEI 7-05, Table 6-1.

FSAR Tier 1, Revision 0, Table 5.0-1 and FSAR Tier 2, Revision 0, Table 2.1-1 defined the 65 m/s (145 mph) wind speed parameter as the "maximum sustained speed." In RAI 10, Question 02.03.01-2, the staff requested that the applicant change the name of this site parameter since the NWS Glossary defines "sustained wind" as the wind speed determined by averaging observed values over a 2-minute period (http://www.weather.gov/glossary/index.php?letter=s, accessed on April 20, 2009). In a May 16, 2008, response to RAI 10, Question 02.03.01-02, the applicant agreed to revise the title of this parameter to "Maximum Speed (Other than Tornado)." RAI 10, Question 02.03.01-02 was being tracked as a confirmatory item. The staff confirmed that FSAR Tier 2, Revision 1, dated May 29, 2009, was revised as committed in the applicant's response to RAI 10, Question 02.03.01-02. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 10, Question 02.03.01-2 resolved.

3. Tornado

The tornado site parameters proposed by the applicant (e.g., maximum wind speed, maximum rotational speed, maximum translational speed, radius of maximum rotational speed, maximum pressure drop, and rate of pressure drop) are the same as the Tornado Intensity Region I design-basis tornado characteristics specified in RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants." Consequently, the staff finds that the applicant has provided an adequate basis for the tornado site parameters.

RG 1.76, Region I represents the central and most of the southeastern portion of the U.S., where the most severe tornadoes frequently occur and corresponds to the most severe design-basis tornado characteristics. Therefore, the tornado site parameters provided by the applicant should be representative of a reasonable number of potential COL sites.

4. Hurricane

In February 2007, the National Weather Service implemented the Enhanced Fujita (EF) Scale, which is a revised assessment relating tornado damage to wind speed. In March 2007, the NRC revised its design-basis tornado regulatory guidance by issuing Revision 1 to RG 1.76 and found that the design-basis tornado wind speeds decreased as a result of the implementation of the EF Scale. Since design-basis tornado wind speeds were decreased as a result of the analysis performed to update RG 1.76, it was

no longer clear to the staff that the revised tornado design-basis wind speeds would bound design-basis hurricane wind speeds in all areas of the U.S.

Since it was no longer clear to the staff that the revised tornado design-basis wind speeds would bound design-basis hurricane wind speeds in all areas of the U.S., the staff initiated an investigation into extreme wind gusts during hurricanes and the relation to design-basis hurricane wind speeds. This investigation resulted in the staff issuing RG 1.221 in October 2011. The staff determined that the design-basis hurricane wind speeds should correspond to the exceedance frequency of $10^{-7}$ per year per nuclear power plant, calculated as a best estimate. This is the same exceedance frequency used to establish the design-basis tornado parameters in RG 1.76, Revision 1 and is consistent with the direction provided to the staff by the Commission in defining the design-basis tornado in the Staff Requirements Memorandum (SRM) related to Commission Paper SECY-04-200, "A Risk-Informed Approach to Defining the Design-Basis Tornado for New Reactor Licensing." The study of extreme wind gusts during hurricanes concluded that the wind speeds from the design-basis tornado remain bounding except for locations along the U.S. gulf coast and the southern U.S. Atlantic coast.

As a result of issuing RG 1.221, in RAI 541, Question 02-3, the staff requested that the applicant add hurricane wind speed and hurricane missiles to its list of site parameter values in FSAR Tier 1 and FSAR Tier 2 and show in FSAR Tier 2, Chapter 3 how SSCs important to safety are protected from the combined effects of hurricane winds and missiles.

In a December 18, 2013, response to RAI 541, Question 02-3, the applicant stated that it added an FSAR Tier 1 and FSAR Tier 2 design-basis hurricane wind speed site parameter value of 103 m/s (230 mph). The applicant also stated that FSAR Tier 2, Section 3.3.2.1 was revised to state that this site parameter was determined to conform to RG 1.221.

The staff reviewed the hurricane wind speed contour maps in RG 1.221 and concluded that, except for locations along the gulf coast and the southern Atlantic coasts, a design-basis hurricane wind speed site parameter value of 103 m/s (230 mph) was bounding. Therefore, the staff finds that a design-basis hurricane wind speed site parameter value of 103 m/s (230 mph) bounds a reasonable number of potential COL sites. The staff also confirmed that FSAR Revision 5, dated July 19, 2013, was revised to include a hurricane wind speed as a FSAR Tier 1 and FSAR Tier 2 site parameter value. Since the applicant added a design-basis hurricane wind speed site parameter value that bounded a reasonable number of potential COL sites, the staff finds the applicant's response to RAI 541, Question 02-3 acceptable with regard to Chapter 2. Accordingly, the staff considers RAI 541, Question 02-3 resolved with regard to Chapter 2.

5. Ambient Air Temperature

The ambient air temperature site parameters proposed by the applicant were based on the EPRI Advanced Light Water Reactor (ALWR) URD and available ESP applications. Consequently, the staff finds that the applicant has provided a basis for the ambient air temperature site parameters.

In RAI 256, Question 02.03.01-13, the staff requested that the applicant clarify the definitions of the zero percent and one percent exceedance ambient air temperature site parameters presented in FSAR Tier 2, Table 2.1-1.

In a May 4, 2010, response to RAI 256, Question 02.03.01-13, the applicant stated that:

- The maximum and minimum one percent ambient air temperature site parameters represent seasonal exceedances. For the maximum values, data from the summer months of June, July, and August are used; for the minimum values, data from the winter months of December, January, and February are used.

- The maximum zero percent and one percent exceedance coincident wet bulb temperatures represent mean values.

- The definition of zero percent exceedance excludes peaks of temperatures less than 2 hours in duration.

RAI 256, Question 02.03.01-13 was being tracked as an open item.

The staff confirmed that FSAR Tier 1, Revision 2, Table 5.0-1 and Tier 2, Revision 2, Table 2.1-1 dated August 31, 2010, were revised to include these clarifications. The applicant also revised these FSAR tables to state that the 100-year return period values and historic extreme values, whichever is bounding for a given site, should be compared to the U.S. EPR zero percent exceedance ambient air temperature site parameter values.

The staff reviewed the applicant's May 4, 2010, response to RAI 256, Question 02.03.01-13 and the associated changes to the FSAR and finds them acceptable because the applicant responded to the staff's request for clarification of the definitions of the U.S. EPR ambient air temperature site parameters in FSAR Tier 1, Table 5.0-1 and Tier 2, Table 2.1-1. Therefore, the staff considers RAI 256, Question 02.03.01-13 closed.

To be consistent with Footnote 2 to FSAR Tier 1, Table 5.0-1 and Footnote 3 to FSAR Tier 2, Table 2.1-1, in RAI 453, Question 02.03.01-18, the staff requested that the applicant consider revising FSAR Tier 2, Section 2.3.1.1, to state that the U.S. EPR zero percent exceedance air temperature site parameter values are based on conservative estimates of 100-year return period values and historic extreme values, whichever is bounding.

In a December 16, 2010, response to RAI 453, Question 02.03.01-18, the applicant committed to modifying the FSAR as suggested by the staff. The staff reviewed the applicant's response to this question and finds it acceptable because the applicant agreed to make the changes to the FSAR suggested by the staff. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the response to RAI 453, Question 02.03.01-18. Accordingly, the staff considers RAI 453, Question 02.03.01-18 resolved.

The reasonableness of the values chosen as ambient temperature site parameters is discussed below.

*Zero Percent Exceedance Temperatures*

To consider if the applicant's zero percent exceedance maximum and minimum ambient dry bulb temperatures are representative of a reasonable number of potential COL sites, the staff reviewed 100-year return period dry bulb temperature data from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE). In accordance with SRP Section 2.3.1, the staff used ASHRAE's "Weather Data Viewer," Version 3.0, to obtain dry bulb and wet bulb temperature data for over 650 weather stations throughout the contiguous U.S.

The ASHRAE Weather Data Viewer generates its temperature statistics based on hourly temperature observations, whereas the U.S. EPR zero percent exceedance temperature site parameters exclude peaks of temperature less than 2 hours in duration. For the purpose of this review the staff relied on ASHRAE 1-hour historical peaks, which would result in slightly higher maximums and slightly lower minimums (i.e., more conservative values) when compared to the definition of the U.S. EPR zero percent exceedance temperature site parameter values.

The ASHRAE Weather Data Viewer provides a calculated 100-year return period maximum dry bulb temperature for each station. The staff noted that only eight percent of the weather stations had a calculated 100-year return period maximum dry bulb temperature greater than the applicant's zero percent exceedance maximum dry bulb temperature site parameter value of 46.1 °C (115 °F). Thus, the staff accepted the applicant's zero percent maximum dry bulb temperature site parameter value as bounding a reasonable number of potential COL sites.

The ASHRAE Weather Data Viewer also provides a calculated 100-year return period minimum dry bulb temperature for each station. The staff noted that 13 percent of the weather stations had a calculated 100-year return period minimum dry bulb temperature of less than -40 °C (-40 °F). Since the applicant's zero percent minimum dry bulb temperature site parameter value of -40 °C (-40 °F) has only been exceeded at 13 percent of the stations throughout the contiguous U.S., the staff accepted the applicant's zero percent minimum dry bulb temperature as bounding a reasonable number of potential COL sites.

To consider if the applicant's zero percent exceedance coincident wet bulb temperature site parameter value of 26.7 °C (80 °F) is representative of a reasonable number of potential COL sites, the staff considered temperature and humidity data from NCDC Solar and Meteorological Surface Observational Network (1961 -1990). Based on temperature, dew point, and pressure, the staff derived hourly wet bulb temperatures for 75 observation stations located along the gulf coast and east coast of the contiguous U.S. The staff primarily considered locations near the coast, because these are areas where atmospheric moisture content is typically highest, which would result in the highest wet bulb temperatures. For all 75 locations, the staff concluded the highest recorded dry bulb temperatures, all of which fell below 46.1 °C (115 °F). The coincident wet bulb temperature was derived for the corresponding hour with the highest recorded dry bulb temperatures. The applicant's proposed site parameter of 26.7 °C (80 °F) was exceeded at only one location. Thus, the staff accepted the applicant's zero percent exceedance coincident wet bulb temperature site parameter value of 26.7 °C (80 °F) as representative of a reasonable number of potential COL sites.

To consider if the applicant's zero percent exceedance non-coincident wet bulb temperature site parameter value of 27.2 °C (81 °F) is representative of a reasonable number of potential COL sites, the staff considered wet bulb temperature data from the ASHRAE Weather Data Viewer. The ASHRAE Weather Data Viewer provides an extreme annual wet bulb temperature for each station. The staff noted that the applicant's proposed zero percent exceedance non-coincident wet bulb temperature site parameter value of 27.2 °C (81 °F) was exceeded at approximately 67 percent of the weather stations, primarily in the eastern two thirds of the contiguous U.S. In RAI 37, Question 02.03.01-10, the staff stated that the proposed zero percent maximum non-coincident wet bulb temperature of 27.2 °C (81 °F) is non-conservative and that the staff is not inclined to approve a plant design that cannot be sited at a reasonable number of potential COL sites without COL applicants requesting a departure from the design as part of their COL applications. The staff requested that the applicant revise the zero percent maximum non-coincident wet bulb temperature site parameter value or provide additional justification regarding how this value is representative of a reasonable number of sites.

In a November 17, 2008, response to RAI 37, Question 02.03.01-10, the applicant stated that the non-coincident wet bulb temperature site parameter value of 27.2 °C (81 °F) was used solely as the design point in the sizing of the UHS cooling towers. The cooling tower design was validated to a bounding time-dependent wet bulb temperature profile (shown in FSAR Tier 2, Table 2.1-4, which later became FSAR Tier 2, Table 9.2.5-4 in Revision 2 to the FSAR dated August 31, 2010) to determine the minimum cooling characteristics of the UHS. The applicant stated that the cooling tower design met the UHS design requirements (i.e., essential service water supply temperature) under a time-dependent heat load for the limiting design-basis event. The applicant stated further that the U.S. EPR UHS design was evaluated using site-specific meteorological data for each of the COL applications referencing the U.S. EPR design to verify that the site-specific data yield acceptable maximum UHS basin temperatures. Therefore, the applicant contends that the design of the UHS cooling towers is representative of the COL application sites referencing the U.S. EPR design. For this reason, the staff considers RAI 37, Question 02.03.01-10, closed.

The staff noted that the applicant's September 8, 2008, response to RAI 37, Question 02.03.01-10, states that, while the 27.2 °C (81 °F) zero percent exceedance non-coincident wet bulb design point may be exceeded at locations throughout the U.S., the cooling tower design can be validated to site-specific time-dependent wet bulb temperature profiles at the time of minimum UHS cooling such that a departure from the U.S. EPR design would not be needed. The staff also noted that it is unclear how a COL applicant can demonstrate that the wet bulb temperature and concurrent dry bulb temperature characteristics for its site fall within the 24 sets of hourly wet bulb temperature and concurrent dry bulb temperature site parameter values presented in FSAR Tier 2, Table 2.1-4. Therefore, the staff requested in RAI 256, Question 02.03.01-14, that the applicant:

- Consider deleting the 27.2 °C (81 °F) zero percent exceedance non-coincident wet bulb air temperature as a site parameter. There is no benefit in specifying a site parameter value that is known to be exceeded at a number of locations. (While cooling tower design depends on local meteorological characteristics such as wet bulb temperature, the designation of zero percent exceedance non-coincident wet bulb air temperature as a site parameter would be

unnecessary to assure proper operation of the cooling towers and unduly restrictive. The staff's evaluation of cooling towers is discussed in Chapter 9 of this report.)

- Consider adding a COL Information Item to FSAR Tier 2, Table 1.8-2 stating that a COL applicant that references the U.S. EPR design certification will demonstrate that the UHS cooling tower design is validated with site-specific time-dependent wet bulb temperature profiles to verify that the site-specific data yield acceptable maximum UHS basin temperatures pursuant to RG 1.27.

- Consider deleting the hourly wet bulb temperature and concurrent dry bulb temperature values presented in FSAR Tier 2, Table 2.1-4 (containing the design values for minimum water cooling from the UHS) as site parameters. It is unclear to the staff how COL applicants can demonstrate that the wet bulb temperature and concurrent dry bulb temperature characteristics for their site fall within the 24 sets of hourly wet bulb temperature and concurrent dry bulb temperature site parameter values presented in FSAR Tier 2, Table 2.1-4. (Rather, a COL applicant will need to verify the adequacy of the UHS design using site-specific hourly wet bulb temperature values and concurrent dry bulb temperature values.)

RAI 256, Question 02.03.01-14 was being tracked as an open item.

In a March 3, 2011, response to RAI 256, Question 02.03.01-14, the applicant stated:

- The 27.2 °C (81 °F) zero percent exceedance non-coincident wet bulb air temperature will be deleted from FSAR Tier 2, Table 2.1-1 as a site parameter but will remain in FSAR Tier 2, Table 9.2.5-2, "Ultimate Heat Sink Design Parameters."

- FSAR Tier 2, Table 2.1-4 will be relocated to FSAR Tier 2, Section 9.2.5 as Table 9.2.5-4.

- A new COL Information Item, 9.2-7, will be added to FSAR Tier 2, Table 1.8-2 stating that a COL applicant referencing the U.S. EPR design certification will confirm that the site characteristic sum of zero percent exceedance maximum non-coincident wet bulb temperature and the site-specific wet bulb correction factor (which accounts for potential recirculation and interference effects of the cooling towers) does not exceed the 27.2 °C (81 °F) non-coincident zero percent exceedance design inlet wet bulb temperature value provided in FSAR Tier 2, Table 9.2.5-2. If the 27.2 °C (81 °F) value in FSAR Tier 2, Table 9.2.5-2 is exceeded, a COL applicant will need to complete an analysis that demonstrates that the maximum UHS cold-water return temperature of °C (95 °F) is not exceeded using the worst combination of site-specific wet bulb and dry bulb temperatures over a 24-hour period from a 30-year hourly regional climatological data set.

The staff reviewed the applicant's March 3, 2011, response to this portion of RAI 256, Question 02.03.01-14 and finds it acceptable. The applicant has agreed to delete the 27.2 °C (81 °F) zero percent exceedance non-coincident wet bulb air temperature from FSAR Tier 2, Table 2.1-1 as a site parameter. This will prevent COL applicants from identifying a departure if their site-specific zero percent exceedance non-coincident wet bulb air temperature exceeds 27.2 °C (81 °F). However, if their site-specific wet bulb

temperatures do exceed 27.2 °C (81 °F), COL Information Item 9.2-7 will require COL applicants to demonstrate that the maximum UHS cold-water return temperature of 35 °C (95°F) is not exceeded using the worst combination of historical meteorological conditions. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the response to this portion of RAI 256, Question 02.03.01-14. Accordingly, the staff considers the portion identified above of RAI 256, Question 02.03.01-14 resolved.

