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2 SITE CHARACTERISTICS

Chapter 2 of this report describes the Nuclear Regulatory Commission (NRC) staff's review of the geography and demography, nearby facilities, and postulated site parameters for the 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.

The staff issued RAI 274, Question 02.00.00-1, and RAI 288, Question 02.00.00-2, to request the applicant to use the terms "site characteristics" and "site parameters," in FSAR Tier 2, Section 2.0, in accordance with the definitions provided in Title 10 of the *Code of Federal Regulations* (CFR) Part 52, Paragraph 52.1(a). **RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2, which are associated with the above request, are being tracked as open items**.

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) referencing 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), 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 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, however, does not clearly distinguish between site characteristics and postulated site parameters. The staff issued RAI 274, Question 02.00.00-1 and RAI 288, Question 02.00.00-2 to request the applicant to 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, which are associated with the above request, are being tracked as open items**.

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 requests for additional information (RAIs).

The applicant has 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, Section 52.47(a)(1)(iii).

2.0.1 Summary of Application

A COL applicant that references the U.S. EPR Design Certification (DC) 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:

1. 10 CFR 52.47(a)(1) as it relates to providing the postulated site parameters for 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 present a safety analysis of the structures, systems, and components (SSCs) and of the facility as a whole.

The related acceptance criteria are:

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 Section 2.0 of the SRP. 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), except for the open items listed throughout Chapter 2 of this report.

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. 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*

Section 2.1 of the FSAR 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:

1. 10 CFR Part 50 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 (2)(iv), and 10 CFR 52.79(a)(1)(vi)).

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); (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.

The related acceptance criteria are:

3. 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.

4. 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) 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 and 10 CFR Part 100.

2.1.1.3 *Technical Evaluation*

The applicant stated in COL Information Item 2.1-1 in FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items," 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 as it is site-specific.

2.1.1.4 *Conclusions*

As set forth above, the applicant has stated in COL Information Item 2.1-1 in FSAR Tier 2, Table 1.8-2, that the COL applicant will provide the site-specific information. Since this information is site-specific, 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 is considered acceptable. For the reasons given above, the staff concludes, as this information is site-specific, 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 excluding or removing personnel and property in the event of an emergency; (3) establishment 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 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.

The related acceptance criteria are:

1. Establishment of Authority: The information submitted by the applicant is adequate and meets the requirements of 10 CFR 50.33, 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 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, 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, 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 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 (χ/Q values) discussed in Section 2.3 and Chapter 15 of this report.

The applicant stated in COL Information Item 2.1-1 in FSAR Tier 2, Table 1.8-2, 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 they do not result in a significant hazard to public health and safety.

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

2.1.2.4 *Conclusions*

As set forth above, the applicant has stated in COL Information Item 2.1-1 in FSAR Tier 2, Table 1.8-2, that the COL applicant will provide the site-specific information. Since this information is site-specific, 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 is considered acceptable. For the reasons given above, the staff concludes, as this information is site-specific, 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 Position C.4 of

Regulatory Guide (RG) 4.7, “General Site Suitability Criteria for Nuclear Power Stations,” 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 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:

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, 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 and 10 CFR 100.21, 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.

The related acceptance criteria are:

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 Section 2.1.3 of RG 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants,” 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; (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 (LPZ): 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 Regulatory Position C.4 of RG 4.7 “General Site Suitability Criteria for Nuclear Power Stations,” the applicant must give special attention to the consideration of alternative sites with lower population densities.

2.1.3.3 *Technical Evaluation*

The applicant stated in COL Information Item 2.1-1 in FSAR Tier 2, Table 1.8-2, that a COL applicant referencing 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 2.1.3 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 (20 miles)

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

2.1.3.4 *Conclusions*

As set forth above, the applicant has stated in COL Information Item 2.1-1 in FSAR Tier 2, Table 1.8-2, that the COL applicant will provide the site-specific information. Since this information is site-specific, 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 is considered acceptable. For the reasons given above, the staff concludes, as this information is site-specific, 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 COL Information Item 2.2-1 in FSAR Tier 2, Table 1.8-2. 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:

1. 10 CFR 100.20(b), which requires that the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, 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.

2. 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.

The related acceptance criteria are:

1. Data in the FSAR adequately describe the locations and distances from the plant of nearby industrial, military, and transportation facilities and that such 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 Subsection III of Section 2.2.1-2.2.2 of NUREG-0800.

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*

The applicant stated in COL Information Item 2.2-1 in FSAR Tier 2, Table 1.8-2, 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 2.2.1-2.2.2 which typically involves reviewing:

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

- the nature and extent of activities conducted at the site and in its vicinity, including the products and materials likely to be processed, stored, used, or transported, in order to identify possible hazards

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

The DC application does not contain this type of information as it is site-specific

2.2.2.4 *Conclusions*

As set forth above, the applicant has stated in COL Information Item 2.2-1 in FSAR Tier 2, Table 1.8-2, that the COL applicant will provide the site-specific information. Since this information is site-specific, the applicant's statement provided in the FSAR that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.2.1-2.2.2 is considered acceptable. For the reasons given above, the staff concludes, as this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at of 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 on site and in the vicinity of the proposed site to confirm that appropriate data and analytical models have been used. The 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:

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 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.

The related acceptance criteria are:

1. Event Probability: The identification of design-basis events (DBE) 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, 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, 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*

The applicant stated in COL Information Item 2.2-2 in FSAR Tier 2, Table 1.8-2, 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 DC application does not contain this type of information as it is site-specific

2.2.3.4 *Conclusions*

As set forth above, the applicant has stated in COL Information Item 2.2-2 in FSAR Tier 2, Table 1.8-2, that the COL applicant will provide the site-specific information. Since this information is site-specific, 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 is considered acceptable. For the reasons given above, the staff concludes, as this information is site-specific, it will be addressed by the COL applicant and, therefore would be reviewed at the time of 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 DC applicant must provide site parameters postulated for the design. According to 10 CFR 52.1(a), site parameters are the postulated physical, environmental, and demographic features of an assumed site specified in a standard DC. As stated in 10 CFR 52.79(c)(1), if a COL application references an approved standard design, the COL 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 the NRC's 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 has 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 Revision 0 to the FSAR, and responses to staff RAIs.

2.3.1 Regional Climatology

2.3.1.1 *Summary of Application*

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 include climatic site parameters related to winter precipitation (for roof loading), maximum wind speed (other than tornado), tornado, temperature, and ultimate heat sink (UHS) meteorological conditions.

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

- Item 2.0-1: A COL applicant that references the U.S. EPR design certification will compare site-specific data to the design parameter data in FSAR Tier 2, Table 2.1-1. If the specific data for the site falls within the assumed design parameter data and characteristics in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific design parameter data or characteristics that are outside the bounds of the assumptions presented in FSAR Tier 2, Table 2.1-1, the COL applicant will confirm that the U.S. EPR design acceptably meets any additional requirements that may be imposed by the more limiting site-specific design parameter data or characteristic, and that the design maintains conformance to the design commitments and acceptance criteria described in this FSAR.

- 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 design 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.

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

- Item 2.3-10: A COL applicant that references the U.S. EPR design certification will 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”].

- Item 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 UHS makeup, including the potential for frazil and anchor ice, maximum ice thickness, and maximum cumulative degree-days below freezing.

- Item 3.3-1: A COL applicant that references the U.S. EPR design certification will determine site-specific wind and tornado design parameters and compare these to the standard plant criteria. If the site-specific wind and tornado parameters are not bounded, then the COL applicant will evaluate the design for site-specific wind and tornado events and demonstrate that these loadings will not adversely affect the ability of safety-related structures to perform their safety functions during or after such events.

- Item 9.2-1: A COL applicant that references the U.S. EPR design certification will provide site-specific information for the UHS make up.

FSAR Tier 2, Section 2.3.1, and COL Information Item 2.3-2 in FSAR Tier 2, Table 1.8-2, states that a COL applicant referencing the U.S. EPR design certification is expected to provide site-specific characteristics for regional climatology.

The application provides the following information concerning winter precipitation, maximum wind speed (other than tornado), tornado, temperature, and UHS meteorological conditions site parameters.

1. Winter Precipitation (for Roof Loading)

   The winter precipitation site parameters presented here differ from those presented in Revision 0 to the U.S. EPR FSAR. The site parameters presented here are based on AREVA’s response to RAI 93, Question 02.03.01-12 and should appear in Revision 1 of the U.S. EPR FSAR. The site parameters will be verified in the final version of the FSAR. **This is confirmatory item 02.03.01-12**.

