2 SITE CHARACTERISTICS

Chapter 2, "Site Characteristics," of this safety evaluation report (SER) describes the results of the review by the staff of the U.S. Nuclear Regulatory Commission (NRC or Commission), hereinafter referred to as the staff, of Chapter 2 of the Design Control Document (DCD), for the Advanced Power Reactor 1400 (APR1400), submitted by Korea Electric Power Corporation (KEPCO) and Korea Hydro & Nuclear Power Co., Ltd (KHNP), hereinafter referred to as the applicant.

The following evaluation focuses on the site parameters and site-related design characteristics the staff needs to be able to reach a conclusion about safety matters related to siting.

2.0 Site Characteristics

2.0.1 Introduction

This chapter discusses the assumed site envelope for the APR1400 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 APR1400 design (referred to as the "COL applicant") will compare site-specific data to the design parameter data identified in DCD Tier 1 Table 2.1-1, "Site Parameters," and Tier 2 Table 2.0-1, "Site Parameters." If the specific data for the site fall within the assumed design parameter data and characteristics in DCD Tier 1 Table 2.1-1 and Tier 2 Table 2.0-1, the APR1400 standard design is bounding for the site. If the site parameters or characteristics fall outside the assumed design parameters in DCD Tier 1 Table 2.1-1 and Tier 2 Table 2.0-1, the COL applicant will need to demonstrate, by some other means, that the proposed facility is acceptable at the proposed site. This might be done by reanalyzing or redesigning the proposed facility.

2.0.2 Summary of Application

DCD Tier 1: The Tier 1 information associated with this section is found in DCD Tier 1 Section 2.1, "Site Parameters." DCD Tier 1 Section 2.1, Table 2.1-1, lists the key site parameters for the APR1400 design basis. DCD Tier 1 Figure 2.1-1, "Horizontal Certified Seismic Design Response Spectra," and Figure 2.1-2, "Vertical Certified Seismic Design Response Spectra," provide the horizontal and vertical APR1400 certified seismic design response spectra (CSDRS), respectively. The COL applicant's site for construction of the APR1400 will be acceptable if its site-specific design-basis values are within the design parameter values shown in DCD Tier 1 Table 2.1-1 and Figures 2.1-1 and 2.1-2.

DCD Tier 2: The applicant has provided a DCD Tier 2 description and summary table identifying design-basis parameters for the APR1400 in Section 2.0, summarized here, in part, as follows.

A COL applicant referencing the APR1400 design certification (DC) will compare site-specific data to the design parameter data in DCD Tier 2 Table 2.0-1. If the specific data for the site fall within the assumed design parameter data and characteristics in DCD Tier 2 Table 2.0-1, the APR1400 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 DCD Tier 2 Table 2.0-1, the COL applicant will confirm that the APR1400 design acceptably meets any

additional requirements that may be imposed by the more limiting site-specific design parameter data or characteristics and that the design maintains conformance to the design commitments and acceptance criteria described in the APR1400 DCD.

DCD Tier 2 Table 2.0-1 contains the same key site parameter descriptions and parameter values as those in DCD Tier 1 Table 2.1-1.

Inspection, test, analysis, and acceptance criteria (ITAAC): There are no ITAAC for this area of review.

Technical Specifications (TS): There are no TS for this area of review.

COL information or action items: See Section 2.0.5 for COL information items.

Technical Reports: There are no technical reports associated with this area of review.

Topical Reports: There are no topical reports associated with this area of review.

APR1400 Interface Issues identified in the DCD: There are no APR1400 interface issues associated with this area of review other than those discussed above.

2.0.3 Regulatory Basis

Section 2.0, "Site Characteristics and Site Parameters," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (hereafter referred to as the "SRP"), provides the relevant NRC requirements for these areas of review and the associated acceptance criteria, as summarized below.

- Title 10 of the Code of Federal Regulations (10 CFR) 52.47(a)(1) requires a DC applicant to provide site parameters postulated for the design.

- The requirements in 10 CFR Part 100, "Reactor Site Criteria," apply to the siting factors and criteria for determining an acceptable site.