The staff notes that in Revision 4 of the FSAR, COL Information Item 9.2-7 as described above was altered and COL Information Item 9.2-11 was added, the combination of which still requires COL applicants to verify that site-specific data yield acceptable maximum UHS basin temperatures.

*One Percent Exceedance Temperatures*

To consider if the applicant's one percent seasonal exceedance ambient temperature site parameter values are representative of a reasonable number of potential COL sites, the staff once again used meteorological data from the ASHRAE Weather Data Viewer. For the purposes of this review, the staff assumed 0.4 percent annual exceedance values are similar to one percent seasonal exceedance maximum values. Therefore, the staff compared the ASHRAE 0.4 percent annual exceedance values with the U.S. EPR one percent seasonal exceedance maximum values. Similarly, the staff assumed 99.6 percent annual exceedance values are similar to one percent seasonal exceedance minimum values and compared the ASHRAE 99.6 percent annual exceedance values with the U.S. EPR one percent seasonal exceedance minimum values.

The staff noted that the one percent seasonal exceedance ambient air temperatures site parameter values proposed by the applicant bound a reasonable number of sites and, are therefore acceptable. The one percent exceedance, maximum dry bulb temperature of 37.8 °C (100 °F) was exceeded at nine percent of the weather stations throughout the contiguous U.S. and the one percent exceedance coincident, wet bulb temperature of 25 °C (77 °F) was exceeded at 12 percent of the weather stations throughout the contiguous U.S. A total of 21 percent of the weather stations exceeded the one percent exceedance, dry bulb temperature or the one percent exceedance, coincident, wet bulb temperature or both. The one percent exceedance, non coincident, maximum wet bulb temperature of 26.7 °C (80 °F) was exceeded at four percent of the weather stations throughout the contiguous U.S. Finally, the one percent exceedance, minimum dry bulb temperature of -23.3 °C (-10 °F) was exceeded at 16 percent of the weather stations throughout the contiguous U.S.

**Meteorological Data for Evaluating the UHS**

RG 1.27 states that the UHS should be capable of providing sufficient cooling for at least 30 days; that is, a 30-day cooling water supply should be available and the design-basis temperature of safety-related equipment should not be exceeded. Therefore, the meteorological conditions resulting in the maximum evaporative and drift loss of water from the UHS as well as the meteorological conditions resulting in minimum water cooling should be considered to ensure the UHS is available to perform its safety functions.

The applicant presented meteorological conditions resulting in the maximum evaporative and drift loss of water for the UHS over a 72-hour period in FSAR Tier 2, Revision 0, Table 2.1-3.

Water makeup to the UHS cooling tower basin beyond 72 hours is site-specific. A COL applicant referencing the U.S. EPR design certification will need to describe the means for providing UHS makeup water sufficient to meet the maximum evaporative and drift water loss after 72 hours through a 30-day period, as specified by RG 1.27. This was COL Information Item 2.3-10 in FSAR Tier 2, Revision 0, Table 1.8-2.

The applicant presented meteorological conditions resulting in minimum water cooling in FSAR Tier 2, Revision 0, Table 2.1-4. The UHS heat loads peak and decline within the first day; thus, only 1 day of the worst meteorological conditions resulting in minimum water cooling were presented by the applicant.

In RAI 37, Question 02.03.01-11, the staff requested that the applicant provide a technical basis for the site parameter values listed in FSAR Tier 2, Tables 2.1-3 and 2.1-4. The staff also requested that the applicant justify that these site parameter values are representative of a number of potential COL sites. In a November 17, 2008, response to RAI 37, Question 02.03.01-11, the applicant stated that the UHS cooling tower design was evaluated using site-specific meteorological data for four COL application sites referencing the U.S. EPR design and verified that the site-specific data yield acceptable maximum UHS basin temperatures and cooling tower basin capacity. Since the applicant provided a technical basis for the UHS site parameter values, the staff considered RAI 37, Question 02.03.01-11 closed.

In RAI 256, Question 02.03.01-14, the staff noted that several site design parameters listed in FSAR Tier 2, Table 2.1-1 can be deleted because (1) comparison with site characteristic values will not be meaningful or (2) there are (or can be) COL Information Items directed at more specific details intended to demonstrate that the design of the U.S EPR is acceptable at a proposed COL site. The staff requested in RAI 256, Question 02.03.01-14, that the applicant:

- Consider deleting the hourly wet bulb temperature and concurrent dry bulb temperature values presented in FSAR Tier 2, Table 2.1-3 (containing the design values for maximum evaporation and drift loss of water from the UHS) as site parameters. It is unclear to the staff how a COL applicant can demonstrate that the wet bulb temperature and concurrent dry bulb temperature characteristics for its site are bounded by the 72 sets of hourly wet bulb temperature and concurrent dry bulb temperature site parameter values presented in FSAR Tier 2, Table 2.1-3.

- Consider adding a COL information item to FSAR Tier 2, Table 1.8-2 stating that a COL applicant that references the U.S. EPR design certification will demonstrate that no makeup water to the UHS cooling tower basin is needed for 3 days following the initiation of a design basis accident under the worst case site-specific environmental conditions pursuant to RG 1.27.

- Consider deleting the potential for water freezing in the UHS water storage facility as a UHS meteorological condition site parameter. FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-8 already directs a COL applicant that references the U.S. EPR design certification to evaluate the potential for freezing temperatures that may affect the performance of the UHS makeup, including the potential for frazil and anchor ice, maximum ice thickness, and maximum cumulative degree-days below freezing.

RAI 256, Question 02.03.01-14 was being tracked as an open item.

In a March 3, 2011, response to RAI 256, Question 02.03.01-14, the applicant stated that:

- FSAR Tier 2, Table 2.1-3 will be relocated to FSAR Tier 2, Section 9.2.5 as FSAR Tier 2, Table 9.2.5-3.

- COL Information Item 9.2-6 will be added to FSAR Tier 2, Section 9.2.5.3 and FSAR Tier 2, Table 1.8-2 stating that a COL applicant that references the U.S. EPR design certification will confirm by analysis of the highest average site-specific wet bulb and dry bulb temperatures over a 72-hour period from a 30-year hourly regional climatological data set that the site-specific evaporative and drift losses for the UHS are bounded by the values presented in FSAR Tier 2, Table 9.2.5-3.

- The potential for water freezing in the UHS water storage facility as a UHS meteorological conditions site parameter was deleted from FSAR Tier 2, Revision 2, Table 2.1-1.

The staff reviewed the applicant's responses discussed above and finds them acceptable because the applicant agreed to make the changes to the FSAR as suggested by the staff. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the response to this portion of RAI 256, Question 02.03.01-14. Accordingly, the staff considers RAI 453, Question 02.03.01-14 resolved.

#### 2.3.1.4 *Conclusions*

The staff finds that the applicant selected the site parameters referenced above for plant design inputs (a subset of which is included as FSAR Tier 1 information) appropriately. The staff agrees that the selected site parameter values should be representative of a reasonable number of sites that have been or may be considered for a COL application. The regional climatology is site-specific and will be addressed by the COL applicant. This is FSAR Tier 2, Table 1.8-2, COL Information Item 2.3-2. This should include the provision of information sufficient to demonstrate that the actual site characteristics specified in a COL application fall within the values of the site parameters specified in the U.S. EPR FSAR.

### 2.3.2 Local Meteorology

#### 2.3.2.1 *Summary of Application*

In FSAR Tier 2, Section 2.3.2, the applicant specified that a COL applicant referencing the U.S. EPR design certification is expected to provide site-specific characteristics for local meteorology. This is listed as COL Information Item 2.3-3 in FSAR Tier 2, Table 1.8-2.

#### 2.3.2.2 *Regulatory Basis*

SRP Section 2.3.2 states that the review of local meteorology includes the following specific review areas:

1. Summaries of local meteorological data based on onsite measurements and NWS station summaries or other standard installation summaries from appropriate nearby locations.

2. 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 resulting from plant construction and operation.

3. A complete topographical description of the site and environs out to a distance of 80 km (50 mi) from the plant.

Design certification applications do not contain this type of information, because it is site-specific and will be addressed by a COL applicant referencing the U.S. EPR design certification.

#### 2.3.2.3 *Technical Evaluation*

There are no postulated site parameters for the U.S. EPR design related to local meteorology. A description of the anticipated local meteorological conditions and the impacts of a proposed plant and associated facilities on the local meteorological conditions (e.g., effects of plant structures, terrain modification, and heat and moisture sources due to plant operation) are site-specific and should be presented by a COL applicant referencing the U.S. EPR design certification. Thus, the staff finds the applicant's statements in FSAR Tier 2, Section 2.3.2 and FSAR Tier 2, Table 1.8-2, COL Information Item 2.3-3, that a COL applicant is to supply site-specific information regarding local meteorology are acceptable.

#### 2.3.2.4 *Conclusions*

There are no postulated site parameters for a design certification related to local meteorology. Local meteorological conditions are site-specific and will be addressed by a COL applicant referencing the U.S. EPR design certification. This should include the provision of information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. The staff finds this acceptable.

### 2.3.3 Onsite Meteorological Measurement Program

#### 2.3.3.1 *Summary of Application*

In FSAR Tier 2, Section 2.3.3, the applicant specified that a COL applicant referencing the U.S. EPR design certification is expected to provide the site-specific onsite meteorological measurements program. This is listed as COL Information Item 2.3-4 in FSAR Tier 2, Table 1.8-2.

#### 2.3.3.2 *Regulatory Basis*

SRP Section 2.3.3 states that review of the onsite meteorological measurements program includes the following specific review areas:

1. Meteorological instrumentation, including siting of sensors, sensor type and performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, data acquisition and reduction procedures, and special considerations for complex terrain sites.

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

Design certification applications do not contain this type of information because it is site-specific and will be addressed by a COL applicant referencing the U.S. EPR design certification.

### 2.3.3.3 *Technical Evaluation*

There are no postulated site parameters in the U.S. EPR design related to the onsite meteorological measurement program. A description of the onsite meteorological measurement program is site-specific and should be presented by a COL applicant referencing the U.S. EPR design certification. Thus, the staff finds the applicant's statements in FSAR Tier 2, Section 2.3.3 and FSAR Tier 2, Table 1.8-2, COL Information Item 2.3-4, that a COL applicant is to supply site-specific information regarding its onsite meteorological monitoring program are acceptable.

### 2.3.3.4 *Conclusions*

There are no postulated site parameters for a design certification related to the onsite meteorological monitoring program. The onsite meteorological monitoring program and the resulting data are site-specific and will be addressed by a COL applicant referencing the U.S. EPR design certification. This should include the provision of information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application. The staff finds this acceptable.

## 2.3.4 Short-Term Atmospheric Dispersion Estimates for Accident Releases

### 2.3.4.1 *Summary of Application*

**Site Parameters**

The list of U.S. EPR site parameters presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 includes accident (short-term) atmospheric dispersion factors $\chi$/Q values for the EAB and outer boundary of the LPZ. The EAB and LPZ $\chi$/Q site parameter values specified as FSAR Tier 1 are the same as those specified as FSAR Tier 2. The list of site parameters presented in FSAR Tier 2, Table 2.1-1 also includes accident main control room (MCR) and technical support center (TSC) $\chi$/Q values. Both the offsite (EAB and LPZ) and onsite (MCR and TSC) site parameter values were used for the applicant's design-basis accident radiological consequence analyses, which are presented in FSAR Tier 2, Section 15.0.3.

One set of EAB and LPZ $\chi$/Q values were used to model the offsite dose consequences for all the design-basis accidents, whereas several sets of MCR and TSC $\chi$/Q values representing different release pathways to the MCR/TSC intake and inleakage locations were used in estimating potential doses for the MCR and TSC. The assumed potential release pathways for modeling doses to the MCR and TSC are as follows:

- a vent stack
- four main steam relief silencers
- two safeguard building canopies
- an open equipment hatch

The assumed (modeled) release pathways for each design-basis accident are listed in Table 2.3.4-1 of this report.

**Table 2.3.4-1 U.S. EPR Design-Basis Accident Release Pathways**

| Design-Basis Accident | Assumed (Modeled) Release Pathways |
|---|---|
| Small Line Break Outside of the Reactor Building | Base of Main Stack |
| Steam Generator Tube Rupture (SGTR) | Closest Main Steam Relief Train Silencer<br>- bounds releases from the condenser evacuation system via the vent stack for the first 30 minutes while the plant is at full power |
| Main Steam Line Break (MSLB) Outside of the Reactor Building | Closest Main Steam Relief Train Silencer<br>- pathway for the unaffected steam generators<br>Closest Safeguard Building Canopy<br>- pathway for the steam generator with the broken main steam line |
| Reactor Coolant Pump (RCP) Locked Rotor | Closest Main Steam Relief Train Silencer |
| Rod Ejection | Closest Main Steam Relief Train Silencer<br>- primary containment leakage pathway during the 305-second annulus drawdown time, post purge isolation<br>- secondary-side leakage pathway throughout the duration of the accident<br>Base of Main Stack<br>- primary containment leakage pathway before purge isolation at 10 seconds and following the end of drawdown |
| Fuel Handling Accident | Base of Main Stack<br>- bounds releases from the reactor building with open containment via equipment hatch releases via material lock |
| Loss-of-Coolant Accident (LOCA) | Closest Main Steam Relief Train Silencer<br>- pathway during the 305-second annulus drawdown time<br>Base of Main Stack<br>- pathway following the end of drawdown |

Most of the information necessary to calculate MCR and TSC $\chi$/Q values for each release pathway and receptor combination is presented in FSAR Tier 2, Table 2.3-1, “ARCON96 Input Parameters for Control Room Air Intake $\chi$/Q values,” and Table 2.3-2, “ARCON96 Input Parameters for Unfiltered Inleakage Control Room $\chi$/Q values.” FSAR Tier 2, Figure 2.3-1 shows the relative locations of the release points and receptors.

The MCR habitability systems are described in FSAR Tier 2, Sections 6.4 and 9.4 and the analytical assumptions used to develop the atmospheric dispersion factors used in the radiological consequence analysis for design-basis accidents are presented in FSAR Tier 2, Section 15.0.3.3.3. The MCR habitability systems protect both the plant operators in the MCR and TSC personnel from the effects of accidental releases of radioactive material and smoke. The TSC is contained within the control room envelope (CRE).

The control room air conditioning system (CRACS) has two identical fresh air intake trains that are physically separated. Each train has its own air intake; the two air intakes are physically separated and located on the roof of Safeguard Buildings 2 and 3. FSAR Tier 2, Figure 2.3-1 provides the relative locations of potential radiological release points and the CRACS air intakes.

During normal operation, the air conditioning system for the CRE area operates in the recirculation mode with fresh air makeup. The CRACS maintains a positive pressure within the CRE areas (which include the MCR and TSC) with respect to the surrounding area to prevent uncontrolled incoming leakage.

Upon receipt of a containment isolation signal or high radiation alarm signal in the air intake ducts, the iodine filtration train starts automatically and the outside air (along with the CRE recirculation air) are automatically diverted through the iodine filtration train. The outside makeup air, along with the CRE recirculation air, continues to maintain a positive pressure in the CRE area relative to the adjacent areas.

Upon actuation of the smoke alarm signal, the outside dampers at the location of the alarm are closed.

The applicant's MCR/TSC analytical model for the radiological habitability evaluations included an intake flow from one of the two CRACS air intakes and an unfiltered inleakage flow from one of the two Safeguard Building heating, ventilation, and air conditioning (HVAC) system air intakes. The two Safeguard Building HVAC system air intakes are physically separated and also located on the roof of Safeguard Buildings 2 and 3. The Safeguard Building 3 outside air intakes were chosen as the basis for calculating atmospheric dispersion factors because they were the closest intakes to the bounding atmospheric release points.

The applicant assumed both CRACS air intakes bring unfiltered air into the CRE during the first minute of each design-basis accident. After the first minute, the filtration system is assumed to realign and bring filtered air into the CRE through the Safeguard Building 3 CRACS air intake. The other filtration system associated with the Safeguard Building 2 intake train is assumed to fail and automatically isolates during the remaining duration of the event.

The applicant combined the $\chi/Q$ values associated with the CRACS air intake and the Safeguard Building HVAC system air intake into one effective $\chi/Q$ value. The MCR/TSC effective $\chi/Q$ value was determined by weighting the flow rate through each air intake as suggested in RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," Subsection C.3.3.2.1.

FSAR Tier 2, Section 2.3.4 states the EAB and LPZ $\chi/Q$ values were either extracted from the EPRI ALWR URD or calculated following the methodology in RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants."

**COL Information Items**

The following COL information items presented in FSAR Tier 2, Table 1.8-2 are related to this section:

- COL Information Item 2.0-1: A COL applicant that references the U.S. EPR design certification will compare the characteristics of its proposed site to the site parameters in FSAR Tier 2, Table 2.1-1. If the characteristics of the site fall within the assumed site parameters in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific characteristics that are outside the bounds of the assumptions presented in FSAR Tier 2, Table 2.1-1, the COL applicant will demonstrate that the U.S. EPR design acceptably meets the regulatory requirements, given the more limiting site-specific characteristic. In such an instance, the COL applicant will also demonstrate that the design commitments and acceptance criteria described in the FSAR do not need to be changed, or will propose new design commitments or acceptance criteria, or both.