   The site parameters 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, are as follows:

   - Normal ground precipitation load is 4.8 kilo-newtons per square meter or kilo-Pascals (kN/m2 or kPa) [100 pounds per square foot (lb/ft2)] [100-year mean return interval (MRI)]

   - Normal roof precipitation load is 3.35 kPa (70 lb/ft2) (100-year MRI)

   - 48-hour probable maximum winter precipitation (PMWP) liquid roof load is 0 kPa (0 lb/ft2)

   - 48-hour PMWP frozen ground load is 2.06 kPa (43 lb/ft2) (based on 1.4 meters [55 inches] of snow)

   - 48-hour PMWP frozen roof load is 1.44 kPa (30 lb/ft2)

   - Extreme roof winter precipitation load is 4.8 kPa (100 lb/ft2) (100-year MRI)

Footnote 1 to FSAR Tier 1, Table 5.0-1 and Footnote 1 to FSAR Tier 2, Table 2.1-1 states that the maximum 48-hour PMWP liquid site parameter value is 0.81 meters (32 inches) (liquid water) based on data from the National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Report (HMR) No. 53, "Seasonal Variation of 10-square-mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," for the three winter months, December through February. However, the applicant states the effect of rainfall 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)

   The site parameter for maximum wind speed (other than tornado), 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 meters (33 feet) 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 site parameter 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 tornado wind speed is 103 meters per second (m/s) (230 mph)
   - The maximum rotational speed is 82 m/s (184 mph)
   - The maximum tornado pressure drop is 83 millibars (mb) [1.2 pounds per square inch (lb/in2)] at a rate of 34.5 mb per second (0.5 lb/in2 per second)
   - The radius of maximum rotational speed is 45.7 meters (150 feet)

   FSAR Tier 2, Table 2.1-1 provides the following additional tornado site parameter:

   - The maximum translational speed is 21 m/s (46 mph)

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

4. Temperature

The site parameters for 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 temperature is 46.1 °C (115 °F) dry bulb and 26.7 °C (80 °F) wet bulb coincident
- The Zero percent exceedance minimum ambient temperature is -40 °C (-40 °F)
- The One percent exceedance maximum ambient temperature is 37.8 °C (100 °F) dry bulb and 25 °C (77 °F) wet bulb, coincident
- The One percent exceedance minimum ambient temperature is -23.3 °C (-10 °F)

FSAR Tier 2, Table 2.1-1 provides the following additional temperature site parameters:

- The Zero percent exceedance maximum wet bulb (non-coincident) temperature is 27.2 °C (81 °F)
- The One percent exceedance maximum wet bulb (non-coincident) temperature is 26.7 °C (80 °F)

FSAR Tier 2, Table 2.1-1 states the non-coincident wet bulb temperatures listed above are used only for UHS design.

FSAR Tier 2, Section 2.3.1.1 states the dry bulb and wet bulb temperatures were based on the Electric Power Research Institute (EPRI) Advanced Light Water Reactor (ALWR) Utility Requirements Document (URD) and available Early Site Permit (ESP) applications.

5. UHS Meteorological Conditions

FSAR Tier 2, Section 9.2.5 describes the 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 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 2.3-10 in FSAR Tier 2, Table 1.8-2). The applicant also states the UHS tower basin contains a minimum 72-hour supply of water.

FSAR Tier 2, Table 2.1-1 states: (1) the conditions resulting in maximum evaporation and drift loss of water from the UHS are presented in FSAR Tier 2, Table 2.1-3, “Design Values for Maximum Evaporation and Drift Loss of Water from the UHS”; (2) the conditions resulting in minimum water cooling in the UHS are presented in FSAR Tier 2, Table 2.1-4, “Design Values for Minimum Water Cooling in the UHS”; and (3) the potential for water freezing in the UHS water storage facility is presented in FSAR Tier 2, Sections 2.4.7 and 9.2.5. FSAR Tier 2, Table 2.1-3 provides 72 hours of wet bulb and concurrent dry bulb temperature data for use as design values for maximum evaporation and drift loss of water from the UHS. FSAR Tier 2, Section 2.3.1.2 states the UHS cooling tower basin is designed considering the air temperature data of FSAR Tier 2, Table 2.1-1 and maintains its cooling function for the Table 2.1-3 meteorological conditions. The footnote to FSAR Tier 2, Table 2.1-3 states

that only 72 hours of temperature data are provided, because the site-specific makeup water system will provide sufficient flow rates of makeup water to compensate for system volume losses for the remaining 27 days of the 30-day period. This is COL Information Item 2.3-10 in FSAR Tier 2, Table 1.8-2.

FSAR Tier 2, Table 2.1-4 provides 24 hours of wet bulb and concurrent dry bulb temperature data for use as design values for minimum water cooling in the UHS. FSAR Tier 2, Section 2.3.1.2 states the meteorological conditions presented in FSAR Tier 2, Table 2.1-4 reflect a one-day period during which evaporative cooling is at a minimum. The applicant further states the UHS heat loads peak and decline within the first day, such that extending the one-day meteorological profile for five 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 2.1-1.

FSAR Tier 2, Section 2.4.7 states the water temperature in each of the four UHS cooling tower basins is monitored. In the event that basin water temperature drops to 4.4 °C (40 °F), an alarm alerts the operator to place the associated train in operation to prevent the formation of ice in the basin. A COL applicant referencing the U.S. EPR design certification will need to evaluate the possibility 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. This is COL Information Item 2.4-8 in FSAR Tier 2, Table 1.8-2.

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 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 DC applicant postulated for the design

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

1. The weight of the 100-year return period snowpack and the weight of the 48-hour 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 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

Section 2.3.1 of the SRP also states that the postulated site parameters should be representative of a reasonable number of sites that may be considered 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 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 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), (ADAMS Accession No. ML091490565).

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 1.27 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*

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 does not distinguish between site parameters and site characteristics as defined in 10 CFR 52.1(a). Further, COL Information Item 2.3-1 does not clearly describe how the actual site characteristics will be compared to the postulated design parameters set forth in the FSAR. **RAI 288, Question 02.03.01-16, which is associated with the above request, is 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.)

Pursuant to SRP Section 2.3.1, the staff verifies 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, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 presented 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 its response to RAI 93, Question 02.03.01-12 dated December 08, 2008, the applicant stated 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 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 it reviewed a map of ground snow loads for the contiguous United States 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 United States.

   In order to further determine 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 United States as reported in Table C7-1 of ASCE/SEI 7-05. The staff found 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 meters (32 inches) 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 meters (55 inches) of snow. The applicant also identified the 48-hour PMWP frozen event of 1.4 meters (55 inches) 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 HMRs published by NOAA's Hydrometeorological Design Studies Center. The applicant stated that the 48-hour liquid PMWP event of 0.81 meters (32 inches) of liquid water was obtained from HMR No. 53 for the three climatological winter months 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. The applicant, therefore, 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 two-day snowfall event and (2) the historical maximum two-day snowfall event in the site region. The applicant stated the 48-hour frozen PMWP event of 1.4 meters (55 inches) of snow was determined from a review of NOAA data for the maximum two-day snowfall for all available stations in the lower 48 states and Alaska. In order 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 meters [55 inches] of snow) bounds a reasonable number of sites that may be considered within a COL application, the staff compared the 1.4 meters (55 inches) of snow value against the two-day record snowfall events at over 9000 NWS locations throughout the contiguous United States as reported by the National Climatic Data Center's (NCDC) Snow Climatology website (http://www.ncdc.noaa.gov/ussc/index.jsp, accessed on October 20, 2008). The staff found that less than one percent had maximum observed two-day record snowfall events exceeding 1.4 meters (55 inches). Note that the 48-hour PMWP frozen event of 1.4 meters (55 inches) 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.

For the reasons cited above, the staff considers RAI 93, Question 02.03.01-12 to be resolved. However, the staff has requested that the applicant change the description of some of the winter precipitation site parameters to be 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 in order to be consistent with the terminology presented in ISG-7. For example, the staff has asked the applicant to:

- 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, which is associated with the above requests, is being tracked as an open item. 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)

   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.

   Figure 6-1 of ASCE/SEI 7-05 shows contours of the 50-year return period 3-second wind gust for the continental United States. Based on ASCE/SEI 7-05, the applicant's extreme wind site parameter of 145 mi/h has the potential to be exceeded in a small portion of the coastal South and Southeast United States. 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 Table 6-1 of ASCE/SEI 7-05.

   FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, 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 two-minute period (http://www.weather.gov/glossary/index.php?letter=s, accessed on April 20, 2009). In its response to RAI 10, Question 02.03.01-02 dated May 16, 2008, the applicant agreed to revise the title of this parameter to "Maximum Speed (Other than Tornado)." **Question 02.03.01-02 is being tracked as a confirmatory item**.

3. Tornado

   The tornado site parameters proposed by the applicant (e.g., maximum wind speed, maximum rotational speed, translational velocity, radius of maximum rotational speed, maximum pressure differential, and rate of pressure change) 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.