Review interfaces with other sections of the SRP can be found in SRP Section 2.0. The following provides the acceptance criteria that are adequate to meet the above requirements:

- The related SRP Chapter 2 or other referenced sections of the SRP provide acceptance criteria associated with site characteristics and design parameters.

DC applications do not contain general descriptions of site characteristics because this information is site specific and is addressed by the COL applicant referencing the APR1400 DC in the COL FSAR.

Acceptance is 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 is to provide sufficient justification (e.g., by request for exemption or amendment from the DC) that the proposed facility is acceptable at the proposed site.

2.0.4 Technical Evaluation

The staff reviewed the DCD using the review procedures described in SRP Section 2.0. The staff based its evaluation of the APR1400 site-related design parameters on a review of APR1400 DCD Chapter 2. The application addressed each of the pertinent site parameters described in 10 CFR 52.47(a)(1)(iii). The applicant described the adequacy of each site parameter in the individual safety analysis sections. As described in more depth below, the staff found that the postulated site parameters of the APR1400 design, as set forth in DCD Tier 1 Table 2.1-1 and DCD Tier 2 Table 2.0-1 were consistent with the applicable regulations and acceptance criteria cited in SRP Chapter 2 in that: (1) pertinent parameters were selected as key site parameters; (2) the key site parameters are representative of a reasonable number of sites that have been or may be considered for a COL application ; and (3) a technical basis was provided for each site parameter.

2.0.5 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2 Table 1.8-2. The following table summarizes the COL information item related to Section 2.0.1.

Table 2.0-1 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.0(1)	The COL applicant is to demonstrate that the APR1400 design meets the requirements imposed by the site-specific parameters and conforms to all design commitments and acceptance criteria if the characteristics of the site fall outside the assumed site parameters in Table 2.0-1.	2.0 2.0.1

2.0.6 Conclusion

As set forth above, the staff reviewed the application to ensure that sufficient information was presented with respect to the characteristics of the postulated site parameters in the DC. Accordingly, as described in more depth below, the staff concludes that the applicant has addressed DC site parameters and thus meets the requirements in 10 CFR 52.47(a)(1).

2.1 Geography and Demography

2.1.1 Site Location and Description

The descriptions of the site area and reactor location are used to assess the acceptability of the reactor site. The staff's review covered 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) a 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 by the "Contents of Application" sections of the applicable subparts to 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The purpose of the review is to ascertain the accuracy of the applicant's description for use in independent evaluations of the exclusion area authority and control, surrounding population, and nearby human-made hazards.

2.1.1.1 Summary of Application

The KHNP APR1400 DCD Tier 2 Section 2.1, addressed the need for site location and description with a statement that a COL applicant referencing the KHNP APR1400 DCD will provide site-specific information related to site location and description, exclusion area authority and control, and population distribution consistent with the guidance in Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants," issued June 2007, and in accordance with COL 2.1(1).

2.1.1.2 Regulatory Basis

The applicable regulatory requirements for identifying site location and description include the following:

- 10 CFR Part 52, "Licenses, Certifications, and Approvals For Nuclear Power Plants," as it relates to the inclusion, in the safety analysis report (SAR), of a detailed description and safety assessment of the site on which the facility will be located, with appropriate attention to features that affect the facility design (10 CFR 50.34(a)(1), 10 CFR 52.47(a)(1), 10 CFR 52.47(a)(2)(vi), and 10 CFR 52.79(a)(1)(vi))

- 10 CFR Part 100, as it relates to the following actions: (1) defining an exclusion area and establishing requirements for activities in that area (10 CFR 100.3, "Definitions"); (2) addressing and evaluating factors that are used to determine the acceptability of the site as identified in 10 CFR 100.20(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 described in 10 CFR 50.34(a)(1) as it relates to the site evaluation factors 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, if one should occur, should ensure a low risk of public exposure

The related acceptance criteria include the following:

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

- Site Area Map. The information submitted by the applicant is adequate and meets the requirements in 10 CFR 50.34(a)(1) as they relate to the site evaluation factors in 10 CFR Part 100 and 10 CFR 52.79(a)(1), if the information 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 evaluation would allow the reviewer to determine (in SRP Section 2.1.2, "Exclusion Area Authority and Control," and Section 2.1.3, "Population Distribution") whether the applicant has met the requirements in 10 CFR 50.34(a)(1) as they relate to the site evaluation factors in 10 CFR Part 100.