- COL Information Item 2.3-1: If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the site parameters in FSAR Tier 2, Table 2.1-1, the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the COL application.

- COL Information Item 2.3-5: A COL applicant that references the U.S. EPR design certification will provide a description of the atmospheric dispersion modeling used in evaluating potential design basis events to calculate concentrations of hazardous materials (e.g., flammable or toxic clouds) outside building structures resulting from the onsite or offsite airborne releases of such materials.

- COL Information Item 2.3-6: A COL applicant that references the U.S. EPR design certification will confirm that the site-specific $\chi$/Q values, based on site-specific meteorological data, are bounded by those specified in FSAR Tier 2, Table 2.1-1 at the EAB, LPZ, and control room. For site-specific $\chi$/Q values that exceed the bounding $\chi$/Q values, a COL applicant that references the U.S. EPR design certification will demonstrate that the radiological consequences associated with the controlling design-basis accident continue to meet the dose reference values given in 10 CFR 50.34, "Contents of Applications; Technical Information," (10 CFR 52.47(a)(2)(iv) and the control room operator dose limits given in GDC 19, "Control Room," using site-specific $\chi$/Q values.

### 2.3.4.2 *Regulatory Basis*

The acceptance criteria for estimating short-term dispersion of accidental releases are based on meeting the relevant requirements of the following NRC regulations:

1. GDC 19, as it relates to the meteorological considerations used to evaluate the personnel exposures inside the control room during radiological and airborne hazardous material accident conditions

2. 10 CFR 52.47(a)(1), as it relates to the postulated site parameters that a design certification applicant shall provide for the design

3. 10 CFR 52.47(a)(2)(iv), as it relates 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 LPZ

SRP Section 2.3.4 states that a design certification applicant should provide EAB, LPZ, and control room $\chi$/Q values for the appropriate time periods as site parameters. These site parameters should be representative of a reasonable number of sites that may be considered for a COL application, and a basis should be provided for each of the site parameters. Tables and figures should be included showing the design features that would be used by a COL applicant referencing the U.S. EPR design certification to generate control room $\chi$/Q values (e.g., intake heights, release heights, building cross-sectional areas, and distance to receptors).

The EAB and LPZ $\chi$/Q values are used to help demonstrate that the offsite radiological consequences of accidents meet the specified radiation dose guidelines for the EAB and LPZ as specified in 10 CFR 52.47(a)(2)(iv). RG 1.145 presents guidance for characterizing atmospheric dispersion conditions for evaluating the consequences of radiological releases to the EAB and LPZ.

The control room $\chi$/Q values are used to help demonstrate that the control room radiological consequences of accidents meet specified radiation dose limits in GDC 19. RG 1.194 presents guidance for characterizing atmospheric dispersion conditions for evaluating the consequences of radiological releases to the control room. RG 1.194 states that the ARCON96, "Code System to Calculate Atmospheric Relative Concentrations in Building Wakes" atmospheric dispersion model (NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes," Revision 1) is an acceptable methodology for assessing control room $\chi$/Q values for use in MCR design-basis accident radiological analyses, subject to the provisions in RG 1.194.

### 2.3.4.3 *Technical Evaluation*

**Site Parameters**

The staff reviewed the FSAR in accordance with the guidance provided in SRP Section 2.3.4 by ensuring that: (1) The FSAR included EAB, LPZ , and MCR $\chi$/Q values in the list of site parameters; (2) the FSAR contained figures and tables describing the design features that would be used by the COL applicant to generate MCR $\chi$/Q values; (3) a basis has been provided for each of the EAB, LPZ, and MCR site parameter $\chi$/Q values; and (4) the EAB, LPZ, and MCR site parameter $\chi$/Q values are representative of a reasonable number of sites that may be considered within a COL application. The staff also reviewed the radiological consequence analyses presented in FSAR Tier 2, Section 15.0.3 and the MCR habitability systems description presented in FSAR Tier 2, Section 6.4 to determine if the assumed fission product transport to the environment for each design-basis accident was compatible with the $\chi$/Q values used to model the release pathway.

1. Offsite $\chi$/Q Values

   SRP Section 2.3.4 states that the design certification applicant should include EAB and LPZ boundary $\chi$/Q values for the appropriate time periods in the list of site parameters. The staff noted that the applicant included the EAB and LPZ $\chi$/Q values as site parameters listed FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1. The staff determined that the titles of the accident atmospheric dispersion factor ($\chi$/Q) site

parameters presented in FSAR Tier 1, Revision 0, Table 5.0-1 and FSAR Tier 2, Revision 0, Table 2.1-1 should not specify EAB and LPZ distances. The distances at which $\chi$/Q values are to be determined by the COL applicants are a function of each COL applicant's EAB and LPZ configuration. Therefore, in RAI 288, Question 02.03.04-9, the staff requested that the applicant revise the FSAR accordingly. RAI 288, Question 02.03.04-9 was being tracked as an open item.

In a February 26, 2010, response to the open item in RAI 288, Question 02.03.04-9, the applicant stated that it agrees that the title of the $\chi$/Q site parameters presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 should not specify the distances for the EAB and LPZ because these distances are site-specific. The applicant agreed to revise the titles of the $\chi$/Q site parameters presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 to remove the distances for the EAB and LPZ. The staff confirmed that FSAR Revision 2 dated August 31, 2010, was revised as committed in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 288, Question 02.03.04-9, resolved.

FSAR Tier 2, Section 2.3.4 states that the accident $\chi$/Q values were either extracted from the EPRI ALWR URD or were calculated following the methodology in RG 1.145. In RAI 10, Question 02.03.04-1, the staff requested that the applicant provide further discussion regarding the $\chi$/Q values based on RG 1.145, such as the meteorological data used, release characteristics, and locations considered. The staff also requested that the applicant explain how the proposed accident $\chi$/Q values could be considered representative of a reasonable number of potential COL sites.

In a July 2, 2008, response to RAI 10, Question 02.03.04-1, the applicant stated that the EAB and LPZ $\chi$/Q values were calculated using meteorological data from the Calvert Cliffs Nuclear Power Plant (CCNPP) and Nine Mile Point (NMP) sites assuming a ground level release with no credit for increased atmospheric dispersion caused by building wake effects. The resulting CCNPP and NMP $\chi$/Q values were then compared to the EPRI ALWR URD $\chi$/Q values and the bounding (maximum) of these values were selected as site parameters for the FSAR. The applicant concluded that the EPRI ALWR URD $\chi$/Q values were bounding. However, because the EPRI ALWR URD does not present a 0-2 hr LPZ $\chi$/Q value, the applicant also chose the CCNPP 0-2 hr LPZ $\chi$/Q value as a site parameter value.

The staff reviewed the July 2, 2008, response to RAI 10, Question 02.03.04-1 and determined that the question was closed because the applicant provided additional information on the proposed accident $\chi$/Q values discussed above.

The staff noticed that Revision 6 of CCNPP Unit 3 COL requires a departure from the U.S. EPR 0-2 hour LPZ $\chi$/Q site parameter value because the U.S. EPR 0-2 hour LPZ $\chi$/Q site parameter value is exceeded by the corresponding CCNPP Unit 3 COL 0-2 hour LPZ $\chi$/Q site characteristic value. Therefore, in RAI 453, Question 02.03.04-10, the staff requested that the applicant justify why the U.S. EPR 0-2 hour LPZ $\chi$/Q site parameter value should not be revised to ensure that a departure will not be required for the CCNPP Unit 3 COL application, especially since, according to the applicant's July 2, 2008, response to RAI 10, Question 02.03.04-1, the U.S. EPR 0-2 hour LPZ $\chi$/Q site parameter value is based on data from the CCNPP site.

In a February 23, 2011, response to RAI 453, Question 02.03.04-10, the applicant stated the U.S. EPR 0-2 hour LPZ $\chi$/Q site parameter value was derived using 5 years of meteorological data (2000-2004) from the CCNPP site as reported in CCNPP Unit 3 COL application, Revision 0. CCNPP Unit 3 COL application, Revision 6 used 2 years of more recent meteorological data (2005 and 2006) in addition to the data from 2000-2004 to update the LPZ dispersion analysis. As a result of the inclusion of the 2005 and 2006 meteorological data, the CCNPP Unit 3 COL 0-2 hour LPZ $\chi$/Q site characteristic value became larger than the corresponding U.S. EPR 0-2 hour LPZ $\chi$/Q site parameter value.

The staff reviewed the applicant's February 23, 2011, response to RAI 453, Question 02.03.04-10 and finds it acceptable. The radiological dose results using the larger CCNPP Unit 3 COL 0-2 hour LPZ $\chi$/Q value are well within regulatory limits and potential departures in future COL applications with site-specific 0-2 hour LPZ $\chi$/Q values exceeding the corresponding U.S. EPR 0-2 hour $\chi$/Q site parameter value are not expected to result in design changes to the plant. Accordingly, the staff considers RAI 453, Question 02.03.04-10 resolved.

To determine whether the U.S. EPR EAB and LPZ site parameter $\chi$/Q values bound a reasonable number of sites that may be considered within a COL application, the staff compared the U.S. EPR EAB and LPZ $\chi$/Q site parameters to the EAB and LPZ $\chi$/Q site characteristics identified in the first four docketed ESP applications (i.e., North Anna, Grand Gulf, Clinton, and Vogtle). The EAB and LPZ $\chi$/Q values presented in these ESP applications were developed in accordance with current regulatory guidance and have been reviewed and approved by the staff. The U.S. EPR site parameter $\chi$/Q values bound the ESP site characteristic $\chi$/Q values if the U.S. EPR $\chi$/Q values are higher than the ESP $\chi$/Q values. Smaller $\chi$/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing the U.S. EPR site parameter $\chi$/Q values with the ESP site characteristic $\chi$/Q values, the ESP sites are acceptable for the U.S. EPR design if the ESP $\chi$/Q values are smaller than the U.S. EPR $\chi$/Q values. Such a comparison shows that the ESP sites have better dispersion characteristics than those specified in the U.S. EPR postulated site parameters. Accordingly, the staff finds that the U.S. EPR EAB and LPZ $\chi$/Q values bound all four ESP sites.

Consequently, the staff finds that the applicant has provided EAB and LPZ site parameter $\chi$/Q values that should bound a reasonable number of sites that may be considered within a COL application, and are therefore acceptable.

2. Onsite $\chi$/Q Values

Revision 0 to the FSAR listed the MCR and TSC $\chi$/Q values in FSAR Tier 2, Table 2.3-1 (main air supply) and Table 2.3-2 (unfiltered inleakage). In RAI 10, Question 02.03.04-3, the staff requested that the applicant consider including the MCR and TSC $\chi$/Q values as site parameters in either FSAR Tier 1, Table 5.0-1 or FSAR Tier 2, Table 2.1-1. In a July 2, 2008, response to RAI 10, Question 02.03.04-3, the applicant stated that because SRP Section 2.0, Appendix A, Table 1 did not list MCR and TSC $\chi$/Q values as examples of site parameters, the applicant declined to change the FSAR. The staff reviewed the July 2, 2008, response to RAI 10, Question 02.03.04-3 and issued follow-up RAI 37, Question 02.03.04-5. In RAI 37, Question 02.03.04-5, the staff stated that SRP Section 2.3.4 specifically states that a

design certification applicant should include EAB, LPZ, and control room atmospheric dispersion factors for the appropriate time periods in the list of site parameters. In a September 8, 2008, response to RAI 37, Question 02.03.04-5, the applicant agreed to relocate the MCR and TSC $\chi$/Q values from FSAR Tier 2, Tables 2.3-1 and 2.3-2 to FSAR Tier 2, Table 2.1-1. RAI 37, Question 02.03.04-5 was being tracked as a confirmatory item.

The staff confirmed that FSAR Tier 2, Revision 1, dated May 29, 2009, was revised as committed in the RAI response. Accordingly, the staff considers RAI 10, Question 02.03.04-3 and RAI 37, Question 02.03.04-5, closed.

In RAI 453, Question 02.03.04-12, the staff requested that the applicant address the following:

- Justify why the $\chi$/Q site parameter values listed in FSAR Tier 2, Table 2.1-1 for the main steam train silencers #1, #2, and #4 should not be the same as the $\chi$/Q site parameter values listed for main steam train silencer #3. Only the $\chi$/Q values for the main steam train silencer #3 are used for the design-basis accident analyses presumably because the $\chi$/Q values for the main steam train silencer #3 bound the $\chi$/Q values for the main steam train silencers #1, #2, and #4.

- Justify why the $\chi$/Q site parameter values listed in FSAR Tier 2, Table 2.1-1 for the safeguard building canopy point #2 should not be the same as the $\chi$/Q site parameter values listed for safeguard building canopy point #1. Only the $\chi$/Q values for the safeguard building canopy point #1 are used for the design-basis accident analyses presumably because the $\chi$/Q values for the safeguard building canopy point #1 bound the $\chi$/Q values for the safeguard building canopy point #2.

- Justify why the $\chi$/Q values for the material lock (open equipment hatch) and depressurization shaft release pathways are included as site parameters in FSAR Tier 2, Table 2.1-1 if these values are not used in any of the design-basis accident radiological consequence analyses.

In a January 28, 2011, response to RAI 453, Question 02.03.04-12, the applicant committed to modifying FSAR Tier 2, Table 2.1-1 to provide (1) only the main steam train silencer #3 set of $\chi$/Q values (which is the highest set of the four sets of silencer $\chi$/Q values) as the set of $\chi$/Q site parameter values for all four steam train silencers and (2) only canopy point #1 set of $\chi$/Q values (which is the higher set of the two sets of canopy values) as the set of $\chi$/Q site parameter values for both safeguard building canopy points. The applicant also stated that although the material lock (open equipment hatch) and depressurization shaft $\chi$/Q values are not required for design basis accident analyses, the material lock (open equipment hatch) and depressurization shaft are potential release points. For this reason, the applicant determined $\chi$/Q values for these release points and included them as site parameters. Nonetheless, the applicant committed to revising FSAR Tier 2, Table 2.1-1 to remove the $\chi$/Q values for these two releases points as site parameters and add a footnote that the material lock (open equipment hatch) and depressurization shaft $\chi$/Q values are bounded by the canopy point $\chi$/Q values.

In FSAR Revision 6, the applicant changed the U.S. EPR design by eliminating the safeguard building depressurization shaft as a release pathway. Therefore, this report describes only the most recent version of the U.S. EPR FSAR and the staff's technical evaluation of that version.

The staff reviewed the applicant's January 28, 2011, response to RAI 453, Question 02.03.04-12 and finds it acceptable because the applicant has agreed to remove $\chi$/Q values from FSAR Tier 2, Table 2.1-1 as site parameter values if the $\chi$/Q values are bounded by other values presented in the table and are not used in any of the design-basis accident radiological consequence analyses. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the response to RAI 453, Question 02.03.01-12. Accordingly, the staff considers RAI 453, Question 02.03.01-12 resolved.

In RAI 10, Question 02.03.04-4, the staff indicated that SRP Section 2.3.4 states that the FSAR should contain figures and tables showing the design features that would be used by COL applicants to generate control room $\chi$/Q values (e.g., intake heights, release heights, building cross-sectional areas, and distances to receptors). The staff requested that the applicant include the necessary input assumptions for the ARCON96 atmospheric dispersion model in FSAR Tier 2, Section 2.3.4.

In a July 2, 2008, response to RAI 10, Question 02.03.04-4, the applicant provided a table containing input parameters for generating control room $\chi$/Q values that was incorporated into FSAR Tier 2, Table 2.3-1 in FSAR Revision 1, dated May 29, 2009. The staff reviewed the July 2, 2008, response to RAI 10, Question 02.03.04-4 and determined that the question is closed.

In RAI 256, Question 02.03.04-7 the staff requested that the applicant consider deleting parameters that are not inputs to ARCON96 and adding parameters that are inputs to ARCON96. The staff also noted that staff guidance on the input values for each of the ARCON96 input parameters is provided in RG 1.194, Appendix A and requested that the applicant identify and justify any deviations from the guidance provided in RG 1.194. RAI 256, Question 02.03.04-7 was being tracked as an open item.

In a February 26, 2010, response to the open item in RAI 256, Question 02.03.04-7, the applicant proposed a revision to FSAR Tier 2, Table 2.3-1 that contains a revised set of input parameters for generating control room $\chi$/Q values that addressed the staff's concerns. The staff reviewed the applicant's response to this open item and finds it acceptable because the applicant deleted parameters that were not inputs to ARCON96 and added parameters that are inputs to ARCON96. The staff confirmed that Revision 2, dated August 31, 2010, to FSAR Tier 2, Table 2.3-1 contains the revised set of input parameters. Accordingly, the staff considers RAI 256, Question 02.03.04-7 resolved.