   Region I of RG 1.76 represents the central and most of the southeastern portion of the United States 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. Temperature

The ambient temperature site parameters proposed by the applicant were based on the EPRI ALWR URD and available ESP applications. Consequently, the staff finds that the applicant has provided a basis for the ambient 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 air temperature site parameters presented in FSAR Tier 2, Table 2.1-1. In particular, the staff requested that the applicant:

- Indicate in FSAR Tier 2, Table 2.1-1 whether the maximum and minimum one percent air temperature site parameters represent annual or seasonal one percent exceedances.

- Indicate in FSAR Tier 2, Table 2.1-1 whether the maximum zero percent and one percent exceedance coincident wet bulb temperatures represent mean or maximum values.

- Indicate in FSAR Tier 2, Table 2.1-1 that the definition of zero percent exceedance excludes peaks of temperatures less than two hours in duration (per the response to RAI 10, Question 02.03.01-7).

- Revise FSAR Tier 2, Section 2.3.1.1 to state that the zero percent exceedance air temperature values in Table 2.1-1 are based on conservative estimates of 100-year return period values and historic extreme values, whichever is bounding. GDC 2, "Design Bases for Protection Against Natural Phenomena" states, in part, that the design bases for SSCs important to safety shall reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. In order to confirm that the certified design complies with GDC 2, the ambient design temperature site characteristics should be based on the higher of either historic or 100-year return period values. Temperatures based on a 100-year return period are considered to provide sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated as required by the regulation.

RAI 256, Question 02.03.01-13, which is associated with the above requests, is being tracked as an open item.

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 United States.

The ASHRAE Weather Data Viewer provides a calculated 100-year return period maximum dry bulb temperature for each station. The staff found that only one 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 accepts 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 found 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). The primary areas where the applicant's minimum dry bulb site parameter value was not bounded were the upper Midwest and upper High Plains regions. A COL applicant referencing the U.S. EPR design in these regions, especially in Minnesota, Montana, North Dakota, and Wyoming, may need to consider the possibility of the zero percent minimum dry bulb temperature site parameter value being exceeded for a particular site. Nonetheless, because 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 United States, the staff accepts 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 United States. 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 determined 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 accepts 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 found 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 United States. 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 its supplement 1 response to RAI 37, Question 02.03.01-10 dated November 17, 2008, 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) 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 the design of the UHS cooling towers is representative of the COL application sites referencing the U.S. EPR design.

The staff notes that the applicant's response to RAI 37, Question 02.03.01-10 dated September 08, 2008, 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 United States, 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 notes that it is not clear 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 has requested 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 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 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 set forth 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 not clear 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, which is associated with the above requests, is being tracked as an open item.

One Percent Exceedance Temperatures

The staff cannot evaluate the reasonableness of the values chosen as one percent exceedance ambient temperature site parameters until the applicant indicates whether these site parameters represent annual or seasonal one percent exceedance values in response to RAI 256, Question 02.03.01-13**.**

5. UHS Meteorological Conditions

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, 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 is COL Information Item 9.2-1 in FSAR Tier 2, Table 1.8-2.

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

The staff requested in RAI 37, Question 02.03.01-11 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 its Supplement 1 response to RAI 37, Question 02.03.01-11 dated November 17, 2008, 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.

The staff believes there are several site design parameters listed in FSAR Tier 2, Table 2.1-1 that can be deleted since (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. In particular, the staff has requested 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 not clear 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 three 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. COL Information Item 2.4-8 in FSAR Tier 2, Table 1.8-2 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, which is associated with the above requests, is being tracked as an open item.

2.3.1.4 *Conclusions*

Pending resolution of **open items associated with RAI 256, Questions 02.03.01-13, 02.03.01-14, and 02.03.01-15, and RAI 288, Question 02.03.01-16, as well as confirmatory items associated with Questions 02.03.01-2 and 02.03.01-12**, the staff finds the applicant has selected the 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 they 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 COL Information Item 2.3-2 in FSAR Tier 2, Table 1.8-2. 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*

The applicant specified in FSAR Tier 2, Section 2.3.2 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 kilometers (50 miles) from the plant.

DC 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) 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 2.3.2 and COL Information Item 2.3-3, in FSAR Tier 2, Table 1.8-2, 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 DC 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.

2.3.3 Onsite Meteorological Measurement Program

2.3.3.1 *Summary of Application*

The applicant specified in FSAR Tier 2, Section 2.3.3 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.

DC 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 COL Information Item 2.3-4, in FSAR Tier 2, Table 1.8-2, 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 DC 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.

2.3.4 Short-Term Atmospheric Dispersion Estimates for Accident Releases

2.3.4.1 *Summary of Application*

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) χ/Q values for the EAB and outer boundary of the LPZ. The EAB and LPZ χ/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) χ/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 χ/Q values were used to model the offsite dose consequences for all the design-basis accidents whereas several sets of MCR and TSC χ/Q values representing different release pathways and intake and in-leakage locations were used in estimating potential doses for the MCR and TSC. A list of release pathways assumed for each design-basis accident is provided 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 - 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 - pathway for the unaffected steam generators Closest Safeguard Building Canopy - 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 - primary containment leakage pathway during the 305-second annulus drawdown time, post purge isolation - secondary-side leakage pathway throughout the duration of the accident Base of Main Stack - primary containment leakage pathway before purge isolation at 10 seconds and following the end of drawdown
Fuel Handling Accident	Base of Main Stack - 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 - pathway during the 305-second annulus drawdown time Base of Main Stack - pathway following the end of drawdown

The MCR habitability systems are described in FSAR Tier 2, Sections 6.4 and 9.4. The MCR habitability systems protect both the plant operators in the MCR and TSC personnel from the effects of accidental releases of radioactive and toxic gases. The TSC is contained within the control room envelope (CRE).

The control room air conditioning system (CRACS) has two identical fresh air intake trains which 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 plant toxic gas alarm signal, the outside air intake dampers close automatically and the CRE air is automatically diverted in the recirculation mode without outside air.

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

FSAR Tier 2, Section 2.3.4 states the EAB and LPZ χ/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."

FSAR Tier 2, Section 2.3.4 also states the following:

- A COL applicant that references the U.S. EPR design certification will confirm that the site-specific χ/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 χ/Q values that exceed the bounding χ/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 [52.47(a)(2)(iv)] and the control room operator dose limits

given in GDC 19, "Control Room," using site-specific χ/Q values. This is listed as COL Information Item 2.3-6 in FSAR Tier 2, Table 1.8-2.

- 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. This is listed as COL Information Item 2.3-5 in FSAR Tier 2, Table 1.8-2.

- A COL applicant that references the U.S. EPR design will provide χ/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. This is listed as COL Information Item 2.3-7 in FSAR Tier 2, Table 1.8-2.

COL Information Item 2.0-1, which is presented in FSAR Tier 2, Table 1.8-2, is also related to this section. This COL Information Item states that a COL applicant that references the U.S. EPR design certification will compare site-specific data to the design parameter data in FSAR Tier 2, Table 2.1-1. If the specific data for the site falls within the assumed design parameter data and characteristics in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific design parameter data or characteristics that are outside the bounds of the assumptions presented in FSAR Tier 2, Table 2.1-1, the COL applicant will confirm that the U.S. EPR design acceptably meets any additional requirements that may be imposed by the more limiting site-specific design parameter data or characteristic, and that the design maintains conformance to the design commitments and acceptance criteria described in this FSAR.

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 Commission regulations:

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

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

3. 10 CFR 52.47(a)(1) with respect to the postulated site parameters that a DC applicant shall provide for the design

SRP Section 2.3.4 states that a DC applicant should provide EAB, LPZ, and control room χ/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 χ/Q values (e.g., intake heights, release heights, building cross-sectional areas, distance to receptors).

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

The control room χ/Q values are used to help demonstrate that the control room radiological consequences of accidents meet specified radiation dose 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 (Revision 1 to NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes") is an acceptable methodology for assessing control room χ/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*

The staff reviewed the U.S. EPR FSAR in accordance with the guidance provided in SRP Section 2.3.4 by ensuring: (1) the FSAR included EAB, LPZ , and MCR χ/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 χ/Q values; (3) a basis has been provided for each of the EAB, LPZ, and MCR site parameter χ/Q values; and (4) the EAB, LPZ, and MCR site parameter χ/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 χ/Q values used to model the release pathway.