2.1.1.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information on the site location and description to include the boundaries of the site; the proposed general location of each facility on the site; the location and description of any industrial, military, or transportation facilities and routes; and prominent natural and manmade features in the site area. The detailed information included the following:

- The reactor location with respect to: (1) latitude and longitude and the universal transverse Mercator coordinate system; (2) political subdivisions; and (3) prominent natural and manmade features of the area for use in conducting 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, "Evaluation of Potential Accidents").

- 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, "Site Location and Description").

The DC application does not contain this type of information because it is site specific.

2.1.1.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2 Table 1.8-2. The following table summarizes the COL information item related to Section 2.1.1.

Table 2.1-1 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.1(1)	The COL applicant is to provide site-specific information on the site location and description of the site, exclusion authority and control, and population distribution as stated in NRC RG 1.206.	2.1.1 2.1.4

2.1.1.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific information in accordance with COL 2.1(1). Because this information is site specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.1 to be acceptable. For the reasons given above, the staff concludes that because this information is site specific, it will be addressed by the COL applicant and therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

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. 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 APR1400 DCD Tier 2 addresses the need for exclusion area authority and control with a statement that a COL applicant that references the APR1400 DCD will provide site-specific information related to exclusion area authority and control in accordance with RG 1.206.

2.1.2.2 Regulatory Basis

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

- 10 CFR Part 52, as it relates 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 52.47(a)(1), and 10 CFR 52.79(a)(1)).

- 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).

The related acceptance criteria are:

- 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.

- 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.

- 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 Basis

The applicant need not postulate a location for the EAB or outer boundary of the low-population zone (LPZ) as site parameters because the points at which radiological doses are calculated pursuant to 10 CFR 52.47(a)(2)(iv) for these locations are implicit in the χ/Qs discussed in Section 2.3 and Chapter 15 of this SER.

The applicant stated in the APR1400 DCD Tier 2, that a COL applicant referencing APR1400 DCD 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; (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; (4) no residences are normally permitted in EAB, if so, the people who live within the EAB are subject to removal; and (5) a highway, railway, or waterway may traverse the exclusion area but is not close enough to the facility to interfere with normal operations.

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

2.1.2.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2 Table 1.8-2. The following table summarizes the COL information item related to Section 2.1.2.

Table 2.1-2 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.1(1)	The COL applicant is to provide site-specific information on the site location and description of the site, exclusion authority and control, and population distribution as stated in NRC RG 1.206.	2.1 2.1.4

2.1.2.5 Conclusions

As set forth above, the applicant has stated in the APR1400 DCD Tier 2, that the COL applicant will provide the site-specific information as per COL 2.1(1). Since this information is site-specific, the applicant's statement provided in the APR1400 DCD Tier 2, 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 it will be addressed by the COL applicant and therefore, would be reviewed at the COL stage. 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.

2.1.3 Population Distribution

The description of population distribution addresses the need for information about: (1) the population in the site vicinity, including transient populations; (2) the 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 1⅓ 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 RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Revision 3, issued March 2014; and (6) any additional information requirements in the "Contents of Application" sections of the applicable subparts of 10 CFR Part 52.

2.1.3.1 Summary of Application

This section of the KHNP APR1400 DCD Tier 2 addresses the need for population distribution with a statement that a COL applicant referencing the KHNP APR1400 DCD will provide site-specific information related to population distribution, consistent with the guidance in RG 1.206 and in accordance with COL information COL 2.1(1).