In RAI 256, Question 02.03.04-8, the staff requested that the applicant also provide a table similar to FSAR Tier 2, Table 2.3-1 listing ARCON96 input values for generating MCR/TSC unfiltered inleakage $\chi$/Q values. RAI 256, Question 02.03.04-8, was being tracked as an open item.

In a February 26, 2010, response to the open item in RAI 256, Question 02.03.04-8, the applicant proposed a new table, FSAR Tier 2, Table 2.3-2, which contained input

parameters for generating MCR/TSC unfiltered inleakage $\chi$/Q values that addressed the staff's concerns. The staff reviewed the applicant's response to this open item and finds it acceptable because the applicant provided the appropriate input parameters for generating MCR/TSC unfiltered inleakage $\chi$/Q values. The staff confirmed that FSAR Revision 2, dated August 31, 2010, contains this table. Accordingly, the staff considers RAI 256, Question 02.03.04-8 closed.

In RAI 453, Question 02.03.04-11, the staff requested that the applicant justify not providing direction-to-source information in terms of degrees from plant north for each modeled source-receptor combination in FSAR Tier 2, Tables 2.3-1 and 2.3-2. The staff also requested that the applicant explain the apparent discrepancy in the stack release height between FSAR Tier 2, Table 2.3-1, "ARCON96 Input Parameters for Control Room $\chi$/Q values," and FSAR Tier 2, Table 2.3-2, "ARCON96 Input Parameters for Unfiltered Inleakage Control Room $\chi$/Q values," (i.e., 32.1 m (105 ft)) versus 33.9 m (111 ft)).

In a January 28, 2011, response to RAI 453, Question 02.03.04-11, the applicant stated that it saw no value added for the COL applicant by including direction information in the FSAR. The staff disagrees with this assertion because each COL applicant will now need to determine the direction-to-source information for each source-receptor combination. However, since this is a feasible task for each COL applicant, the staff finds the applicant's response acceptable.

In the January 28, 2011, response to RAI 453, Question 02.03.04-11, the applicant also stated that conservative values were chosen in specifying the stack heights in FSAR Tier 2, Tables 2.3-1 and 2.3-2; the stack height input of 32.1 m (105 ft) for the control room $\chi$/Q values (FSAR Tier 2, Table 2.3-1) is based on the assumption that the stack release height is the same as the mid-point of the control room air intake, whereas the stack height input of 33.9 m (111 ft) for the unfiltered inleakage (FSAR Tier 2, Table 2.3-2) is based on the slant distance from the main steam train silencer #3 to the control room air intake, which is approximately the same as the slant distance from the stack to the ingress point. Although the applicant's explanation for selecting the stack height input value of 33.9 m (111 ft) for the unfiltered inleakage is unclear to the staff, this stack height value is similar to the unfiltered inleakage air intake elevation of 32.1 m (105 ft) and, for this reason, is acceptable to the staff. The applicant committed to adding footnotes to FSAR Tier 2, Tables 2.3-1 and 2.3-2 to clarify the basis for the different release heights used for the stack.

The staff finds the applicant's response to RAI 453, Question 02.03.04-11 acceptable for the reasons described above. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the response to RAI 453, Question 02.03.01-11. Accordingly, the staff considers RAI 453, Question 02.03.01-11 resolved.

In RAI 10, Question 02.03.04-2, the staff requested that the applicant provide the technical basis for the MCR/TSC $\chi$/Q values to be presented as site parameters in FSAR Tier 2, Table 2.1-1. In a July 2, 2008, response to RAI 10, Question 02.03.04-2, the applicant stated that the site parameter $\chi$/Q values were determined by executing the ARCON96 atmospheric dispersion model for the NMP and CCNPP COL sites by aligning the release-to-intake direction with each of the 16 cardinal compass directions to determine the bounding direction for the vent stack release. The bounding wind

direction was then used for the other post-accident release points. Since the staff did not have access to the ARCON96 model inputs requested by RAI 256, Questions 02.03.04-7 and 02.03.04-8 when the safety evaluation with open items was written, the staff could not verify that the MCR/TSC site parameter $\chi$/Q values are representative of a reasonable number of sites that may be considered within a COL application. Therefore, RAI 10, Question 02.03.04-2 was being tracked as a confirmatory item.

To confirm that the U.S. EPR MCR/TSC $\chi$/Q values listed as site parameters are representative of a reasonable number of sites that have been or may be considered for a COL application, the staff generated a set of site-specific MCR/TSC $\chi$/Q values using hourly onsite meteorological data provided in support of the four ESP applications (North Anna, Clinton, Grand Gulf, and Vogtle). The onsite data provided in support of these ESP applications were reviewed and approved by the staff and determined to be representative of site conditions. The staff executed the ARCON96 computer code with a subset of the source/receptor information presented in FSAR Tier 2, Tables 2.3-1 and 2.3-2 assuming the U.S. EPR was aligned to true north at each ESP site. The staff noted that the U.S. EPR MCR/TSC $\chi$/Q site parameter values bounded the corresponding ESP site characteristic values for three of the four ESP sites. Consequently, the staff finds that the applicant has provided MCR/TSC $\chi$/Q site parameter values that should bound a reasonable number of sites that may be considered within a COL application and are, therefore, acceptable. Accordingly, the staff considers RAI 10, Question 02.03.04-2 resolved.

**COL Information Items**

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in FSAR Tier 2, Table 1.8-2.

FSAR Tier 2, Revision 0, Table 1.8-2 contained COL Information Item 2.3-7, which stated that a COL applicant that references the U.S. EPR design will provide $\chi$/Q values for each cumulative frequency distribution which exceeds the median value (50 percent of the time) as part of the assessment of the postulated impact of an accident on the environment. The staff concluded that COL Information Item 2.3-7, in FSAR Tier 2, Table 1.8-2, is not needed either in the design certification or the COL FSAR and, therefore, is not an appropriate COL information item. The 50-percentile $\chi$/Q values should be presented in a COL applicant's Environmental Report instead of the FSAR. Therefore, in RAI 453, Question 02.03.04-13, the staff requested that the applicant justify including COL Information Item 2.3-7 in FSAR Tier 2, Table 1.8-2.

In a December 16, 2010, response to RAI 453, Question 02.03.04-13, the applicant committed to deleting COL Information Item 2.3-7 from FSAR Tier 2, Table 1.8-2, and FSAR Tier 2, Section 2.3.4. The staff reviewed the applicant's response to RAI 453, Question 02.03.04-13 and finds it acceptable. The staff confirmed that FSAR Tier 2, Revision 3, dated August 10, 2011, was revised as committed in the response to RAI 453, Question 02.03.04-13. Accordingly, the staff considers RAI 453, Question 02.03.04-13 resolved.

### 2.3.4.4 *Conclusions*

The staff concludes that the applicant selected the short term (post-accident) site parameters referenced above for plant design inputs (a subset of which is included as FSAR Tier 1 information) appropriately, and the staff agrees that these site parameter values should be

representative of a reasonable number of sites that have been or may be considered for a COL application. The short-term atmospheric dispersion characteristics for accidental release are site-specific and will be addressed by the COL applicant. This should include the provision of information sufficient to demonstrate that the actual site characteristics fall within the values of the site parameters specified in the U.S. EPR FSAR. The staff finds this acceptable.

## 2.3.5 Long-Term Dispersion Estimates for Routine Releases

### 2.3.5.1 *Summary of Application*

**Site Parameters**

The list of U.S. EPR site parameters presented in FSAR Tier 2, Table 2.1-1 includes an atmospheric dispersion factor ($\chi$/Q value) of 4.973E-06 seconds per meter cubed ($s/m^3$) and an atmospheric deposition factor (D/Q) value of 5.0E-8 per meter squared ($m^2$). These are maximum annual average (long-term) site parameter values for the limiting sector. The applicant used these site parameter values to calculate: (1) Annual average site boundary airborne concentrations to demonstrate compliance with 10 CFR Part 20, "Standards for Protection Against Radiation," Subpart D, "Radiation Dose Limits for Individual Members of the Public"; and (2) doses to the maximally exposed individual (MEI) from routine airborne releases to demonstrate compliance with 10 CFR Part 50, 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." FSAR Tier 2, Section 11.3.3, "Radioactive Effluent Releases," describes these calculations.

The U.S. EPR gaseous waste processing system collects radioactive waste gases from the various systems in which they are generated, processes these waste gases, provides sufficient holdup time for radioactive decay to reduce the activity present, and controls the subsequent release of the process waste gases to the atmosphere in compliance with regulatory limits. The gaseous waste processing system is described in FSAR Tier 2, Section 11.3.

FSAR Tier 2, Section 11.3.3.3 states that gaseous effluents originating from the U.S. EPR gaseous waste processing system are released at the top of the vent stack at an elevation of 64.6 m (212 ft) above grade and approximately 30.5 m (100 ft) above the top of the adjacent Fuel Building roof and 2.1 m (7 ft) above the top of the Reactor Building. The FSAR further states the inner diameter of the vent stack at the point of release is 3.81 m (12.5 ft) and the combined flows of all the ventilation exhaust systems from the plant stack during normal operations results in an effluent exit velocity of approximately 10.1 meters per second (1,988 feet per minute). These data are input to the dispersion modeling performed by COL applicants to determine site-specific long-term dispersion estimates.

**COL Information Items**

The following COL information items presented in FSAR Tier 2, Table 1.8-2 are related to this section:

- COL Information Item 2.0-1: A COL applicant that references the U.S. EPR design certification will compare the characteristics of its proposed site to the site parameters in FSAR Tier 2, Table 2.1-1. If the characteristics of the site fall within the assumed site parameters in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific characteristics that are outside the bounds of the

assumptions presented in FSAR Tier 2, Table 2.1-1, the COL applicant will demonstrate that the U.S. EPR design acceptably meets the regulatory requirements, given the more limiting site-specific characteristic. In such an instance, the COL applicant will also demonstrate that the design commitments and acceptance criteria described in the FSAR do not need to be changed, or will propose new design commitments or acceptance criteria, or both.

- COL Information Item 2.3-1: If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the site parameters in FSAR Tier 2, Table 2.1-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the COL application.

- COL Information Item 2.3-8: A COL applicant that references the U.S. EPR design certification will provide the site-specific, long-term diffusion estimates for routine releases. In developing this information, the COL applicant should consider the guidance provided in RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants"; RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I"; RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors"; and RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors."

- COL Information Item 2.3-9: A COL applicant that references the U.S EPR design certification will also provide estimates of annual average atmospheric dispersion ($\chi$/Q values) and deposition (D/Q values) for 16 radial sectors to a distance of 80 km (50 mi) from the plant as part of its environmental assessment.

Similar to COL Information Item 2.3-8 in FSAR Tier 2, Table 1.8-2, FSAR Tier 2, Section 2.3.5 states that a COL applicant that references the U.S. EPR design certification will provide the site-specific, long-term diffusion estimates for routine releases and in developing this information, the COL applicant should consider the guidance provided in RG 1.23, RG 1.109, RG 1.111, and RG 1.112. FSAR Tier 2, Section 2.3.5 goes beyond COL Information Item 2.3-8 by stating that if a reactor site has an annual average $\chi$/Q value that exceeds the reference value, then a site-specific evaluation will be performed. The issue of site-specific evaluations is addressed by COL Information Item 11.3-3 in FSAR Tier 2, Table 1.8-2.

### 2.3.5.2 *Regulatory Basis*

The acceptance criteria for estimating long-term dispersion of routine releases are based on meeting the relevant requirements of the following NRC regulations:

1. 10 CFR Part 20, Subpart D, as it relates to the postulated atmospheric dispersion site parameters used in demonstrating compliance with dose limits for individual members of the public.

2. 10 CFR 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents—Nuclear Power Reactors," and 10 CFR Part 50, Appendix I, Sections II.B, II.C and II.D, as they relate to the postulated atmospheric dispersion site parameters used in determining that 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 as low as is reasonably achievable.

SRP Section 2.0, Appendix A states that the design certification applicant should include the maximum long-term (routine release or annual average) site boundary atmospheric dispersion factors ($\chi$/Q values) and deposition factors (D/Q values) in the list of site parameters. SRP Section 2.3.5 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 annual average atmospheric dispersion and deposition factors are used in the calculation of offsite concentrations and dose consequences of postulated routine airborne radioactive releases to demonstrate compliance with 10 CFR Part 20, Subpart D and 10 CFR Part 50, Appendix I. RG 1.111 presents criteria for characterizing atmospheric dispersion and deposition conditions for evaluating the consequences of routine releases.

### 2.3.5.3 *Technical Evaluation*

**Site Parameters**

The staff reviewed the FSAR in accordance with the guidance provided in SRP Section 2.3.5 to ensure: (1) The FSAR included the maximum annual average site boundary $\chi$/Q and D/Q values in the list of site parameters; (2) a basis has been provided for the annual average site parameter $\chi$/Q and D/Q values; and (3) the annual average site parameter $\chi$/Q and D/Q values are representative of a reasonable number of sites that may be considered within a COL application.

FSAR Tier 2, Table 2.1-1 lists a maximum annual average atmospheric dispersion factor ($\chi$/Q) value of 4.973E-06 s/m$^3$ as a site parameter. This $\chi$/Q value (rounded to a value of 5.0E-06 s/m$^3$) is also listed in FSAR Tier 2, Table 11.3-4 as an input parameter for the GASPAR II computer code for use in calculating annual offsite doses to the MEI from gaseous releases. An annual average ground deposition (D/Q) value of 5.0E-08 m$^{-2}$ is also listed in FSAR Tier 2, Table 11.3-4 as an input to the GASPAR II computer code. In RAI 10, Question 02.03.05-4, the staff requested that the applicant also include the annual average ground deposition value of 5.0E-08 m$^{-2}$ as a site parameter in FSAR Tier 2, Table 2.1-1.

In a July 2, 2008, response to RAI 10, Question 02.03.05-4, the applicant stated that the parameter “annual average ground deposition factor” is not identified as one of the parameters to be included in FSAR Tier 2, Table 2.1-1 per SRP Section 2.0. The staff reviewed the response to RAI 10, Question 02.03.05-4 and determined that the question was closed.

SRP Section 2.0, Appendix A, Table 1 lists routine release D/Q values at the site boundary as an example of a site parameter that should be listed in a design certification. In RAI 256, Question 02.03.05-6, the staff requested that the applicant reconsider listing the annual average ground deposition value of 5.0E-08 m$^{-2}$ as a site parameter. RAI 256, Question 02.03.05-6 was being tracked as an open item.

In an April 20, 2010, response to the open item in RAI 256, Question 02.03.05-6, the applicant agreed to revise FSAR Tier 2, Table 2.1-1 to include the annual average ground deposition (D/Q) value of 5.0E-08 m$^{-2}$ as a site parameter. The staff confirmed that FSAR Tier 2, Revision 2, dated August 31, 2010, was revised as committed in the RAI response.

Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 256, Question 02.03.05-6 resolved.

The title of the maximum annual average $\chi$/Q site parameter presented in FSAR, Tier 2, Revision 0, Table 2.1-1, specified a distance of 0.8 km (0.5 mi). The staff determined that the title of the maximum annual average $\chi$/Q site parameter presented in FSAR Tier 2, Table 2.1-1 should not specify a distance. The distances at which $\chi$/Q values are to be determined by the COL applicants are a function of each COL applicant's site configuration. Therefore, in RAI 288, Question 02.03.05-8, the staff requested that the applicant revise the FSAR accordingly. RAI 288, Question 02.03.05-8, was being tracked as an open item.

In a February 26, 2010, response to the open item in RAI 288, Question 02.03.05-8, the applicant agreed that the title of the maximum annual average $\chi$/Q site parameter presented in FSAR Tier 2, Table 2.1-1 should not specify a distance because this distance is site-specific. The applicant stated that the title of the maximum annual average $\chi$/Q site parameter presented in FSAR Tier 2, Table 2.1-1 will be revised to remove the distance. The staff confirmed that FSAR Tier 2, Revision 2, dated August 31, 2010, was revised as committed in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 288, Question 02.03.05-8 resolved.

In RAI 10, Question 02.03.05-1, the staff requested that the applicant provide a technical basis for the maximum annual average $\chi$/Q value of 4.973E-06 $s/m^3$ presented in FSAR Tier 2, Table 2.1-1. In a July 2, 2008, response to RAI 10, Question 02.03.05-1, the applicant stated this $\chi$/Q value was determined using the methodologies from RG 1.111 as implemented by the applicant's AEOLUS3 atmospheric dispersion computer code using meteorological data from the CCNPP site. A mixed-mode (part-time ground, part-time elevated) release was assumed pursuant to RG 1.111. From reviewing CCNPP Unit 3 COL FSAR, Revision 4, Tables 2.3-119 and 2.3-127 (which present routine release $\chi$/Q and D/Q values for the CCNPP Unit 3 site area as a function of downwind sector for various downwind radial distances), the staff concludes that the applicant chose $\chi$/Q and D/Q values that approximated the highest $\chi$/Q and D/Q values shown in these tables (0.5 miles downwind in the NE sector). FSAR Tier 2, Section 11.3.3.4 states that the MEI, as well as the dose receptors for the farm products (i.e., the nearest garden, nearest meat animal, and nearest milk animal) were also assumed to reside at this location. Therefore, the staff concludes that the applicant has provided a technical basis for the chosen annual average $\chi$/Q and D/Q site parameter values and, therefore, considers RAI 10, Question 02.03.05-1 closed.