1. Offsite χ/Q Values

   SRP Section 2.3.4 states that the DC applicant should include EAB and LPZ boundary χ/Q values for the appropriate time periods in the list of site parameters. The staff found that the applicant has included the EAB and LPZ χ/Q values as site parameters listed FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1. The staff has determined that the titles of the accident atmospheric dispersion factor (χ/Q) site parameters presented in FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 should not specify EAB and LPZ distances. The distances at which χ/Q values are to be determined by the COL applicants are a function of each COL applicant's EAB and LPZ configuration. The staff has requested that the applicant revise the FSAR accordingly. **RAI 288, Question 02.03.04-9, which is associated with the above request, is being tracked as an open item.**

   FSAR Tier 2, Section 2.3.4 states that the accident χ/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 χ/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 χ/Q values could be considered representative of a reasonable number of potential COL sites.

In its response to RAI 10, Question 02.03.04-1 dated July 02, 2008, the applicant stated the EAB and LPZ χ/Q values were calculated utilizing 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 due to building wake effects. The resulting CCNPP and NMP χ/Q values were then compared to the EPRI ALWR URD χ/Q values, and the bounding (maximum) of these values were selected as site parameters for the FSAR. The applicant found that the EPRI ALWR URD χ/Q values were bounding. However, because the EPRI ALWR URD does not present a 0-2 hr LPZ χ/Q value, the applicant also chose the CCNPP 0-2 hr LPZ χ/Q value as a site parameter value.

In order to determine whether the U.S. EPR EAB and LPZ site parameter χ/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 χ/Q site parameters to the EAB and LPZ χ/Q site characteristics identified in the first four docketed ESP applications (i.e., North Anna, Grand Gulf, Clinton, and Vogtle). The EAB and LPZ χ/Q values presented in these ESP applications were developed in accordance with current regulatory guidance. The U.S. EPR site parameter χ/Q values bound the ESP site characteristic χ/Q values if the U.S. EPR χ/Q values are higher than the ESP χ/Q values. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing the U.S. EPR site parameter χ/Q values with the ESP site characteristic χ/Q values, the ESP sites are acceptable for the U.S. EPR design if the ESP χ/Q values are smaller than the U.S. EPR χ/Q values. Such a comparison shows that the ESP sites have better dispersion characteristics than that specified in the U.S. EPR postulated site parameters. Accordingly, the staff finds that the U.S. EPR EAB and LPZ χ/Q values bound all four ESP sites.

Consequently, the staff finds that the applicant has provided EAB and LPZ site parameter χ/Q values that should bound a reasonable number of sites that may be considered within a COL application and are therefore acceptable. Therefore, the staff considers RAI 10, Question 02.03.04-1 to be resolved.

COL Information Item 2.3-7, in FSAR Tier 2, Table 1.8-2, is not needed either in the design certification or the FSAR for the COL and, therefore, is not an appropriate COL item.

2. Onsite χ/Q Values

The FSAR listed the MCR and TSC χ/Q values in FSAR Tier 2, Table 2.3-1 (main air supply) and Table 2.3-2 (unfiltered inleakage). The staff issued RAI 10, Question 02.03.04-3 asking the applicant to consider including the MCR and TSC χ/Q values as site parameters in either FSAR Tier 1 Table 5.0-1 or FSAR Tier 2 Table 2.1-1. In its response to RAI 10, Question 02.03.04-3 dated July 02, 2008, the applicant stated that because Table 1 of Appendix A to SRP Section 2.0 did not list MCR and TSC χ/Q values as examples of site parameters, the applicant declined changing the FSAR. The staff subsequently issued RAI 37, Question 02.03.04-5 stating that SRP Section 2.3.4 specifically states that a DC applicant should include EAB, LPZ, and control room atmospheric dispersion factors for the appropriate time periods in the list of site parameters. In its response to RAI 37, Question 02.03.04-5 dated September 08, 2008, the applicant agreed to relocate the MCR and TSC χ/Q values from FSAR Tier 2, Tables 2.3-1 and 2.3-2 to FSAR Tier 2, Table 2.1-1. **Question 02.03.04-5 is being tracked as a confirmatory item**.

The staff issued RAI 10, Question 02.03.04-4, which 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 χ/Q values (e.g., intake heights, release heights, building cross-sectional areas, and distances to receptors) and requested that the applicant include the necessary input assumptions for the ARCON96 atmospheric dispersion model in FSAR Tier 2, Section 2.3.4.

The applicant provided a table containing input parameters for generating control room χ/Q values in its response to RAI 10, Question 02.03.04-4 dated July 02, 2008 which it plans to incorporate into FSAR Tier 2, Section 2.3.4 in a future revision to the FSAR. In reviewing the table incorporated in this response, 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 Appendix A to RG 1.194 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, which is associated with the above request, is being tracked as an open item**.

The applicant's response to RAI 10, Question 02.03.04-4 provided a table that listed input values for the ARCON96 atmospheric dispersion model for use in generating MCR/TSC intake χ/Q values. The staff requested that the applicant should also provide a similar table for FSAR Tier 2, Section 2.3.4 which lists ARCON96 input values for generating MCR/TSC unfiltered inleakage χ/Q values. **RAI 256, Question 02.03.04-8, which is associated with the above request, is being tracked as an open item**.

The staff requested in RAI 10, Question 02.03.04-2 that the applicant provide the technical basis for the MCR/TSC χ/Q values to be presented as site parameters in FSAR Tier 2, Table 2.1-1. In its response to RAI 10, Question 02.03.04-2 dated July 02, 2008, the applicant stated that the site parameter χ/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.

In order to confirm that the U.S. EPR MCR/TSC χ/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 intends to generate a subset of site-specific MCR/TSC χ/Q values using hourly meteorological data provided in support of the four docketed ESP applications (North Anna, Clinton, Grand Gulf, and Vogtle). However, the staff cannot perform this analysis until the ARCON96 model inputs requested by RAI 256, Questions 02.03.04-7 and 02.03.04-8 are provided; thus, **RAI 256, Questions 02.03.04-7 and 02.03.04-8 are being tracked as open items**. Consequently, RAI 10 Question 02.03.04-2 remains unresolved and is designated as **confirmatory item 02.03.04-2.**

2.3.4.4 *Conclusions*

Pending resolution of **open items associated with RAI 256, Questions 02.03.04-7 and 02.03.04-8, and RAI 288, Question 02.03.04-9, as well as confirmatory items associated with Questions 02.03.04-5 and 02.03.04-2**, the applicant has 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 they 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.

2.3.5 Long-Term Dispersion Estimates for Routine Releases

2.3.5.1 *Summary of Application*

The list of U.S. EPR site parameters presented in FSAR Tier 2, Table 2.1-1 includes a maximum annual average (long-term) atmospheric dispersion factor (χ/Q value) of 4.973E-06 seconds per meter cubed (s/m^3) at 0.8 kilometers (0.5 miles). The applicant used this site parameter to calculate: (1) annual average site boundary airborne concentrations to demonstrate compliance with Subpart D to 10 CFR Part 20, and (2) doses to the maximally exposed individual (MEI) from routine airborne releases to demonstrate compliance with Appendix I to 10 CFR Part 50. 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 plant stack at an elevation of 64.3 meters (211 feet) above grade and approximately 30.5 meters (100 feet) above the top of the adjacent Fuel Building roof and 2.1 meters (7 feet) above the top of the Reactor Building. The FSAR further states the inner diameter of the plant stack at the point of release is 3.81 meters (12.5 feet) 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.

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. 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." This is listed as COL Information Item 2.3-8 in FSAR Tier 2, Table 1.8-2. FSAR Tier 2, Section 2.3.5 further states that if a reactor site has an annual average χ/Q value that exceeds the reference value, then a site-specific evaluation will be performed.

FSAR Tier 2, Section 2.3.5 also states a COL applicant that references the U.S. EPR design certification will also provide estimates of annual average atmospheric dispersion (χ/Q values) and deposition (D/Q values) for 16 radial sectors to a distance of 80 kilometers (50 miles) from the plant as part of its environmental assessment. This is also COL Information Item 2.3-9 in FSAR Tier 2, Table 1.8-2.

COL Information Item 2.0-1, which is presented in FSAR Tier 2, Table 1.8-2, is also related to this section. This COL Information Item states that a COL applicant that references the U.S. EPR design certification will compare site-specific data to the design parameter data in FSAR Tier 2, Table 2.1-1. If the specific data for the site falls within the assumed design parameter data and characteristics in FSAR Tier 2, Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific design parameter data or characteristics that are outside the bounds of the assumptions presented in FSAR Tier 2, Table 2.1-1, the COL applicant will confirm that the U.S. EPR design acceptably meets any additional requirements that may be imposed by the more limiting site-specific design parameter data or characteristic, and that the design maintains conformance to the design commitments and acceptance criteria described in this FSAR.