The staff noticed that CCNPP Unit 3 COL Revision 6 requires a departure from the U.S. EPR maximum annual average $\chi$/Q site parameter value because the U.S. EPR maximum annual average $\chi$/Q site parameter value is exceeded by the corresponding CCNPP Unit 3 COL site characteristic value. In RAI 453, Question 02.03.05-9, the staff requested that the applicant justify why the U.S. EPR maximum annual average $\chi$/Q site parameter value should not be revised to ensure that a departure will not be required for the CCNPP Unit 3 COL application, especially since, according to the July 2, 2008, response to RAI 10, Question 02.03.05-1, the U.S. EPR maximum annual average $\chi$/Q site parameter value is based on data from the CCNPP site.

In a February 23, 2011, response to RAI 453, Question 02.03.05-9, the applicant stated the U.S. EPR maximum annual average $\chi$/Q site parameter value was derived using 6 years of meteorological data (from 2000 through 2005) from the CCNPP site as reported in CCNPP

Unit 3 COL application, Revision 0. CCNPP Unit 3 COL application Revision 6 used one additional year of more recent meteorological data (2006) in addition to the data from 2000 through 2005 to update the maximum annual average $\chi$/Q analysis. As a result of the inclusion of the 2006 meteorological data, the CCNPP Unit 3 COL maximum annual average $\chi$/Q site characteristic value became larger than the corresponding U.S. EPR maximum annual average $\chi$/Q site parameter value.

The staff finds the applicant's February 23, 2011, response to RAI 453, Question 02.03.05-9 acceptable because the radiological dose results using the larger CCNPP Unit 3 COL maximum annual average $\chi$/Q value are well within regulatory limits and potential departures in future COL applications with site-specific maximum annual average $\chi$/Q values exceeding the corresponding U.S. EPR maximum annual average $\chi$/Q site parameter value are not expected to result in design changes to the plant. Accordingly, the staff considers RAI 453, Question 02.03.05-9 resolved.

To determine whether the U.S. EPR annual average $\chi$/Q and D/Q site parameters bound a reasonable number of sites that may be considered within a COL application, the staff compared the U.S. EPR annual $\chi$/Q and D/Q site parameters to the annual average site boundary $\chi$/Q and D/Q site characteristics identified in the site FSARs for the first four docketed ESP applications (North Anna, Grand Gulf, Clinton, and Vogtle) in Table 2.3.5-1 of this report. The annual average $\chi$/Q and D/Q site characteristics presented in these ESP applications were reviewed and approved by the staff and were developed in accordance with current regulatory guidance.

**Table 2.3.5-1 Comparison of Annual Average ESP Site Boundary $\chi$/Q and D/Q Site Characteristic Values with the Corresponding U.S. EPR $\chi$/Q and D/Q Site Parameter Values**

| Document | Annual Average Site Boundary $\chi$/Q | | Annual Average Site Boundary D/Q | |
|---|---|---|---|---|
| | Value ($s/m^3$) | Ratio ESP/U.S. EPR | Value ($m^{-2}$) | Ratio ESP/U.S. EPR |
| North Anna ESP Site Safety Analysis Report (SSAR) | 3.7E-06 | 74% | 1.2E-08 | 24% |
| Clinton ESP SSAR | 2.0E-06 | 40% | 1.5E-08 | 30% |
| Grand Gulf ESP SSAR | 8.8E-06 | 177% | 1.2E-08 | 24% |
| Vogtle ESP SSAR | 5.5E-06 | 111% | 1.7E-08 | 34% |

Table 2.3.5-1 above shows that the U.S. EPR annual average $\chi$/Q bounds two out of the four ESP sites, and the U.S. EPR annual average D/Q values bounds all four ESP sites. The U.S. EPR site parameter $\chi$/Q and D/Q values bound the ESP site characteristic $\chi$/Q and D/Q values when the U.S. EPR $\chi$/Q and D/Q values are higher than the ESP $\chi$/Q and D/Q

values. Smaller $\chi$/Q and D/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing the U.S. EPR site parameter $\chi$/Q and D/Q values with the ESP site characteristic $\chi$/Q and D/Q values, the ESP sites are acceptable for the design if the ESP site characteristic $\chi$/Q and D/Q values are smaller than the U.S. EPR site parameter $\chi$/Q and D/Q values. Such a comparison shows that the ESP sites have better dispersion characteristics than that required by the U.S. EPR reactor design.

All four ESP applicants used bounding conservative assumptions in generating their annual average atmospheric dispersion $\chi$/Q and D/Q site characteristic values by assuming ground-level releases; whereas, the U.S. EPR vent stack design qualifies as a mixed-mode release pursuant to RG 1.111, because the plant stack release height is above the height of adjacent solid structures. Based on staff experience, it is not unreasonable to assume that the four ESP $\chi$/Q and D/Q site characteristic values would decrease at least by a factor of two if the four ESP applicants assumed mixed-mode releases instead of ground-level releases. Under this assumption, the U.S. EPR annual average $\chi$/Q and D/Q values would bound all four ESP sites. Therefore, the staff concludes that the U.S. EPR annual average $\chi$/Q and D/Q site parameters should bound a reasonable number of sites that may be considered within a COL application, and are therefore acceptable.

The staff noticed that the legend in FSAR Tier 2, Figure 1.2-3, "Plant Configuration," defines location "UKH" as the vent stack. Therefore, in RAI 288, Question 02.03.05-7, the staff requested that the applicant:

- Confirm that this is the same release location for the gaseous waste management system that is referred to as the "nuclear auxiliary building ventilation stack" in FSAR Tier 2, Section 11.3.1.2.3 and the "plant stack" in FSAR Tier 2, Section 11.3.3.3.

- Confirm that this is the same release location for several design-basis accidents that is referred to as the "main stack" throughout FSAR Tier 2, Section 15.0.3.

- Compare and explain the bases for the assumptions that: (1) The release point for the gaseous waste management system is at the top of the plant stack (i.e., release height of 64.3 m (211 ft) per FSAR Tier 2, Section 11.3.3.3) versus (2) one of the release points for many of the design-basis accidents is at the base of the main stack (i.e., release height of 32.1 m (105.3 ft) per Table 2.3-3 provided in the July 2, 2008, response to RAI 10, Question 02.03.04-4).

- Confirm that the release point for the gaseous waste management system is uncapped and vertically oriented.

RAI 256, Question 02.03.05-7 was being tracked as an open item.

In a February 26, 2010, partial response to the open item in RAI 256, Question 02.03.05-7, the applicant stated that:

- The vent stack defined as "UKH" in FSAR Tier 2, Figure 1.2-3 is the same release location as the "Nuclear Auxiliary Building (NAB) ventilation stack" in FSAR Tier 2, Section 11.3.1.2.3 and the "plant stack" in FSAR Tier 2, Section 11.3.3.3.

- The vent stack defined as “UKH” in FSAR Tier 2, Figure 1.2-3 is the same release location as the “main stack” referred to for several design-basis accidents in FSAR Tier 2, Section 15.0.3.

- Normal effluent releases (non-safety-related) are via the vent stack. Design-basis accident releases (safety-related) assume that the vent stack is not standing (i.e., it is conservatively assumed that the stack height cannot be credited for atmospheric dispersion).

In an April 20, 2010, partial response to the open item in RAI 256, Question 02.03.05-7, the applicant stated that:

- FSAR Tier 2, Figure 1.2-1, “3-Dimensional Conceptual Configuration of U.S. EPR Buildings,” shows that the vent stack, which is the release point for the gaseous waste management system, is a vertical structure. There are no caps in the U.S. EPR design of the vent stack.

The staff reviewed the applicant’s responses to this open item and finds them acceptable because the responses addressed the staff’s questions. Accordingly, the staff considers RAI 256, Question 02.03.05-7 resolved.

**COL Information Items**

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in FSAR Tier 2, Table 1.8-2. The staff finds that the applicant has properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.3.5, and has stated in COL Information Items 2.3-8 and 2.3-9 that a COL applicant referencing the U.S. EPR design certification will provide site-specific, long-term diffusion estimates for routine releases.

### 2.3.5.4 *Conclusions*

The staff finds that the applicant has selected the long-term (routine release) atmospheric dispersion and deposition site parameters referenced above in Section 2.3.5 for plant design inputs and the staff agreed they should be representative of a reasonable number of sites that have been or may be considered for a COL application. The long-term atmospheric dispersion and deposition characteristics are site-specific and will be addressed by the COL applicant. This should include the provision of information sufficient to demonstrate that the actual site characteristics fall within the values of the site parameters specified in the U.S. EPR FSAR. The staff finds this acceptable.

## 2.4 Hydrologic Engineering

In this section, the applicant provided information to allow an independent hydrologic engineering review to be made of all hydrology related design bases for operation of structures, systems and components important to safety, to be conducted consistent with the guidance provided in the SRP. The review areas include: Hydrological Description, Floods, Probable Maximum Flood (PMF) on Streams and Rivers, Potential Dam Failures, Probable Maximum Surge and Seiche Flooding, Probable Maximum Tsunami (PMT) Flooding, Ice Effects, Cooling Water Channels and Reservoirs, Channel Diversion, Flooding Protection Requirements, Low Water Considerations, Groundwater, Accidental Release of Liquid Effluents in Ground and

Surface Waters, and Technical Specification and Emergency Operation Requirements. For the U.S. EPR design certification review, site-specific issues will be deferred to the COL applicant. Hydrological parameters that constitute the U.S. EPR Standard Plant design bases for siting suitability by a COL applicant under 10 CFR Part 52 are reviewed here.

### *2.4.0.1 Summary of Application*

FSAR Tier 1, Table 5.0-1, FSAR Tier 2, Table 2.1-1, and FSAR Tier 2, Section 2.4, "Hydrologic Engineering," provide the following Site Design Envelope parameters:

- Maximum rainfall rate of 49.3 centimeters per hour (19.4 in./h)
- Maximum groundwater level of 1 m (3.3 ft) below finished grade
- Maximum flood (or tsunami) level of 0.3 m (1 ft) below finished grade

The staff reviewed the following FSAR sections:

1. FSAR Tier 1
    - Chapter 5.0, "Site Parameters"
2. FSAR Tier 2
    - Chapter 1, Section 1.8.1 "COL Information Items"
    - Chapter 1, Table 1.8.2 "U.S. EPR COL Information Items"
    - Chapter 2, Table 2.1-1 "U.S. EPR Site Design Envelope"
    - Chapter 2, Section 2.4 "Hydrologic Engineering"

The FSAR states, "the hydrologic information in Section 2.4 is site-specific and will be provided by the COL applicant that references the U.S. EPR design certification." These are provided as COL Information Items 2.4-1 through 2.4-15 in FSAR Tier 2, Table 1.8-2.

### *2.4.0.2 Regulatory Basis*

The staff used guidance provided in the following SRP Sections:

- Section 2.0, "Site Characteristics and Site Parameters"
- Section 2.4.1, "Hydrologic Description"
- Section 2.4.2, "Floods"
- Section 2.4.3, " Probable Maximum Flood (PMF) on Streams and Rivers"
- Section 2.4.4, "Potential Dam Failures"
- Section 2.4.5, "Probable Maximum Surge and Seiche Flooding"
- Section 2.4.6, "Probable Maximum Tsunami Hazards"

- Section 2.4.7, “Ice Effects”
- Section 2.4.8, “Cooling Water Canals and Reservoirs”
- Section 2.4.9, “Channel Diversions”
- Section 2.4.10, “Flooding Protection Requirements”
- Section 2.4.11, “Low Water Considerations”
- Section 2.4.12, “Groundwater”
- Section 2.4.13, “Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters”
- Section 2.4.14, “Technical Specifications and Emergency Operation Requirements”

The hydrology information provided by the applicant will be considered adequate if it meets the applicable codes and standards, and conforms to regulatory guidance. This will ensure that the relevant requirements of 10 CFR Part 20, 10 CFR Part 50, and 10 CFR Part 52, as they relate to the design certification, are met. These requirements are discussed below:

1. 10 CFR 20.1406, “Minimization of Contamination,” states that applications shall describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

2. 10 CFR Part 50, Appendix A, GDC 2, states, in part, 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.

3. 10 CFR Part 50, Appendix A, GDC 44, states in part, 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.

4. 10 CFR Part 50, Appendix A, GDC 60, “Control of Releases of Radioactive Material to the Environment,” states that the nuclear power unit design shall include means to suitably control 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 retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations on the release of such effluents to the environment.

5. 10 CFR 52.47(a)(1) states that an application for design certification must contain the site parameters postulated for the design, and an analysis and evaluation of the design in terms of such parameters.

### 2.4.0.3 Technical Evaluation

The site parameters used to satisfy 10 CFR Part 52, and which form the basis of the hydrologic engineering design, have been identified by the applicant, while the COL applicant will identify the corresponding site characteristics, which are based on site-specific information. These are provided as COL Information Items 2.4-1 through 2.4-15 in FSAR Tier 2, Table 1.8-2.

The applicant postulated the following three site parameters: maximum rainfall rate, maximum groundwater level, and the maximum flood level.

The applicant specified a value of 49.3 cm/h (19.4 in./h) for the maximum rainfall rate. This value is used frequently for bounding analysis and is found in NOAA Hydrometeorological Report 52 (HMR-52), which is referenced in NUREG-0800 and SRP Section 2.4.2. Accordingly, the staff finds this maximum rainfall rate reasonable.

The applicant identified a value of 1.0 m (3.3 ft) below finished grade for the maximum groundwater level and a value of 0.3 m (1.0 ft) below finished grade for the maximum flood level. Both of these values are close to those specified in the EPRI Utility Requirements Document and NUREG-1242, "NRC Review of Electric Power Research Institute's Advanced Light Water Reactor Utility Requirements Document." As such, the staff finds these values reasonable.

The staff noted differences between FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1. In FSAR Tier 1, Table 5.0-1, the applicant stated that the maximum rainfall rate parameters were being used for roof design, while FSAR Tier 2, Table 2.1-1 did not discuss roof design. In RAI 13, Question 02.04.00-1, the staff requested the applicant explain this difference. In a June 20, 2008, response, to RAI 13, Question 02.04.00-1, the applicant removed the mention of roof design from FSAR Tier 1, Table 5.0-1 to be consistent with FSAR Tier 2, Table 2.1-1. The staff finds that removing the limitation of using this site parameter only for roof design is reasonable and finds the response acceptable. Additionally, the staff confirmed that Revision 1 of the FSAR dated May 29, 2009, Tier 1, Table 5.0-1 was revised as committed in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, considers RAI 13, Question 02.04.00-1 resolved.

### 2.4.0.4 Conclusions

The applicant identified the following site parameters: Maximum rainfall rate; maximum groundwater level; and maximum flood level. Additionally, the applicant stated that these were standard plant design bases for the U.S. EPR. The applicant also requires any COL applicant to specify site-specific values for these three parameters. Based on this information, the staff finds FSAR Tier 2, Section 2.4 acceptable to meet the hydrologic requirements of 10 CFR Part 20, 10 CFR Part 50, and to CFR Part 52.

### 2.4.1.0 Hydrologic Description

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.1, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-1, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### 2.4.2.0 Floods

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.2, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-2, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### 2.4.3.0 Probable Maximum Flood (PMF) on Streams and Rivers

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.3, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-3, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### 2.4.4.0 Potential Dam Failures

The title of this section in the application indicated that the applicant appeared to be addressing only seismically-induced dam failures in this section. In RAI 13, Question 02.04.04-1, the staff requested that the applicant justify the exclusion of non-seismic induced dam failures. In a June 20, 2008, response to RAI 13, Question 02.04.04-1, the applicant modified the restrictive language in the application such that all potential dam failure mechanisms (seismic and non-seismic) would need to be addressed by the COL applicant. The staff finds this response acceptable. The staff confirmed that Revision 1 of FSAR dated May 29, 2009, Tier 2, Section 2.4.4 and Table 1.8-2 was revised as committed in the RAI response.

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.4, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-4, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### 2.4.5.0 Probable Maximum Surge and Seiche Flooding

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.5, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-5, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### 2.4.6.0 Probable Maximum Tsunami (PMT) Flooding

The staff notes that the applicant did not clearly state that the COL applicant would address the effects of the PMT. In RAI 13, Question 02.04.06-1, the staff requested that the applicant clarify the COL applicant's responsibilities in this area. In a June 20, 2008, response to RAI 13, Question 02.04.06-1, the applicant modified the application to ensure that the COL applicant will

have to address tsunami effects including those from the PMT. The staff finds this response acceptable. The staff confirmed that Revision 1 of FSAR dated May 29, 2009, Tier 2, Section 2.4.6 and Table 1.8-2 was revised as committed in the RAI response.

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.6, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-6, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.7.0 Ice Effects*

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.7, and stated in in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-7 and 2.4-8, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.8.0 Cooling Water Canals and Reservoirs*

The staff reviewed FSAR Tier 2, Section 9.2.5 as part of its review of this section. In RAI 13, Question 09.02.05-1, the staff requested that the applicant clarify the postulated meteorological parameters provided in FSAR Tier 2, Table 9.2.5-2 of the application and used to design the UHS. In a June 20, 2008, response to RAI 13, Question 09.02.05-1, the applicant stated that these meteorological parameters were based on the EPRI ALWR URDs intended to allow for siting at most available sites in the U.S., but did not encompass worst-case conditions. Since the values of these parameters bound a reasonable number of sites, the staff finds this response acceptable and considers RAI 13, Question 09.02.05-1 resolved.

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.8, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-9, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.9.0 Channel Diversions*

The staff notes that the applicant did not clearly state that the COL applicant would address the effects of both upstream and downstream channel diversions. Therefore, in RAI 13, Question 02.04.09-1, the staff requested that the applicant explain why COL applicants would not consider downstream diversions that could affect water supplies at the site. In a June 20, 2008, response to RAI 13, Question 02.04.09-1, the applicant deleted "upstream" from the paragraph describing the responsibilities of the COL applicant, thereby indicating that the COL applicant should consider all diversions or re-routing of the source cooling water. The staff finds this revision acceptable. The staff confirmed that Revision 1 of FSAR dated May 29, 2009, Tier 2, Section 2.4.9 and Table 1.8-2, specifically, COL Information Item 2.4-10, was revised as committed in the RAI response. Accordingly, the staff finds that the applicant adequately addressed this issue and, therefore, considers RAI 13, Question 02.04.09-1 resolved.

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.9, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-10, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.10.0 Flood Protection Requirements*

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.10, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-11, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.11.0 Low Water Considerations*

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.11, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-12, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.12.0 Groundwater*

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.12, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-13, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.13.0 Pathways of Liquid Effluents in Ground and Surface Waters*

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.13, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-14, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

### *2.4.14.0 Technical Specifications and Emergency Operation Requirements*

The staff notes that the applicant properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.14, and stated in FSAR Tier 2, Table 1.8-2, COL Information Item 2.4-15, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See Section 2.4.0.1 of this report for a discussion of the applicant's postulated site parameters.

# 2.5 Geology, Seismology, and Geotechnical Engineering

In FSAR Tier 2, Section 2.5, "Geology, Seismology, and Geotechnical Engineering," the applicant describes postulated site parameters that are related to geologic, seismic, and geotechnical engineering properties and selected for the U.S. EPR design. FSAR Tier 2, Section 2.5 also specifies related requirements for a COL applicant referencing this standard design. FSAR Tier 2, Section 2.5.1, "Basic Geologic and Seismic Information," presents geologic and seismic characteristics of the site and region that need to be determined by COL applicants referencing the U.S. EPR design. FSAR Tier 2, Section 2.5.2, "Vibratory Ground Motion," identifies the vibratory ground motion assessment, including the safe-shutdown earthquake (SSE) and design response for COL applicants to follow. FSAR Tier 2, Section 2.5.3, "Surface Deformation," describes the requirements for addressing the potential for surface tectonic and non-tectonic deformation at the COL site. FSAR Tier 2, Sections 2.5.4, "Stability of Subsurface Materials and Foundations," and FSAR Tier 2, Section 2.5.5, "COL Information for Stability of Slopes," describe the foundation, subsurface material and slopes stability criteria to be met by COL applicants.

This portion of the report, compiled by the staff, is divided into five main sections, Sections 2.5.1 through 2.5.5, which parallel the five main sections included in the FSAR, along with the FSAR Tier 1 information that is related to these FSAR Tier 2 sections. Each of the five sections in this report is then divided into four sub-sections (1) "Summary of Application" describes the technical content of the FSAR; (2) "Regulatory Basis" provides a summary of the regulations and NRC regulatory guides used by the staff to evaluate the FSAR; (3) "Technical Evaluation" describes the staff's evaluation of the applicant's technical submittals, including RAIs, open items, and any confirmatory analyses performed by the staff; and (4) "Conclusions," which provides the staff's conclusions and documents whether or not the applicant provided adequate information and requirement for COL applicants that meet the requirements of the regulations.

## 2.5.1 Basic Geologic and Seismic Information

### 2.5.1.1 *Summary of Application*

FSAR Tier 2, Section 2.5.1 specifies that COL applicants must provide site-specific geologic, seismic, geophysical, and geophysical information.

### 2.5.1.2 *Regulatory Basis*

The applicable regulatory requirements for reviewing geologic and seismic information are based on meeting the relevant requirements of the following NRC regulations:

1. 10 CFR Part 50, Appendix A, GDC 2, as it relates to the 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.

2. 10 CFR Part 100, Section 100.23, "Geologic and Seismic Siting Criteria," as it relates to the requirement that an evaluation of the suitability of a proposed site based on consideration of geologic, geotechnical, geophysical, and seismic characteristics of the proposed site. Geologic and seismic siting factors must include the SSE for the site and the potential for surface tectonic and non-tectonic deformation.

In addition, the geologic characteristics should be consistent with appropriate sections from the following applicable regulatory guidance documents:

1. RG 1.132, “Site Investigations for Foundations of Nuclear Power Plants”

2. RG 1.138, “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants”

3. RG 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites”

4. RG 1.206, “Combined License Applications for Nuclear Power Plants - LWR Edition”

5. RG 1.208, “A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion”

6. RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations”

### 2.5.1.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and the basic geologic and seismic information requirements provided in FSAR Tier 2, Section 2.5.1 for the COL applicant referencing the U.S. EPR design. The staff also notes that FSAR Tier 2, Table 1.8-2, COL Information Item 2.5-1 contains information related to this section.

The staff finds that the applicant provided sufficient information on basic geologic and seismic COL information requirements in this section of the application.

### 2.5.1.4 *Conclusions*

Based on its review of FSAR Tier 2, Section 2.5.1, the staff concludes that the applicant provided descriptions of the necessary geologic and seismic information and investigations, and the applicable regulations and regulatory guides that potential COL applicants must address when submitting a COL application. These requirements are consistent with the requirements of GDC 2 and 10 CFR 100.23; therefore, the staff considers FSAR Tier 2, Section 2.5.1 acceptable.

## 2.5.2 Vibratory Ground Motion

### 2.5.2.1 *Summary of Application*

**FSAR Tier 1 Information**

The FSAR Tier 1 information associated with this section is found in FSAR Tier 1, Section 5.0, “Site Parameters.” FSAR Tier 1, Table 5.0-1, “Site Parameters for the U.S. EPR Design,” specifies seismic and soil related parameters.

**FSAR Tier 2 Information**

FSAR Tier 2, Section 2.5.2 describes the geologic, seismic, geophysical, and geotechnical investigations that COL applicants must provide to determine the SSE for a site where the U.S. EPR is to be built.

The SSE represents the design earthquake ground motion and is the vibratory ground motion for which certain SSCs are designed to remain functional. The applicant stated that a COL applicant that references the U.S. EPR design certification shall determine the site-specific SSE based on detailed evaluation of the regional and local earthquake potential, ground motion attenuation, and the site-specific characterization of the local subsurface soil and rock properties, and compare it with certified seismic design response spectra (CSDRS) for the U.S. EPR.

As shown in FSAR Tier 1, Figure 5.0-1 and specified in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, "U.S. EPR Site Design Envelope" the CSDRS for the U.S. EPR are anchored at a 0.3 g peak ground acceleration design ground motion, both horizontal and vertical based on European Utility Requirements (EUR) document; and 0.21 g horizontal, 0.18 g vertical for hard-rock site high frequency (HF) response. The applicant further stated that a COL applicant referencing the U.S. EPR design will verify that the site-specific seismic ground motion is enveloped by the CSDRS and the soil profiles that are used in the U.S. EPR design and described in FSAR Tier 2, Section 3.7.1.3.

FSAR Tier 2, Section 2.5.2.6 presents evaluation guidelines for developing the site-specific ground motion response spectra (GMRS) and developing the foundation input response spectrum (FIRS). Specifically, FSAR Tier 2, Section 2.5.2.6 provides the steps necessary to compare the GMRS and FIRS to the CSDRS. The applicant stated that if the conditions of those steps are not met, then the COL applicant needs to use other appropriate evaluations to demonstrate that the seismic design basis of the U.S. EPR is suitable at the proposed site. If the evaluations are not sufficient, then the COL applicant needs to perform detailed site-specific soil-structure interaction (SSI) analysis to determine whether the in-structure response spectra (ISRS) exceed that specified in the standard design. Based on the site-specific SSI analysis results, the COL applicant may need to redesign selected features of the U.S. EPR, which will be identified as exceptions to the U.S. EPR FSAR in the COL application.

**Site Parameter Interfaces**

The applicant related the following site parameter interfaces: Site-specific seismic characteristics (FSAR Tier 2, Table 1.8-1, COL Information Item 2-4), and soil conditions and profiles (FSAR Tier 2, Table 1.8-1, COL Information Item 2-5). Specific SSE acceleration values are provided in FSAR Tier 1, Table 5.0-1 "Site Parameters for the U.S. EPR Design," and FSAR Tier 2, Table 2.1-1, "U.S. EPR Site Design Envelope."

### 2.5.2.2 *Regulatory Basis*

The applicable regulatory requirements for reviewing the applicant's discussion of vibratory ground motion are based on meeting the relevant requirements of the following NRC regulations:

- 10 CFR 100.23, "Geologic and Seismic Siting Criteria," as it relates to the requirement to obtain geologic and seismic information necessary to determine site suitability and ascertain that any new information derived from site-specific investigations does not impact the GMRS derived by a probabilistic seismic hazard analysis. The site-specific GMRS must satisfy all requirements with respect to the development of the SSE.

In addition, the determination of vibratory ground motion characteristics should be consistent with appropriate sections from the following applicable regulatory guidance documents:

1. RG 1.206, “Combined License Applications for Nuclear Power Plants - LWR Edition”

2. RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants”

3. RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations”

### 2.5.2.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and FSAR Tier 2, Section 2.5.2, which describes the geologic, seismic, geophysical, and geotechnical information requirements, including requirements for seismic hazard analysis, seismic wave transmission characteristics, GMRS and FIRS determination, as well as the specific conditions under which detailed site-specific SSI analyses will be required and evaluated whether the relevant requirements of GDC 2 and 10 CFR 100.23 are met.

In FSAR Tier 2, Section 2.5.2, “Vibratory Ground Motion,” the applicant stated, “the certified seismic design response spectra (CSDRS) for the U.S. EPR are shown in Figure 3.7.1- 1, ‘Design Response Spectra for EUR Control Motions (Hard, Medium, and Soft Soils).’” Since the applicant also stated, “for soil-structure interaction (SSI) analysis for the U.S. EPR design certification, the assumed generic shear wave velocities in each profile are taken to be strain-compatible values during seismic events.” In RAI 35, Question 02.05.02-1, the staff requested that the applicant clarify whether the soil degradation properties were considered in the site response analyses.

In an August 28, 2008, response to RAI 35, Question 02.05.02-1, the applicant stated that soil properties of the 10 generic soil profiles used in the SSI analysis for the FSAR are taken to be strain-compatible (or degraded properties); therefore, no site response analyses are needed. The response pointed out that the reconciliation process for a COL site-specific soil properties are developed from a site response analysis, and comparisons are made to the strain-compatible properties assumed in the standard design are specified by FSAR Tier 2, Section 2.5.2.6, COL item, Guideline 5. The applicant finally stated that the COL applicant may redesign selected features of the U.S. EPR, as required. Redesigned features will be identified as an exception to the U.S. EPR FSAR and addressed by the COL applicant.

After reviewing the applicant’s August 28, 2008, response to RAI 35, Question 02.05.02-1 and information provided in the FSAR, the staff finds that the definitions of vibratory ground motion related site parameters, GMRS and CSDRS are adequate. Because (1) the applicant clarified that the generic soil profiles used in the SSI analysis for the U.S. EPR design are strain-compatible, or in other words, analyses take soil degradation properties into consideration; and (2) this section of the U.S. EPR FSAR also requires the COL applicants to determine whether the site-specific soil profile meets the design requirements if these requirements are not met, additional studies or site-specific SSI analysis will be performed to demonstrate that the seismic design basis of the U.S. EPR is acceptable at the proposed site. If needed, redesign of selected features of the U.S. EPR will be required and associated issues will have to be addressed by the COL applicant. In a July 8, 2011, updated response, the applicant referred to its response to RAI 320, Question 03.07.02-63 and associated markups in FSAR Tier 2, Section 2.5.2.6. The staff confirmed that FSAR Tier 2, Revision 5, dated July 19, 2013, was revised as committed in the RAI response. Accordingly, the staff finds that the applicant adequately addressed the related requirements of GDC 2 and 10 CFR 100.23 and, therefore, considers RAI 35, Question 02.05.02-1 resolved.

During the course of its review of FSAR Tier 2, Revision 0, Section 2.5.2.6, "Ground Motion Response Spectrum," the staff noticed that the applicant stated, "A COL applicant that references the U.S. EPR design certification will verify that the site-specific seismic parameters are enveloped by the CSDRS (anchored at 0.3 g peak ground acceleration (PGA)) and the 10 generic soil profiles discussed in Section 2.5.2 and Section 3.7.1." Since the applicant divided the 10 generic soil profiles into three different site groups (i.e., soft site, medium site, and hard site), and developed three corresponding CSDRSs, the staff requested in RAI 35, Question 02.05.02-2, that the applicant clarify the criteria for COL applicants to determine the appropriate site group for the proposed site, and how the site-specific response spectrum must be enveloped by the CSDRS corresponding to that particular site group. In an August 1, 2008, response, to RAI 35, Question 02.05.02-2, the applicant stated that the COL applicant will reconcile and compare the FIRS and the site-specific soil profile with the CSDRS and the soil profiles used in the U.S. EPR design, as stated in FSAR Tier 2, Section 2.5.2.6, Guidelines 3 and 5. The applicant also stated that the COL applicant's proposed site is acceptable for a U.S. EPR if the site-specific FIRS is enveloped by any one of the CSDRS, and the site-specific soil profile is bounded by the corresponding soil conditions analyzed with that CSDRS. The staff reviewed this information and concludes that the applicant adequately clarified the definition of how the COL applicant should verify that the site-specific seismic parameters will be enveloped by the CSDRS for a given site with a site-specific soil profile. Accordingly, the staff considers RAI 35, Question 02.05.02-2 resolved. In an updated response of July 8, 2011, the applicant referred to its response to RAI 320, Question 03.07.02-63 and associated FSAR Tier 2, Section 2.5.2.6 markups. The staff reviewed the response and noted that the FSAR Tier 2, Revision 5, dated July 19, 2013, updated the CSDRS by adding high frequency response spectra with different anchoring PGAs for hard rock sites; however, this change does not affect the resolution of RAI 35, Question 02.05.02-2.

The staff also noted that FSAR Tier 2, Section 2.5.2.6, "Ground Motion Response Spectrum," states in Guideline step 8 that the comparison of structural seismic responses of the CSDRS with detailed site-specific SSI analyses will be made at some key locations as defined in FSAR Tier 2, Section 3.7.2, but the specified control points given in these sections are inconsistent. Therefore, in RAI 35, Question 02.05.02-3, the staff requested that the applicant verify the control point elevation for the fuel building (FB), as defined in FSAR Tier 2, Section 2.5.2.6, compared with that described in FSAR Tier 2, Section 3.7.2. In an October 7, 2008, response to RAI 35, Question 02.05.02-3, the applicant stated that it would revise FSAR Tier 2, Section 3.7.2 to include the U.S. EPR Fuel Building's in-structure response spectra (ISRS) test and figures for elevation +3.7 m (+12 ft, 1-3/4 in.) as specified in FSAR Tier 2, Section 2.5.2.6, Guideline step 8, item F. The staff reviewed this information and noted that FSAR Tier 2, Revision 3, dated August 10, 2011, makes the SSI analysis control points consistent throughout the FSAR. Accordingly, the staff considers RAI 35, Question 02.05.02-3 resolved.

Because FSAR Tier 1, Table 5.0-1, "Site Parameters for the U.S. EPR Design," lists the parameter for seismology as "Seismology (Shutdown Earthquake response spectra using figures)," but it does not mention any corresponding figures in its "Value(s)" column, in RAI 35, Question 02.05.02-4, the staff requested that the applicant specify the figures related to SSE response spectra. In an August 1, 2008, response to RAI 35, Question 02.05.02-4, the applicant stated that FSAR Tier 2, Figure 3.7.1-1 will be added to FSAR Tier 1, Chapter 5, identified as Figure 5.0-1. The applicant also stated that FSAR Tier 1, Table 5.0-1 will be updated to reference this figure. The staff reviewed the information provided in the applicant's response, especially the proposed markup and updates to the FSAR, and confirmed that the proposed markup has been incorporated in later revisions of the FSAR. Accordingly, the staff

finds that the applicant adequately addressed this issue and, therefore, considers RAI 35, Question 02.05.02-4 resolved.