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, with respect 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 and Sections II.B, II.C and II.D of Appendix I of 10 CFR Part 50 with respect 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

Appendix A of Section 2.0 of the SRP states that the DC applicant should include the maximum long-term (routine release or annual average) site boundary atmospheric dispersion factors (χ/Q values) and deposition factors (D/Q values) in the list of site parameters. SRP Section 2.3.5 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 Subpart D of 10 CFR Part 20 and Appendix I to 10 CFR Part 50. 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*

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 χ/Q and D/Q values in the list of site parameters; (2) a basis has been provided for the annual average site parameter χ/Q and D/Q values; and (3) the annual average site parameter χ/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 (χ/Q) value of 4.973E-06 s/m^3 as a site parameter. This χ/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 per meter squared (m^{-2}) is also listed in FSAR Tier 2, Table 11.3-4 as an input to the GASPAR II computer code. The staff requested in RAI 10, Question 02.03.05-4 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 response to RAI 10, Question 02.03.05-4 dated July 02, 2008, 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. However, Table 1 in Appendix A to SRP Section 2.0 lists routine release D/Q values at the site boundary as an example of a site parameter that should be listed in a DC, therefore, the staff has 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, which is associated with the above request, is being tracked as an open item**.

The staff has determined that the title of the maximum annual average χ/Q site parameter presented in FSAR Tier 2, Table 2.1-1 should not specify a distance. The distances at which χ/Q values are to be determined by the COL applicants are a function of each COL applicant's site configuration. The staff has requested that the applicant revise the FSAR accordingly. **RAI 288, Question 02.03.05-8, which is associated with the above request, is being tracked as an open item.**

In RAI 10, Question 02.03.05-1, the staff requested the applicant provide a technical basis for the maximum annual average χ/Q value of 4.973E-06 s/m^3 presented in FSAR Tier 2, Table 2.1-1. In its response to RAI 10, Question 02.03.05-1 dated July 02, 2008, the applicant stated this χ/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 Revision 4 to CCNPP Unit 3 COL FSAR Tables 2.3-119 and 2.3-127 (which present routine release χ/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 χ/Q and D/Q values which approximated the highest χ/Q and D/Q values shown in these tables (0.5 miles downwind in the NE sector). U.S. EPR 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. The staff, therefore, concludes that the applicant has provided a technical basis for the chosen annual average χ/Q and D/Q site parameter values and, therefore, considers RAI 10, Question 02.03.05-1 to be resolved.

To determine whether the U.S. EPR annual average χ/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 χ/Q and D/Q site parameters to the annual average site boundary (EAB) χ/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.

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

Document	Annual Average Site Boundary χ/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 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 χ/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 χ/Q and D/Q values bound the ESP site characteristic χ/Q and D/Q values when the U.S. EPR χ/Q and D/Q values are higher than the ESP χ/Q and D/Q values. Smaller χ/Q and D/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing the U.S. EPR site parameter χ/Q and D/Q values with the ESP site characteristic χ/Q and D/Q values, the ESP sites are acceptable for the design if the ESP site characteristic χ/Q and D/Q values are smaller than the U.S. EPR site parameter χ/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 χ/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 χ/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 χ/Q and D/Q values would bound all four ESP sites. Therefore, the staff concludes that the U.S. EPR annual average χ/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 has noticed that the legend in FSAR Tier 2, Figure 1.2-3 (Plant Configuration) defines location “UKH” as the vent stack. The staff has subsequently 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 meters [211 feet] 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 meters [105.3 feet] per Table 2.3-3 provided in the response to RAI Question 10, 02.03.04-4 dated July 02, 2008).

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

RAI 256, Question 02.03.05-7, which is associated with the above requests, is being tracked as an open item.

2.3.5.4 *Conclusions*

Pending resolution of **open items associated with RAI 256, Questions 02.03.05-6 and 02.03.05-7, and RAI 288, Question 02.03.05-8**, 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.

2.4 Hydrologic Engineering

In this section, the applicant provides 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 found 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 DC 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 meter (3.3 ft) below finished grade
- Maximum flood (or tsunami) level of 0.3 meters (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:

- 2.0, “Site Characteristics and Site Parameters.”
- 2.4.1, “Hydrologic Description.”
- 2.4.2, “Floods.”
- 2.4.3, “ Probable Maximum Flood (PMF) on Streams and Rivers”
- 2.4.4, “Potential Dam Failures”
- 2.4.5, “Probable Maximum Surge and Seiche Flooding”
- 2.4.6, “Probable Maximum Tsunami Hazards”
- 2.4.7, “Ice Effects”
- 2.4.8, “Cooling Water Canals and Reservoirs”
- 2.4.9, “Channel Diversions”
- 2.4.10, “Flooding Protection Requirements”
- 2.4.11, “Low Water Considerations”
- 2.4.12, “Groundwater”
- 2.4.13, “Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters”
- 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 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 DC, are met. These requirements are discussed below:

1. 10 CFR 20.1406 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 control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.

5. 10 CFR 52.47(a)(1) states that an application for DC 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 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 2.4.2. Accordingly, the staff believes this maximum rainfall rate to be reasonable.

The applicant identified a value of one meter below finished grade for the maximum groundwater level and a value of 0.3 meters 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. As such, the staff finds these values to be reasonable.

The staff noticed 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, it was stated that the maximum rainfall rate parameters were being used for roof design, while FSAR Tier 2, Table 2.1-1 did not mention roof design. In RAI 13, Question 02.04.00-1, the staff asked the applicant to explain this difference. In a response dated June 20, 2008, 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 to be acceptable. Additionally, the staff has confirmed that Revision 1 of 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, the staff considers RAI 13, Question 02.04.00-1 resolved.

2.4.0.4 Conclusions

The applicant stated in COL Information Items 2.4-1 thru 2.4.-15 in FSAR Tier 2, Table 1.8-2, that a COL applicant referencing U.S. EPR design certification will address the site-specific information pertaining to the hydrologic information of the plant site. Having provided the postulated site parameters as standard plant design bases and identified the responsibility of

the COL applicant, the hydrologic description found in this section is considered adequate and, for the reasons discussed above, meets the hydrologic requirements of 10 CFR Part 20, 10 CFR Part 50, and 10 CFR Part 52.

2.4.1.0 Hydrologic Description

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.2.0 Floods

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.3.0 Probable Maximum Flood (PMF) on Streams and Rivers

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

See section 2.4.0 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 asked the applicant to justify the exclusion of non-seismic induced dam failures. In a response dated June 20, 2008, the applicant modified the restrictive language in the application such that all potential dam failure mechanisms (seismic/non-seismic) would need to be addressed by the COL applicant. The staff finds this response to be acceptable and the staff has 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 applicant has properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.4, and has stated in COL Information Item 2.4-4 in FSAR Tier 2, Table 1.8-2, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.5.0 Probable Maximum Surge and Seiche Flooding

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.6.0 Probable Maximum Tsunami (PMT) Flooding

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 asked the applicant to clarify the COL applicant's responsibilities in this area. In a response dated June 20, 2008, 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 to be acceptable and the staff has 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 applicant has properly identified the responsibility of the COL applicant in FSAR Tier 2, Section 2.4.6, and has stated in COL Information Item 2.4-6 in FSAR Tier 2, Table 1.8-2, that a COL applicant referencing the U.S. EPR design certification will address the site-specific information.

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.7.0 Ice Effects

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

See section 2.4.0 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. The staff asked the applicant in RAI 13, Question 09.02.05-1 to 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 response dated June 20, 2008, the applicant responded 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 do not encompass worst-case conditions. Because the values of these parameters bound a reasonable number of sites, the staff finds this response to be acceptable and considers the issue to be resolved.

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.9.0 Channel Diversions

The applicant did not clearly state that the COL applicant would address the effects of both upstream and downstream channel diversions. In RAI 13, Question 02.04.09-1, the staff asked the applicant to explain why COL applicants would not consider downstream diversions that could affect water supplies at the site. In a response dated June 20, 2008, the applicant responded by deleting "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 to be acceptable and the staff has confirmed that Revision 1 of FSAR (dated May 29, 2009) Tier 2, Section 2.4.9 and Table 1.8-2, specifically COLA Information Item 2.4-10, was revised as committed in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 13, Question 02.04.09-1 resolved.

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.10.0 Flood Protection Requirements

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.11.0 Low Water Considerations

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.12.0 Groundwater

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.13.0 Pathways of Liquid Effluents in Ground and Surface Waters

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.4.14.0 Technical Specifications and Emergency Operation Requirements

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

See section 2.4.0 for a discussion of the applicant's postulated site parameters.

2.5 Geology, Seismology, and Geotechnical Engineering

In Section 2.5, “Geology, Seismology, and Geotechnical Engineering,” of FSAR Tier 2, the applicant described the geologic, seismic, and geotechnical engineering properties to be considered when 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 applicant to follow. FSAR Tier 2, Section 2.5.3, “Surface Faulting,” describes the information a COL applicant must consider to address the potential for surface tectonic and non-tectonic deformation at its proposed 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.

2.5.1 Basic Geologic and Seismic Information

2.5.1.1 *Summary of Application*

FSAR Tier 2, Section 2.5.1 briefly describes the site-specific geologic, seismic, and geophysical information and site investigations that COL applicants must provide to estimate the potential for damaging earthquake ground motion and surface deformation at the site. In FSAR Tier 2, Section 2.5.1, the applicant also described non-tectonic geologic hazards and conditions caused by human activities.

2.5.1.2 *Regulatory Basis*

The applicable regulatory requirements for reviewing geologic and seismic information are:

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," requires an evaluation of the suitability of a proposed site and the adequacy of the design basis 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. The site-specific ground motion response spectrum (GMRS) satisfies requirements of 10 CFR 100.23 with respect to the development of the SSE.

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

- RG 1.165, “Identification and Characterization of Seismic Sources and Determination of SSE Ground Motion”

- RG 1.208, “A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion”
- 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 4.7, “General Site Suitability Criteria for Nuclear Power Stations”
- RG 1.206, “Combined License Applications for Nuclear Power Plants - LWR Edition”

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 COL Information Item 2.5-1 listed in FSAR Tier 2, Table 1.8-2 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 to enable the COL applicant to satisfy the criteria of 10 CFR Part 50 and 10 CFR 100.23.

2.5.1.4 *Conclusions*

Based on its review of FSAR Tier 2, Section 2.5.1, the staff concludes that the applicant provided description of the necessary geologic and seismic information, site investigations and the applicable regulations and RGs that potential COL applicants must address when submitting a COL application. Although this information is not required for design certification and is entirely site-specific, the COL applicant needs to provide it in order to meet the requirements of GDC 2 and 10 CFR 100.23, therefore, the staff considers this section of FSAR to be 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 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 a COL applicant must provide to determine the GMRS for a site where it seeks to build a U.S. EPR.

The GMRS is defined as the site-specific SSE to distinguish it from the certified seismic design response spectra (CSDRS), used as the design ground motion for the various certified designs.

The applicant stated that the GMRS will be determined 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.

As shown in FSAR Tier 2, Figure 3.7.1-1, the CSDRS for the U.S. EPR is anchored at a 0.3 g peak ground acceleration design ground motion. The applicant used 10 generic soil profiles in U.S. EPR design soil structure interaction (SSI) analyses, divided the soil profiles into three different site groups: soft site, medium site, and hard site, and developed three corresponding CSDRSs (details were provided in FSAR Tier 2, Section 3.7.1.3). The applicant 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 10 generic soil profiles. COL Information Item 2.5-3 in FSAR Tier 2, Table 1.8-2 also described this requirement.

Section 2.5.2.6 of the FSAR Tier 2 presents evaluation guidelines for developing the site-specific GMRS and developing the foundation input response spectrum (FIRS), which is the site-specific GMRS at the foundation level. Specifically, FSAR Tier 2, Section 2.5.2.6 provides the steps necessary to compare the FIRS to the CSDRS. The applicant stated that if the FIRS exceed the CSDRS, then the COL applicant may need to redesign selected features of the U.S. EPR, which will be identified as departures from the FSAR and will be addressed by the COL applicant.

Site Parameter Interfaces

The FSAR relates the following site parameter interfaces: Site-specific seismic characteristics (COL Information Item 2-4 in FSAR Tier 2, Table 1.8-1), and soil conditions and profiles (COL Information Item 2-5 in FSAR Tier 2, Table 1.8-1). Those site characteristics relate to the CSDRS or SSE acceleration values , as provided in the 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:

1. 10 CFR 100.23, "Geologic and Seismic Siting Criteria,” requires 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. In complying with this regulation, the applicant also needs to meet guidance in RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants;” RG 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion;” and RG 1.208, “A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion.”

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

- RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations”
- RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants”
- RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”

2.5.2.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and the geologic, seismic, geophysical, and geotechnical information requirements to evaluate whether the relevant requirements of GDC 2 and 10 CFR 100.23 were addressed. The information in the application the staff considered included seismic hazard analysis, seismic wave transmission characteristics, GMRS and FIRS determination, and the specific conditions under which detailed site-specific soil-structure interaction (SSI) analyses will be required. This information is provided in FSAR Tier 2, Section 2.5.2, and described in COL Information Item 2.5-2 in FSAR Tier 2, Table 1.8-2.

The staff focused its review on FSAR Tier 2, Section 2.5.2 "Vibratory Ground Motion." In this section, the applicant stated that "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)." In FSAR Tier 2, Section 3.7.1, the applicant provided detailed information on how the CSDRS was determined. It considered potential sites in the Central and Eastern United States (CEUS), past precedent and competitive designs, research and recent studies over the past several decades, and the original design basis for the European EPR design. The applicant also followed the guidelines described in RG 1.60, Rev. 1, with some modification at higher frequencies when determining the CSDRS. The applicant also stated that "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 asked the applicant to clarify whether the soil degradation properties were considered in the site response analyses.

In response to RAI 35, Question 02.05.02-1 dated August 28, 2008, 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. It pointed out that the reconciliation process for a COLA considers site-specific soil properties that are developed from a site response analysis, and comparisons are made to the strain-compatible properties assumed for the FSAR as specified by Guideline 5 in FSAR Tier 2, Section 2.5.2.6. The applicant indicated that the COL applicant may redesign selected features of the U.S. EPR, if necessary. Redesigned features will be identified as departures from to the FSAR and addressed by the COL applicant.

After reviewing the applicant's 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; since (1) the applicant clarified that the generic soil profiles used in the SSI analysis for the U.S. EPR design are strain-compatible, that is, they take the degradation properties into consideration for the soil involved in the analysis; and (2) this section of the U.S. EPR also calls for a COL applicant to determine whether the site-specific soil profile falls within that postulated in the FSAR. If the CSDRS does not envelope the FIRS, then redesign is needed and associated issues have to be addressed by the COL applicant. Accordingly, the staff considers RAI 35, Question 02.05.02-1 resolved.

During the course of its review of FSAR Tier 2, Section 2.5.2.6 "Ground Motion Response Spectrum," the staff noticed that the applicant stated that "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 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 and developed three corresponding CSDRSs, in RAI 35, Question 02.05.02-2, the staff asked the applicant to clarify the criteria for COL applicants to determine

which site group the specific site belongs to, and how the site-specific response spectrum would be enveloped by the CSDRS corresponding to that particular site group. In a response dated August 28, 2008, the applicant responded by stating that the COL applicant will reconcile and compare the FIRS and the site-specific soil profile with the CSDRS and the 10 generic soil profiles used in the U.S. EPR design, as stated in FSAR Tier 2, Section 2.5.2.6 Guidelines 3 and 5. In its response, the applicant also stated that a COL applicant's site is acceptable for a U.S. EPR if its 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 above information clarifies the process by which the COL applicant should verify that the site-specific seismic parameters are 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.

FSAR Tier 2, Section 2.5.2.6 also 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 Section 3.7.2. The specified control points given in these sections, however, are inconsistent. In RAI 35, Question 02.05.02-3, the staff asked the applicant to 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 Section 3.7.2. In its response dated October 07, 2008, the applicant stated that it would revise FSAR Tier 2, Section 3.7.2 of the FSAR to include the U.S. EPR FB in-structure response spectra (ISRS) test and figures for elevation + 3.7 m (+12 ft, 1-2/3 in.) as specified in FSAR Tier 2, Section 2.5.2.6, Guideline Step 8, Item F. This revision makes the SSI analysis control points consistent throughout the FSAR. In addition, the staff confirmed that Revision 1 of FSAR (dated May 29, 2009) Tier 2, Section 3.7.2 was revised as committed in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 35, Question 02.05.02-3 resolved.

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 asked the applicant to specify the figures related to SSE response spectra. In a response dated August 28, 2009, the applicant stated that Figure 3.7.1-1 in FSAR Tier 2 will be added to FSAR Tier 1, Chapter 5, identified as Figure 5.0-1. The applicant also stated that Table 5.0-1 in FSAR Tier 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 finds that the proposed changes adequately identified the figures related to SSE response spectra. The staff confirmed that Revision 1 of FSAR (dated May 29, 2009) Tier 1, Table 5.0-1 was added as committed in the RAI response. Accordingly, the staff finds that the applicant has adequately addressed this issue and, therefore, the staff considers RAI 35, Question 02.05.02-4 resolved.