The staff also notes that COL Information Items 2.5-2 and 2.5-3, as listed in FSAR Tier 2, Table 1.8-2, are related to this section of the FSAR.

### 2.5.2.4 *Conclusions*

Based on its review of FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Section 2.5.2, and the responses to related RAIs from the applicant, the staff concludes that the applicant adequately described the requirements on geologic, seismic, geophysical, and geotechnical information and investigations necessary for COL applicants to develop site-specific GMRS, FIRS, and other specific conditions under which detailed site-specific SSI analyses or other measures may be required. The applicant also provided a set of site parameters related to the geological and seismological design basis for the U.S. EPR standard design, such as requirements on SSE and associated site response spectra. The staff further concludes that the geological and seismological related site parameters identified as part of the design basis, and requirements for COL applications presented in this section are adequate and meet the regulatory requirements of GDC 2, 10 CFR 100.23, and 10 CFR 52.47(a)(1). Accordingly, the staff finds FSAR Tier 2, Section 2.5.2 acceptable.

## 2.5.3 Surface Deformation

### 2.5.3.1 *Summary of Application*

FSAR Tier 2, Section 2.5.3 describes the site-specific geologic and seismic information that COL applicants must provide to determine the potential for surface deformation at the site. The applicant stated that the potential for surface deformation is considered to be absent from the site. The applicant stated that the COL applicant referencing the U.S. EPR design will evaluate the potential for surface deformation at the site. If the potential for surface deformation is present at the site, the evaluation will address the effects of potential surface deformation on the design and operation of the U.S. EPR.

FSAR Tier 2, Table 2.1-1 provides the U.S. EPR site design envelope parameters and assumes no surface deformation to be present for safety-related SSCs, while FSAR Tier 2, Section 2.5.3 provides details on the evaluation of potential for surface deformation at the site.

### 2.5.3.2 *Regulatory Basis*

The applicable regulatory requirements for reviewing the applicant's discussion of surface deformation are based on meeting the relevant requirements of the following NRC regulations:

1. 10 CFR Part 50, Appendix A, GDC 2, as it relates to the requirement for 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

2. 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," as it relates to the design of nuclear power plant structures, systems, and components important to safety to withstand the effects of surface deformation

3. 10 CFR 100.23, as it relates to the requirement for determining the potential for surface tectonic and non-tectonic deformations at and in the region surrounding the site

In addition, the determination of the potential for surface deformation should be consistent with appropriate sections from the following applicable regulatory guidance documents:

1. RG 1.132, “Site Investigations for Foundations of Nuclear Power Plants”

2. RG 1.206, “Combined License Applications for Nuclear Power Plants - LWR Edition”

3. RG 1.208, “A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion”

4. RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations”

### 2.5.3.3 *Technical Evaluation*

The staff reviewed the regulatory guidance provided in FSAR Tier 2, Section 2.5.3 of the site-specific geologic and seismic information and investigations necessary to determine the potential for surface deformation to ensure there is no potential for surface deformation at the site that would have an adverse impact on the functionality of safety-related structures, systems, and components. The staff notes that FSAR Tier 2, Revision 6, dated April 3, 2014, clearly defined the requirements regarding the evaluation of potential for surface deformation, which complies with the requirements of 10 CFR 100.23.

### 2.5.3.4 *Conclusions*

Based on its review of FSAR Tier 2, Section 2.5.3, the staff concludes that the applicant provided an adequate description of the site-specific geologic information and investigations that COL applicants must provide to determine the potential for surface deformation at the site; it meets the relevant requirements of GDC 2 and 10 CFR 100.23 and, therefore, the staff concludes that this section of the application is acceptable.

## 2.5.4 Stability of Subsurface Materials and Foundations

### 2.5.4.1 *Summary of Application*

**FSAR Tier 1 Information**

The FSAR Tier 1 information associated with this section is provided in FSAR Tier 1, Section 5.0, “Site Parameters.” Table 5.0-1 in this section specifies seismic and other site parameters.

**FSAR Tier 2 Information**

FSAR Tier 2, Section 2.5.4, describes the site-specific geotechnical and geophysical information and investigations that COL applicants must provide to determine the properties of all soils and rock that may affect the nuclear power plant facilities under both static and dynamic loading conditions, including the vibratory ground motions associated with the SSE. This section also specifies postulated stability-related site parameters for subsurface materials and foundation that are components of the standard design basis.

FSAR Tier 2, Section 2.5.4.2 specifies some postulated design site parameters, specifically, minimum angle of internal friction of 26.6 degrees, a coefficient of friction (acting on the foundation basemat and near surface foundations for Seismic Category I structures) of 0.5 minimum, a saturated soil density of 2,146 kilograms per cubic meter ($kg/m^3$) (134 pounds per cubic foot (pcf)), moist soil density of 2,050 $kg/m^3$ (128 pcf), and dry soil density of 1,762 $kg/m^3$ (110 pcf) for the design of U.S. EPR Seismic Category I structures. FSAR Tier 2, Table 2.1-1 provides design envelope parameters and specifies strain-compatible shear wave velocity values directly beneath the foundation basemat of 304.8 m/s ((1000 fps) for soft soils, 500 m/s (1640 fps) for medium soils, and greater than or equal to 2,012 m/s (6,601 fps) for hard soils.

FSAR Tier 2, Section 2.5.4.3 states that the COL applicant will confirm that the site soils have (1) a sliding coefficient of friction equal to at least 0.5, (2) adequate shear strength to provide adequate static and dynamic bearing capacity, (3) adequate elastic and consolidation properties to satisfy the limits on settlement described in FSAR Tier 2, Section 2.5.4.10.2, and (4) adequate dynamic properties (i.e., shear wave velocity and strain-dependent modulus reduction and hysteretic damping properties) to support the Seismic Category I structures of the U.S. EPR under earthquake loading conditions.

FSAR Tier 2, Table 2.1-1, which provides the U.S. EPR site design envelope parameters, specifies that the U.S. EPR design assumes that the plant is not founded on liquefiable material. The applicant also specified that the maximum static bearing demand is 1,106 kPa (23 kips per square foot (ksf)) at the bottom of Seismic Category I structure basemats. For a specific site, the ultimate static bearing capacity, divided by 3.0, should be greater than or equal to the maximum static bearing demand. Additionally, the maximum dynamic bearing demands are 1,819 kPa (38 ksf) for soft soil, 2,298 kPa (48 ksf) for medium soil, and 2,872 kPa (60 ksf) for hard soil. The site-specific ultimate dynamic bearing capacity, divided by 2.0, should be greater than or equal to the maximum dynamic bearing demand. The maximum tilt settlement across the basemat is 1.3 cm (0.5 in.) in 15.2 m (50 ft) in any direction, and the maximum groundwater is 1.0 m (3.3 ft) below grade.

FSAR Tier 2, Section 2.5.4.10.1 also specifies that a COL applicant referencing the U.S. EPR design certification will perform a site-specific analysis to determine the bearing pressure demand and peak displacement of the Nuclear Auxiliary Building (NAB). Factors of safety of 3.0 (under static loading conditions) and 2.0 (under combined static and dynamic loading) will be used to determine the minimum bearing capacity of the foundation soils beneath the NAB foundation basemat.

During excavations and backfill, the U.S. EPR design recommends mud mats under foundations for ease of construction. However, the applicant also stated that the use of waterproofing membranes is site-specific and will be addressed by the COL applicant.

FSAR Tier 2, Section 2.5.4.10.3 addresses uniformity and variability of foundation support media and states that the U.S. EPR design considers a broad range of subsurface conditions, which were evaluated by a series of SSI analyses. The applicant stated that the analyses assume the underlying layers of soil and rock are horizontal with uniform properties and that the foundation conditions do not have extreme variation within the foundation footprints. The applicant also proposed a design margin that allows for adaptation of other sites that might be classified as non-uniform or having highly variable properties. The applicant stated that the COL applicant that references the U.S. EPR design certification is responsible for investigating and determining the uniformity of the underlying layers of site-specific soil conditions beneath

the foundation basemats of Seismic Category I structures. The applicant provided guidance for performing a site-specific evaluation of uniformity for soil profiles under the Seismic Category I structures and further stated that the COL applicant would need to perform a site-specific analysis if the underlying layers of soil and rock have a dip angle greater than 20 degrees or the site has a profile with non-uniform soil conditions.

FSAR Tier 2, Sections 2.5.4.10.4 and 2.5.4.10.5 describe the site investigation requirements for uniform and non-uniform sites, respectively.

**Site Parameter Interfaces**

This section of the FSAR contains information related to the following site parameter interface: Soil conditions and profiles; bearing pressure of soil beneath the nuclear island basemat; and foundation settlements (FSAR Tier 2, Table 1.8-1, Item 2-5, 2-6 and 2-7). Specific soil properties, including minimum angle of internal friction, minimum shear wave velocity, minimum bearing capacity (both static and dynamic), maximum differential settlement, maximum groundwater level values and liquefaction potential specification, are provided in FSAR Tier 2, Table 2.1-1, "U.S. EPR Site Design Envelope," and in FSAR Tier 1, FSAR Table 5.0-1, "Site Parameters for the U.S. EPR Design."

## 2.5.4.2 *Regulatory Basis*

The applicable regulatory requirements for reviewing the applicant's discussion of stability of subsurface materials and foundations are based on meeting the relevant requirements of the following NRC regulations:

1. 10 CFR Part 50, Appendix A, GDC 1, "Quality Standards and Records," as it relates to the requirement that SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions. It also requires that appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit

2. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena," as it relates to the requirement for 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

3. 10 CFR Part 50, Appendix A, GDC 44, "Cooling Water," as it relates to the requirement that a system be provided with the safety function of transferring the combined heat load from SSCs important to safety to an ultimate heat sink under normal operating and accidental conditions

4. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants," as it relates to the requirements for the design, construction, and operation of those SSCs of nuclear power plants that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public

5. 10 CFR Part 50, Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” as it relates to the requirement that the design of nuclear power plant SSCs important to safety withstand the effects of earthquakes

6. 10 CFR Part 100, "Reactor Site Criteria," provides the criteria that guide the evaluation of the suitability of proposed sites for nuclear power and testing reactors

7. 10 CFR 100.23, provides the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

In addition, the determination of stability of subsurface materials and foundations should be consistent with appropriate sections from the following applicable regulatory guidance documents:

1. RG 1.132, “Site Investigations for Foundations of Nuclear Power Plants”

2. RG 1.138, “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants”

3. RG 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites”

4. RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants”

5. RG 1.28, “Quality Assurance Program Requirements (Design and Construction)”

### 2.5.4.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and the description provided in FSAR Tier 2, Section 2.5.4 of the site-specific geotechnical and geophysical information and site investigations necessary to determine the properties and stability of soils and rocks under both static and dynamic loading conditions. The staff reviewed this information to ensure that the requirements of GDC 1, GDC 2, GDC 44 as well as 10 CFR Part 50, Appendices B and S, and 10 CFR 100.23 are adequately stated in the FSAR.

Because the applicant specified in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1, that the soil liquefaction potential was “none” without any elaboration, in RAI 35, Question 02.05.04-1, the staff requested that the applicant clarify the restrictions with regard to soil liquefaction. In an August 28, 2008, response to RAI 35, Question 02.05.04-1, the applicant stated that, as indicated in FSAR Tier 2, Section 2.5.4.8, the U.S. EPR design is assumed to be founded on non-liquefiable materials and that the COL applicant will address any site-specific liquefaction potential. The staff reviewed this information and considered that the applicant analyzed the Nuclear Island (NI) and other safety-related structures as surface-founded structures and structural embedment is ignored in the SSI analysis. Therefore, the staff concludes that requiring the COL applicant to address any site-specific liquefaction potential to ensure that the design is not founded on liquefiable materials, 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. Accordingly, the staff finds the applicant’s response to RAI 35, Question 02.05-04-1 acceptable. The staff noted that FSAR Tier 1, Revision 3 dated August 10, 2011, Table 5.0-1, “Site Parameters for the U.S. EPR Design,” revised the liquefaction potential

site parameter to “no potential for liquefaction under footprint of Seismic Category I structures from site-specific SSE.” This revision provided a more specific description on the requirement of liquefaction potential at a site, which does not change the design basis or requirement for COL application. Therefore, it does not affect the resolution of RAI 35, Question 02.05.04-1.

The staff focused its review on FSAR Tier 2, Section 2.5.4.10.1, which initially states, “the maximum bearing pressure under static loading conditions for the foundation basemat beneath the NI Common Basemat Structures is 22,000 lb/ft$^2$ [(psf) 1.053 kPa )],” and “the maximum bearing pressure under safe shutdown earthquake loads combined with other loads, as described in Section 3.8.5, is 25,000 lb/ft$^2$ [psf 1.197 kPa)].” In RAI 35, Question 02.05.04-2, the staff requested that the applicant explain how the maximum dynamic/seismic bearing pressure was determined and justify the value presented in the FSAR. The staff also requested that the applicant explain why there is no maximum dynamic or seismic bearing pressure related parameter in the FSAR Tier 1 document.

In an October 7, 2008, response to RAI 35, Question 02.05.04-2, the applicant stated that it calculated the maximum dynamic bearing pressure under SSE loads “using a nonlinear time history analysis with explicit representation of soil properties, Nuclear Island foundation mat and superstructure.” Since the calculated maximum dynamic bearing pressure was 1,655 kPa (34,560 psf), the applicant proposed to revise FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 to list the minimum soil dynamic bearing capacity accordingly. In FSAR Revision 3, submitted on August 10, 2011, Tier 1, Table 5.0-1, “Site Parameters for the U.S. EPR Design,” the applicant revised the minimum soil dynamic bearing capacity value to 1,676 kPa (35,000 psf) to give more safety margin. It also specified that the factor of safety of 3.0 should be applied to static or 2.0 to dynamic conditions, to evaluate whether the COL site meets the bearing capacity requirement. The staff reviewed the applicant’s response and concluded that although the applicant provided a revised value for dynamic bearing capacity, no details on the dynamic bearing capacity determination, such as the model and corresponding soil profiles used in the analysis were provided. Because the dynamic bearing pressure for the foundation basemat is affected by many factors, such as the analysis model used (i.e., 2D or 3D), the soil properties, and the loading condition considered, more information was needed for the staff to evaluate the adequacy of the dynamic bearing capacity requirement. Accordingly, in follow-up RAI 261, Question 02.05.04-4, the staff requested that the applicant provide additional information on the dynamic bearing capacity analyses. RAI 261, Question 02.05.04-4 was being tracked as an open item.

In a February 10, 2011, response to RAI 261, Question 02.05.04-4, the applicant stated that dynamic bearing pressures would be determined based on loads from SSI analysis results described in the responses to RAI 320, Question 03.07.02-63 and RAI 371, Question 03.07.02-69 and the bearing pressure results would be provided in the response to RAI 376, Question 03.08.05-28. The applicant subsequently submitted June 22, 2011, and April 30, 2013, responses to RAI 320, Question 03.07.02-63; a June 24, 2011, response to RAI 371, Question 03.07.02-69; and a January 5, 2012, response to RAI 376, Question 03.08.05-28. The staff reviewed these RAI responses with respect to the soil bearing pressure analysis and concluded that the evaluation for dynamic soil bearing capacities is acceptable because the new 3-D model captured appropriate physical processes for dynamic loading conditions and that appropriate factors of safety were applied in developing the site parameters for soil bearing capacities. The staff also confirmed that these RAI responses were incorporated into FSAR Tier 2, Revision 5, dated July 19, 2013.

The maximum static bearing demand is 1,106 kPa (23.1 ksf) and a factor of safety of 3.0 will be used when determining minimum static bearing capacity requirement. The maximum dynamic bearing demands are 1,819 kPa (38 ksf) for soft soil, 2,298 kPa (48 ksf) for medium soil and 2,872 kPa (60 ksf) for hard soil, and a factor of safety of 2.0 will be used when determining minimum dynamic bearing capacity requirement. Furthermore, the staff considers that the factor of safety values used in the site bearing-capacity determination are consistent with common engineering practices and will provide an adequate safety margin for foundation stability. Accordingly, the staff finds that the applicant acceptably addressed the open item and, therefore, considers RAI 261, Question 02.05.04-4 resolved.