2.5.2.4 *Conclusions*

As described above, the staff reviewed FSAR Tier 1, Table 5.0-1, FSAR Tier 2, Section 2.5.2, COL Information Items 2.5-2 and 2.5-3 in FSAR Tier 2, Table 1.8-2, and the responses of related RAIs from the applicant. Because the CSDRS for the U.S. EPR was determined by following the guidelines of RG 1.60, Rev. 1, and considered potential sites in the CEUS, the staff concludes that the CSDRS is a reasonable basis for design. In addition, the applicant adequately described the geologic, seismic, geophysical, and geotechnical information and site investigations necessary for COL applicants to develop site-specific GMRS, FIRS, and other specific conditions needed for the detailed site-specific SSI analyses so that the site will meet

the relevant requirements of GDC 2 and 10 CFR 100.23. Therefore, the staff concludes that this section of the FSAR is acceptable.

2.5.3 Surface Faulting

2.5.3.1 *Summary of Application*

FSAR Tier 2, Section 2.5.3 describes the potential for surface faulting postulated as bases for design, and the site-specific geologic and seismic information that a COL applicant must provide to determine the potential for surface deformation at its proposed site. The applicant stated that no surface faulting should be present under the foundation of Seismic Category 1 structures. The applicant stated that the COL applicant will verify that any faults located under safety-related structures are non-capable, and that these faults will not have significant impact on the structural integrity of the safety-related SSCs. The COL Information Item 2.5-5 in FSAR Tier 2, Table 1.8-2 also describes this requirement.

FSAR Tier 2, Table 2.0-1 provides the U.S. EPR site envelope parameters and specifies that the U.S. EPR design assumes no faulting displacement to be present for safety-related SSCs.

2.5.3.2 *Regulatory Basis*

The applicable regulatory requirements for reviewing the applicant's discussion of surface faulting are:

1. 10 CFR Part 50, Appendix A, GDC 2, requires 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 100.23 requires determining the potential for surface tectonic and non-tectonic deformations at and in the region surrounding the site.

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

- RG 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motions"

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

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

- RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations"

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

2.5.3.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and the description necessary to determine the potential for surface deformation provided in FSAR Tier 2, Section 2.5.3 for a COL applicant referencing the U.S. EPR design (COL Information Item 2.5-5 in FSAR Tier 2, Table 1.8-2). The applicant clearly stated that no surface faulting should be present under foundations of Seismic Category 1 structures. Since there are many sites in the U.S. where capable faults are not present, the staff finds that this is a reasonable basis for design. The applicant also provided sufficient information on basic geologic and seismic COL information requirements in this section of the application.

2.5.3.4 *Conclusions*

Based on its review of FSAR Tier 2, Section 2.5.3, as documented above, the staff concludes that the applicant provided an adequate description of no potential for surface faulting postulated as bases for design, and the site-specific geologic information that COL applicants must provide to determine the potential for surface deformation at the site (COL Information Item 2.5-5 in FSAR Tier 2, Table 1.8-2). This information will assure that the potential for surface faulting will be determined in accordance with the requirements of GDC 2 and 10 CFR 100.23. In addition, as described above, the assumption of no surface faulting is an adequate basis for design. Accordingly, the staff considers this section of the FSAR to be 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 found in FSAR Tier 1, Section 5.0, "Site Parameters." Table 5.0-1 in this section specifies seismic and soil related parameters.

FSAR Tier 2 Information

FSAR Tier 2, Section 2.5.4, and COL Information Item 2.5-6 in FSAR Tier 2, Table 1.8-2 describe the site-specific geotechnical and geophysical information and site investigations that COL applicants must provide to determine the properties of all soils and rock which may affect the nuclear power plant facilities under both static and dynamic loading conditions, including the vibratory ground motions associated with the SSE.

FSAR Tier 2, Section 2.5.4.2 specifies an angle of friction of 35 degrees, a coefficient of friction (acting on the foundation basemat and near surface foundations for Seismic Category I structures) of 0.7, a saturated soil density of 2,146 kilograms per cubic meter (kg/m^3) [134 pounds per cubic foot (lb/ft^3)], moist soil density of 2,050 kg/ m^3 (128 lb/ft^3), and dry soil density of 1,762 kg/ m^3 (110 lb/ft^3) for the design of U.S. EPR Seismic Category I structures. FSAR Tier 2, Table 2.1-1 provides the U.S. EPR site design envelope parameters and specifies that the minimum shear wave velocity for the U.S. EPR Design is 304.8 m/s [(1000 feet per second (fps)].

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 0.7, (2) shear strength adequate to provide adequate static and dynamic bearing capacity, (3) elastic and consolidation properties adequate to satisfy the limits on settlement described in FSAR Section 2.5.4.10.2, and (4) dynamic properties (i.e., shear wave velocity and strain-dependent modulus reduction and hysteretic damping properties) adequate to support the Seismic Category I structures of the U.S. EPR under earthquake loading conditions. COL Information Items 2.5-4 and 2.5-7 in FSAR Tier 2, Table 1.8-2 describe the bearing capacity and settlement requirements that the COL applicant must meet.

FSAR Tier 2, Table 2.0-1, 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 minimum bearing capacity is 1,053 kPa [22 kips per square foot (ksf)] in localized areas and 718 kPa (15 ksf) on average across the total area of the bottom of the nuclear island (NI) basemat. In addition, the maximum differential settlement across the basemat is 1.3 cm (½ inch) in 15.2 m (50 ft) in any direction and the maximum ground water is 1.0 m (3.3 ft) below grade.

During excavations and backfill, the U.S. EPR design recommends mudmats 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. This is COL Information Item 3.8-11 in FSAR Tier 2, Table 1.8-2.

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 basement and foundation settlements (COL Information Items 2.5-5, 2.5-6, and 2.5-7 in FSAR Tier 2, Table 1.8-2), and soil conditions and profiles (COL Information Item 2.5-9 in FSAR Tier 2, Table 1.8-2). FSAR Tier 2, Table 2.1-1, "U.S. EPR Site Design Envelope" and FSAR Tier 1, Section 5.0 contain design values or basis for specific soil properties: minimum shear wave velocity, minimum bearing capacity (static), maximum differential settlement and liquefaction potential.

Uniformity and Variability of Foundation Support Media

FSAR Tier 2, Section 2.5.4.10.3 states that the 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 to be 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 referencing the U.S. EPR design is responsible for investigating and determining the uniformity of the underlying layers of site-specific soil conditions beneath the foundation basemats. The applicant further stated that the COL applicant would need to perform a site-specific analysis if the site has a dip angle greater than 20 degrees that was the maximum dip angle assumed in design analysis, or 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 investigations for uniform and non-uniform sites, respectively. COL Information Item 2.5-10 in FSAR Tier 2, Table 1.8-2 describes the need to address site uniformity.

COL Information Item 2.5-9 in FSAR Tier 2, Table 1.8-2 requires that a COL applicant will address the site-specific soil properties, as compared with those used for design of U.S. EPR seismic category I structures and foundations as described in FSAR Tier 2, Section 3.8.

2.5.4.2 *Regulatory Basis*

1. The applicable regulatory requirements for reviewing the applicant's discussion of stability of subsurface materials and foundations are:10 CFR Part 50, Appendix A, GDC 2, requires 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," requires the design of nuclear power plant SSCs important to safety to withstand the effects of earthquakes.

3. 10 CFR Part 100, "Reactor Site Criteria," provides the criteria which guide the evaluation of the suitability of proposed sites for nuclear power and testing reactors.

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 geologic characteristics 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)"

2.5.4.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and the description of the site-specific geotechnical and geophysical information and site investigations provided in FSAR Tier 2, Section 2.5.4. This information is necessary for COL applicants to determine the properties and stability of soils and rocks under both static and dynamic conditions. The staff reviewed this information to ensure that the requirements of GDC 2, Appendix S, to 10 CFR Part 50 and 10 CFR 100.23, are adequately covered in the FSAR.

Since the applicant specified in 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 asked the applicant to clarify the restrictions in regard to soil liquefaction. In its response dated August 28, 2008, 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. Considering that the applicant analyzed the nuclear island and other safety-related structures as founded on the plant grade surface, and structural

embedment was ignored in the SSI analysis, the staff concludes that calling for the COL applicant to address any site-specific liquefaction potential to assure that the design is not founded on liquefiable materials, will meet the requirements of 10 CFR 100.23 (d)(4), which states that liquefaction potential must be evaluated for design of nuclear power plants. Accordingly, the staff concludes the applicant's response to RAI 35, Question 02.05-04-1 is acceptable.

FSAR Tier 2, Section 2.5.4.10.1, states that "the maximum bearing pressure under static loading conditions for the foundation basemat beneath the NI Common Basemat Structures is 1,053 kPa (22,000 lb/ft^2)," and "the maximum bearing pressure under safe shutdown earthquake loads combined with other loads, as described in Section 3.8.5, is 1,197 kPa (25,000 lb/ft^2)." In RAI 35, Question 02.05.04-2, the staff asked the applicant to explain how the maximum dynamic/seismic bearing pressure was determined and to justify the value presented in the FSAR. The staff also asked the applicant to explain why there is no maximum dynamic/seismic bearing pressure related parameter in the FSAR Tier 1 document.