The staff noted that FSAR Tier 2, Table 1.8-2, COL Information Items 2.5-1 through 2.5-10 are related to FSAR Tier 2, Section 2.5, but that there is no mention of Table 1.8-2 in FSAR Tier 2, Section 2.5.4. Therefore, in RAI 35, Question 02.05.04-3, the staff requested that the applicant discuss the COL Information Items listed in FSAR Tier 2, Table 1.8-2 in the corresponding FSAR sections. In an August 28, 2008, response to RAI 35, Question 02.05.04-3, the applicant stated that to be consistent with design control documents, FSAR Tier 2, Section 1.8 contains a summary of all the COL information items with reference to the pertinent sections. These COL information items are explained in detail within the individual sections of the FSAR; therefore, there is no need to mention the COL information table in all related FSAR sections. The staff reviewed FSAR Tier 2, Section 1.8 and concluded that FSAR Tier 2, Section 1.8 is the appropriate section where a COL applicant would find the COL information items that need to be addressed for a site that references the U.S. EPR design. Accordingly, the staff considers RAI 35, Question 02.05.04-3 resolved.

### 2.5.4.4 *Conclusions*

Based on its review of the FSAR Tier 1, Table 5.0-1, and FSAR Tier 2, Tables 1.8-1, 1.8-2 and 2.1-1, and Section 2.5.4, as well as RAI responses, the staff concludes that the applicant provided a set of postulated site parameters that are related to the geological, seismological, geotechnical engineering and foundation stability requirements as components of the basis for the U.S. EPR standard design. The applicant also provided adequate descriptions of the site-specific geotechnical and geophysical information and investigations that COL applicants must provide to determine the properties and stability of all soils and rock that may affect the safety of nuclear power plant facilities under both static and dynamic loading conditions, including the vibratory ground motions associated with the SSE. The staff further concludes that the site-specific information and site investigations requirement, the design-basis site parameters, and the procedures to properly determine required site-specific parameters by COL applicants described in the FSAR, are sufficient to ensure that the relevant requirements of GDC 2, 10 CFR Part 50 and 10 CFR Part 100 can be met. For the same reasons, the staff concludes that FSAR Tier 2, Section 2.5.4 is acceptable.

## 2.5.5 Stability of Slopes

### 2.5.5.1 *Summary of Application*

#### FSAR Tier 1 Information

The FSAR Tier 1 information associated with this section is found in FSAR Tier 1, Section 5.0, “Site Parameters.” FSAR Tier 1, Table 5.0-1 specifies seismic and soil related parameters.

**FSAR Tier 2 Information**

FSAR Tier 2, Section 2.5.5 describes requirements that COL applicants must meet to determine the stability of all slopes, both natural and manmade, whose failure, under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the plant. The evaluation of slope stability is performed for the seismic level of the site-specific GMRS.

FSAR Tier 2, Table 2.1-1 provides the U.S. EPR site design envelope parameters and specifies that the U.S. EPR design assumes no slope failure potential to be present for safety-related SSCs.

### 2.5.5.2 *Regulatory Basis*

The applicable regulatory requirements for reviewing the applicant's discussion of stability of slopes are based on meeting the relevant requirements of the following NRC regulations:

1. 10 CFR Part 50, Appendix A, GDC 2, as it relates to the requirement for 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

2. 10 CFR Part 50, Appendix S, as it relates to the requirement that the design of nuclear power plant SSCs important to safety withstand the effects of earthquakes

3. 10 CFR 50.55a, as it relates to the requirement that SSCs shall be designed, fabricated, erected, constructed, tested, and inspected in accordance with the requirements of applicable codes and standards commensurate with the importance of the safety functions that they perform

4. 10 CFR 100.23, provides the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants

In addition, the slope stability evaluation should be consistent with appropriate sections from the following applicable regulatory guidance documents:

- RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants"

- RG 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants"

- RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites"

- RG 1.206, "Combined License Applications for Nuclear Power Plants - LWR Edition"

- RG 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Motion"

### 2.5.5.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and the description provided in FSAR Tier 2, Section 2.5.5 of the site-specific geotechnical and geologic information and site investigations necessary to determine the stability of all slopes. The staff also reviewed FSAR Tier 2, Table 1.8-2, COL Information Item 2.5-8, related to this section of the FSAR to ensure that the relevant requirements of GDC 2, 10 CFR Part 50, Appendix S, and 10 CFR 100.23 can be met by COL applicants.

### 2.5.5.4 *Conclusions*

Based on its review of FSAR Tier 1, Table 5.0-1, and FSAR Tier 2, Tables 1.8-2 and Section 2.5.5, the staff concludes that the applicant provided adequate requirements that COL applicants must meet to determine the stability of all slopes, both natural and man-made, the failure of which under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the plant. The staff further concludes that these requirements are consistent with the relevant requirements of GDC 2, and 10 CFR Part 50 and 10 CFR Part 100. Accordingly, the staff considers that FSAR Section 2.5.5 is acceptable.

## 2.6 COL Information Items

Table 2.6-1 below provides a complete list of COL Information Items and descriptions applicable to FSAR Tier 2, Section 2. The COL Information Items applicable to FSAR Tier 2, Section 2 have been discussed throughout Section 2 of this report, and are summarized below.

**Table 2.6-1 U.S. EPR COL Information Items Applicable to FSAR Tier 2, Section 2**

| Item No. | Description | FSAR Tier 2 Section |
|---|---|---|
| 2.0-1 | A COL applicant that references the U.S. EPR design certification will compare the characteristics of its proposed site to the site parameters in Table 2.1-1. If the characteristics of the site fall within the assumed site parameters in Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific characteristics that are outside the bounds of the assumptions presented in Table 2.1-1, the COL applicant will demonstrate that the U.S. EPR design acceptability meets the regulatory requirements, given the site-specific characteristic. In such an instance, the COL applicant will also demonstrate that the design commitments and acceptance criteria described in the FSAR do not need to be changed, or will propose new design commitments or acceptance criteria, or both. | 2.0 |
| 2.1-1 | A COL applicant that references the U.S. EPR design certification will provide site-specific information related to site location and description, exclusion area authority and control, and population distribution. | 2.1 |
| 2.2-1 | A COL applicant that references the U.S. EPR design certification will provide site-specific information related to the identification of potential hazards stemming from nearby industrial, transportation, and military facilities within the site vicinity, including an evaluation | 2.2 |

| Item No. | Description | FSAR Tier 2 Section |
|---|---|---|
| | of potential accidents (such as explosions, toxic chemicals, and fires). | |
| 2.2-2 | A COL applicant that references the U.S. EPR design certification will provide information concerning site-specific evaluations to determine the consequences that potential accidents at nearby industrial, transportation, and military facilities could have on the site. The information provided by the COL applicant will include specific changes made to the U.S. EPR design to qualify the design of the site against potential external accidents with an unacceptable probability of severe consequences. | 2.2.3 |
| 2.3-1 | If a COL applicant that references the U.S. EPR design certification identifies site-specific meteorology values outside the range of the site parameters in Table 2.1-1, then the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of the Combined License application. | 2.3 |
| 2.3-2 | A COL applicant that references the U.S. EPR design certification will provide site-specific characteristics for regional climatology. | 2.3.1 |
| 2.3-3 | A COL applicant that references the U.S. EPR design certification will provide site-specific characteristics for local meteorology. | 2.3.2 |
| 2.3-4 | A COL applicant that references the U.S. EPR design certification will provide the site-specific, onsite meteorological measurement program. | 2.3.3 |
| 2.3-5 | A COL applicant that references the U.S. EPR design certification will provide a description of the atmospheric dispersion modeling used in evaluating potential design basis events to calculate concentrations of hazardous materials (e.g., flammable or toxic clouds) outside building structures resulting from the onsite and/or offsite airborne releases of such materials. | 2.3.4 |
| 2.3-6 | A COL applicant that references the U.S. EPR design certification will confirm that site-specific $\chi/Q$ values, based on site-specific meteorological data, are bounded by those specified in Table 2.1-1 at the EAB, LPZ and the control room. For site-specific $\chi/Q$ values that exceed the bounding $\chi/Q$ values, a COL applicant that references the U.S. EPR design certification will demonstrate that the radiological consequences associated with the controlling design basis accident continue to meet the dose reference values given in 10 CFR 50.34 and the control room operator dose limits given in GDC 19 using site-specific $\chi/Q$ values. | 2.3.4 |
| 2.3-7 | Deleted | Deleted |
| 2.3-8 | A COL applicant that references the U.S. EPR design certification will provide the site-specific, long-term diffusion estimates for routine releases. In developing this information, the COL applicant should consider the guidance provided in Regulatory Guides 1.23, 1.109, 1.111, and 1.112. | 2.3.5 |
| 2.3-9 | A COL applicant that references the U.S EPR design certification will also provide estimates of annual average atmospheric dispersion ($\chi/Q$ values) and deposition (D/Q values) for 16 radial | 2.3.1.1 |

| Item No. | Description | FSAR Tier 2 Section |
|---|---|---|
| | sectors to a distance of 50 miles (80 km) from the plant as part of its environmental assessment. | |
| 2.3-10 | Deleted. | Deleted |
| 2.4-1 | A COL applicant that references the U.S. EPR design certification will provide a site-specific description of the hydrologic characteristics of the plant site. | 2.4.1 |
| 2.4-2 | A COL applicant that references the U.S. EPR design certification will identify site-specific information related to flood history, flood design considerations, and effects of local intense precipitation. | 2.4.2 |
| 2.4-3 | A COL applicant that references the U.S. EPR design certification will provide site-specific information to describe the probable maximum flood of streams and rivers and the effect of flooding on the design. | 2.4.3 |
| 2.4-4 | A COL applicant that references the U.S. EPR design certification will verify that the site-specific potential hazards to the safety-related facilities due to the failure of upstream and downstream water control structures are within the hydro-geologic design basis. | 2.4.4 |
| 2.4-5 | A COL applicant that references the U.S. EPR design certification will provide site-specific information on the probable maximum surge and seiche flooding and determine the extent to which safety-related plant systems require protection. The applicant will also verify that the site-specific characteristic envelope is within the design maximum flood level, including consideration of wind effects. | 2.4.5 |
| 2.4-6 | A COL applicant that references the U.S. EPR design will provide site-specific information and determine the extent to which safety-related facilities require protection from tsunami effects, including Probable Maximum Tsunami Flooding. | 2.4.6 |
| 2.4-7 | A COL applicant that references the U.S. EPR design certification will provide site-specific information regarding ice effects and design criteria for protecting safety-related facilities from ice-produced effects and forces with respect to adjacent water bodies. | 2.4.7 |
| 2.4-8 | A COL applicant that references the U.S. EPR design certification will evaluate the potential for freezing temperatures that may affect the performance of the ultimate heat sink makeup, including the potential for frazil and anchor ice, maximum ice thickness, and maximum cumulative degree-days below freezing. | 2.4.7 |
| 2.4-9 | A COL applicant that references the U.S. EPR design certification will provide site-specific information and describe the design basis for cooling water canals and reservoirs used for makeup to the UHS cooling tower basins. | 2.4.8 |
| 2.4-10 | A COL applicant that references the U.S. EPR design certification will provide site-specific information and demonstrate that in the event of diversion or rerouting of the source of cooling water, alternate water supplies will be available to safety-related | 2.4.9 |

| Item No. | Description | FSAR Tier 2 Section |
|---|---|---|
| | equipment. | |
| 2.4-11 | A COL applicant that references the U.S. EPR design certification will use site-specific information to compare the location and elevations of safety-related facilities, and of structures and components required for protection of safety-related facilities, with the estimated static and dynamic effects of the design basis flood conditions. | 2.4.10 |
| 2.4-12 | A COL applicant that references the U.S. EPR design certification will identify natural events that may reduce or limit the available cooling water supply, and will verify that an adequate water supply exists for operation or shutdown of the plant in normal operation, anticipated operational occurrences, and in low water conditions. | 2.4.11 |
| 2.4-13 | A COL applicant that references the U.S. EPR design certification will provide site-specific information to identify local and regional groundwater reservoirs, subsurface pathways, onsite use, monitoring or safeguard measures, and to establish the effects of groundwater on plant structures. | 2.4.12 |
| 2.4-14 | A COL applicant that references the U.S. EPR design certification will provide site-specific information on the ability of the groundwater and surface water environment to delay, disperse, dilute, or concentrate accidental radioactive liquid effluent releases, regarding the effects that such releases might have on existing and known future uses of groundwater and surface water resources. | 2.4.13 |
| 2.4-15 | A COL applicant that references the U.S. EPR design certification will describe any emergency measures required to implement flood protection in safety-related facilities and to verify there is an adequate water supply for shutdown purposes. | 2.4.14 |
| 2.5-1 | A COL applicant that references the U.S. EPR design certification will use site-specific information to investigate and provide data concerning geological, seismic, geophysical, and geotechnical information. | 2.5.1 |
| 2.5-2 | A COL applicant that references the U.S. EPR design certification will review and investigate site-specific details of seismic, geophysical, geological, and geotechnical information to determine the safe shutdown earthquake (SSE) ground motion for the site and compare site-specific ground motion to the Certified Seismic Design Response Spectra (CSDRS) for the U.S. EPR. | 2.5.2 |
| 2.5-3 | A COL applicant that references the U.S. EPR design certification will compare the final strain-dependent soil profile with the U.S. EPR design soil parameters and verify that the site-specific seismic response is enveloped by the CSDRS and the soil profiles discussed in Sections 2.5.2, 2.5.4.7, and 3.7.1 and summarized in Table 3.7.1-6, Table 2.7.1-8, and Table 3.7.1-9. | 2.5.2.6 |
| 2.5-4 | A COL applicant that references the U.S. EPR design certification will verify that site-specific foundation soils beneath the foundation basemats of Seismic Category I structures have the capacity to support the bearing pressure with a factor of safety of 3.0 under | 2.5.4.10.1 |

| Item No. | Description | FSAR Tier 2 Section |
|---|---|---|
| | static conditions or 2.0 under dynamic conditions, whichever is greater. | |
| 2.5-5 | A COL applicant that references the U.S. EPR design certification will investigate site-specific surface and subsurface geologic, seismic, geophysical, and geotechnical aspects within 25 miles around the site and evaluate any impact to the design. The COL applicant will evaluate the potential for surface deformation at the site in accordance with the requirements of 10 CFR 100.23 and of 10 CFR Part 50, Appendix S. If the potential for surface deformation is present at the site, the COL applicant will evaluate the effects of potential surface deformation on the design and operation of the U.S. EPR. | 2.5.3 |
| 2.5-6 | A COL applicant that references the U.S. EPR design certification will present site-specific information about the properties and stability of soils and rocks that may affect the nuclear power plant facilities under both static and dynamic conditions, including the vibratory ground motions associated with the CSDRS and the site-specific SSE. | 2.5.4 |
| 2.5-7 | A COL applicant that references the U.S. EPR design certification will verify that the tilt settlement value of ½ in per 50 ft in any direction across the foundation basemat of a Seismic Category I structure is not exceeded. Settlement values larger than this may be demonstrated acceptable by performing additional site-specific evaluations. | 2.5.4.10.2 |
| 2.5-8 | A COL applicant that references the U.S. EPR design certification will evaluate site-specific information concerning the stability of earth and rock slopes, both natural and manmade (e.g., cuts, fill, embankments, dams, etc.), of which failure could adversely affect the safety of the plant. | 2.5.5 |
| 2.5-9 | A COL applicant that references the U.S. EPR design certification will reconcile the site-specific soil properties with those used for design of U.S. EPR Seismic Category I structures and foundations described in Section 3.8. | 2.5.4.2 |
| 2.5-10 | A COL applicant that references the U.S. EPR design certification will investigate and determine the uniformity of the soil layer(s) underlying the foundation basemats of Seismic Category I structures. | 2.5.4.10.3 |
| 2.5-11 | Deleted | Deleted |
| 2.5-12 | A COL applicant that references the U.S. EPR design certification will provide an assessment of predicted settlement values across the basemat of Seismic Category I structures during and post construction. The assessment will address both short term (elastic) and long term (heave and consolidation) settlement effects with the site-specific soil parameters, including the soil loading effects from adjacent structures. | 2.5.4.10.2 |
| 2.5-13 | A COL applicant that references the U.S. EPR design certification will perform a site-specific analysis to determine the bearing | 2.5.4.10.1 |

| Item No. | Description | FSAR Tier 2 Section |
|---|---|---|
| | pressure demand and peak displacement of the NAB. The foundation soils beneath the NAB foundation basemat shall have the capacity to support the bearing pressure with a factor of safety of 3.0 under static conditions or 2.0 under combined static and dynamic conditions, whichever is greater. The minimum required separation distance is a factor of two times the calculated absolute sum of the maximum combined site-specific NAB and U.S. EPR NI design displacements, but not less than 30 inches. | |
| 3.8-11 | A COL applicant that references the U.S. EPR design certification will evaluate and identify the need for the use of waterproofing membranes and epoxy coated rebar based on site-specific groundwater conditions. | 3.8.5.6.1 |
| 9.2-1 | A COL applicant that references the U.S. EPR design certification will provide site specific information for the UHS support systems such as makeup water, blowdown, and chemical treatment (to control biofouling). | 9.2.5.2 |