In a response dated October 07, 2008, 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 lb/ft^2), the applicant revised FSAR Tier 1, Table 5.0-1 and FSAR Tier 2, Table 2.1-1 to list the minimum soil dynamic bearing capacity requirement as 1,655 kPa (34,560 lb/ft^2). The staff reviewed the applicant's response and found that, although the applicant provided a revised value for dynamic bearing capacity, the applicant did not provide any detail on the determination of the dynamic bearing capacity analysis. Since the dynamic bearing pressure for the foundation basemat is affected by many factors, such as the analysis model used (2D or 3D), the soil properties and loading condition, more information is needed for the staff to evaluate the adequacy of the dynamic bearing capacity specified in FSAR Tier 2, Section 2.5.4.10. Accordingly, the staff has requested the applicant to provide additional information on the dynamic bearing capacity analyses. **This is RAI 261, Question 02.05.04-4, which is being tracked as an open item**.

The staff noted that COL Information Items 2.5-1 through 2.5-10 listed in FSAR Tier 2, Table 1.8-2 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 asked the applicant to mention the COL Information Items listed in Table 1.8-2 in the corresponding FSAR sections. In a response dated August 28, 2008, the applicant stated that to be consistent with common practice in design certification, Section 1.8 of FSAR Tier 2 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 U.S. EPR FSAR; therefore, there is no need to mention the COL information table in all related FSAR sections. Since FSAR Tier 2, Section 1.8 clearly identifies these COL Information Items and is the appropriate section where a COL applicant will find the COL Information Items needed to be addressed for a site referencing the U.S. EPR design, the staff considers RAI 35, Question 02.05.04-3 resolved.

With respect to the properties and stability of sub-surface material under both static and dynamic conditions, but not discussed in the RAIs above, the postulated parameter values are within typical ranges of values used in engineering practice in the staff's experience. Accordingly, the staff finds that the values are reasonable bases for design.

2.5.4.4 *Conclusions*

Based on its review of the FSAR Tier 1, Table 5.0-1, FSAR Tier 2, Table 1.8-1 and 1.8-2, and FSAR Tier 2, Section 2.5.4, as documented above, the staff finds that the applicant provided adequate descriptions of the site-specific geotechnical and geophysical information and site investigations that COL applicants must provide to determine the properties and stability of all soils and rock, which may affect the safety of nuclear power plant facilities under both static and dynamic conditions including the vibratory ground motions associated with the GMRS. The staff concludes that the site-specific information and site investigations, as well as the design site parameters described in the FSAR are sufficient to ensure that the relevant requirements of GDC 2, 10 CFR Part 50 and Part 100 can be met. For the same reasons, the staff further concludes that the FSAR Tier 2, Section 2.5.4 is acceptable, with the exception of **open item 02.05.04-4**.

As described in Section 2.5.4.3 of this report, the staff has identified **open item 02.05.04-4** relating to the dynamic bearing pressure. The staff's review of Section 2.5.4 will be complete once the open item has been resolved.

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 that COL applicants will determine the stability of all slopes, both natural and manmade, to investigate whether the failure of the slopes, 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 will be performed under the seismic loading condition associated with the site-specific GMRS.

FSAR Tier 2, Table 2.0-1 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:

1. 10 CFR Part 50, Appendix A, GDC 2, requires 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, requires the design of nuclear power plant SSCs important to safety to withstand the effects of earthquakes

3. 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 geologic characteristics 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)"

2.5.5.3 *Technical Evaluation*

The staff reviewed the regulatory guidance and the description of the site-specific geotechnical and geologic information and site investigations provided in FSAR Tier 2, Section 2.5.5 necessary to determine the stability of all slopes. The criterion for no slope failure potential at the plant site eliminates the adverse effect of possible slope failure on the safety of the plant, is in accordance with the guidance of SRP 2.5.5, and, accordingly, is a reasonable basis for design. The staff also reviewed COL Information Item 2.5-8, as listed in FSAR Tier 2, Table 1.8-2 related to this section of the FSAR to ensure that the U.S. EPR design specifies necessary information requirements for potential COL applicants to follow so that the relevant requirements of GDC 2, Appendix S to 10 CFR Part 50 and 10 CFR 100.23 can be met for a proposed site.

2.5.5.4 *Conclusions*

Based on its review of FSAR Tier 1, Table 5.0-1, and FSAR Tier 2, Section 2.5.5, and Table 1.8-2, as documented above, the staff concludes that the applicant reasonably specified no slope failure as a basis of design. Further, the staff concludes that the applicant adequately described that COL applicants will determine the stability of all slopes, both natural and man-made, whose failure, under any of the conditions to which they could be exposed during the life of the plant and could adversely affect the safety of the plant. Since the applicant specifies that no slope failure potential is considered in the design of safety related structures, systems and components, the required information that a COL applicant must provide will assure that the potential failure of all slopes, both natural and manmade, will be determined in accordance with the requirements of GDC 2, and 10 CFR Parts 50 and 100. Accordingly, the staff considers this section of the FSAR to be acceptable.

2.6 COL Information Items

Table 2.6-1 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	Action Required by COL Applicant
2.0-1	A COL applicant that references the U.S. EPR design certification will compare site-specific data to the design parameter data in Table 2.1-1. If the specific data for the site falls within the assumed design parameter data and characteristics in Table 2.1-1, then the U.S. EPR standard design is bounding for the site. For site-specific design parameter data or characteristics that are outside the bounds of the assumptions presented in Table 2.1-1, the COL applicant will confirm that the U.S. EPR design acceptably meets any additional requirements that may be imposed by the more limiting site-specific design parameter data or characteristic, and that the design maintains conformance to the design commitments and acceptance criteria described in this FSAR	2.0	Y
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	Y
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 of potential accidents (such as explosions, toxic chemicals, and fires).	2.2	Y
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	Y
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 design 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	Y
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	Y
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	Y
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	Y

Item No.	Description	FSAR Tier 2 Section	Action Required by COL Applicant
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	Y
2.3-6	A COL applicant that references the U.S. EPR design certification will confirm that site-specific χ/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 χ/Q values that exceed the bounding χ/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 χ/Q values.	2.3.4	Y
2.3-7	A COL applicant that references the U.S. EPR design will provide χ/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.	2.3.4	Y
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	Y
2.3-9	A COL applicant that references the U.S EPR design certification will also provide estimates of annual average atmospheric dispersion (χ/Q values) and deposition (D/Q values) for 16 radial sectors to a distance of 50 miles (80 km) from the plant as part of its environmental assessment.	2.3.1.1	Y
2.3-10	A COL applicant that references the U.S. EPR design certification will 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.	2.4.1	Y
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.	2.4.2	Y
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.	2.4.3	Y
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	Y
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	Y
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	2.4.5	Y

Item No.	Description	FSAR Tier 2 Section	Action Required by COL Applicant
	safety-related plant systems require protection. The applicant will also verify that the site-parameter envelope is within the design maximum flood level, including consideration of wind effects.		
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	Y
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	Y
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	Y
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	Y
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 equipment.	2.4.9	Y
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	Y
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	Y
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	Y
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	Y
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	Y
2.5-1	A COL applicant that references the U.S. EPR design certification	2.5.1	Y

Item No.	Description	FSAR Tier 2 Section	Action Required by COL Applicant
	will use site-specific information to investigate and provide data concerning geological, seismic, geophysical, and geotechnical information.		
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	Y
2.5-3	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 PGA) and the 10 generic soil profiles discussed in Sections 2.5.2 and 3.7.1 and summarized in Table 3.7.1-6.	2.5.2.6	Y
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 static conditions.	2.5.4.10.1	Y
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 demonstrate that no capable faults exist at the site in accordance with the requirements of 10 CFR 100.23 and of 10 CFR 50, Appendix S. If non-capable surface faulting is present under foundations for safety-related structures, the COL applicant will demonstrate that the faults have no significant impact on the structural integrity of safety-related structures, systems, or components.	2.5.3	Y
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	Y
2.5-7	A COL applicant that references the U.S. EPR design certification will verify that the differential 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	Y
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	Y
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	Y
2.5-10	A COL applicant that references the U.S. EPR design certification will investigate and determine the uniformity of the underlying	2.5.4.10.3	Y

Item No.	Description	FSAR Tier 2 Section	Action Required by COL Applicant
	layers of site-specific soil conditions beneath the foundation basemats. The classification of uniformity or non-uniformity will be established by a geotechnical engineer.		
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	Y
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	Y