2.1.3.2 Regulatory Basis

The applicable regulatory requirements for identifying population distribution include the following:

- 10 CFR 50.34(a)(1), as it relates to consideration of the site evaluation factors in 10 CFR 100.3; 10 CFR Part 100 (including consideration of population density); 10 CFR 52.17, "Contents of applications; technical information"; 10 CFR 52.47, "Contents of applications; technical information"; and 10 CFR 52.79, "Contents of applications; technical information in final safety analysis report," as they relate to information provided by the applicant in the SAR of the existing and projected future population profile of the area surrounding the site.

- 10 CFR 100.20, "Factors to be considered when evaluating sites," and 10 CFR 100.21, "Non-seismic siting criteria," as they relate to determining the acceptability of a site for a power reactor; and 10 CFR 100.3, 10 CFR 100.20(a), and 10 CFR 100.21(b), which include definitions and other requirements for determining an exclusion area, LPZ, and population center distance.

The related acceptance criteria include the following:

- Population Data. The population data supplied by the applicant in the SAR are 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 consistent with the geographical format in Section 2.1.3 of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 3, issued November 1978, and with the guidance in RG 1.206; (2) the SAR describes the methodology and sources used to obtain the population data, including the projections; and (3) the SAR includes information on transient populations in the site vicinity.

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

- Low Population Zone (LPZ). The specified LPZ is acceptable if a determination is made that appropriate protective measures could be taken on behalf of the enclosed populace in the event of a serious accident.

- Nearest Population Center Boundary. The nearest boundary of the closest population center containing 25,000 or more residents is at least 1⅓ times the distance from the reactor to the outer boundary of the LPZ.

- Population Density. If the population density exceeds the guidelines in Regulatory Position C.4 of RG 4.7, the applicant must consider alternative sites with lower population densities.

2.1.3.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information on population distribution, population center, and population density. SRP Section 2.1.3 addresses the specific criteria deemed acceptable to meet the relevant requirements. Such requirements typically involve a review of the following:

- Data about the population in the site vicinity.

- The population in the exclusion area.

- The LPZ to determine whether appropriate protective measures could be taken on behalf of the populace in that zone in the event of a serious accident.

- The nearest boundary of the closest population center containing 25,000 or more residents to determine whether this boundary is at least 1⅓ times the distance from the reactor to the outer boundary of the LPZ.

- The population density in the site vicinity, including the weighted transient population at the time of initial site approval and within 5 years thereafter to determine whether it exceeds 500 persons per square mile averaged over any radial distance out to 32.2 kilometers (km) (20 miles).

The DC application does not contain this type of information because it is site specific.

2.1.3.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2 Table 1.8-2. The following table summarizes the COL information item related to Section 2.1.3.

Table 2.1-3 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.1(1)	The COL applicant is to provide site-specific information on the site location and description of the site, exclusion authority and control, and population distribution as stated in NRC RG 1.206.	2.1 2.1.4

2.1.3.5 Conclusion

As set forth above, the applicant has stated in the KHNP APR1400 DCD Tier 2 that the COL applicant will provide the site-specific information in accordance with COL 2.1(1). Because this information is site specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.1.3 to be acceptable. For the reasons given above, the staff concludes that, because this information is site specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application.

2.2 Nearby Industrial, Transportation, and Military Facilities

A COL applicant referencing the KHNP APR1400 DCD will provide site-specific information on the identification and evaluation 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, as described in SRP Section 2.2.3; Section 3.5.1.5, "Site Proximity Missiles (Except Aircraft)," and Section 3.5.1.6, "Aircraft Hazards," can be performed. The review covers the following specific areas: (1) the locations (identified on maps) of, and separation distances from the plant 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 in the "Contents of Application" sections of the applicable subparts of 10 CFR Part 52.

2.2.2 Descriptions

As stated 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 the KHNP APR1400 DCD Tier 2. This information will describe the primary function of each facility and the nature of the hazards that it presents. This information for each facility includes its primary function; major products; number of employees; materials regularly manufactured, stored, used, or transported near the site; and the hazards that could result from accidents at the facilities.

2.2.2.1 Summary of Application

This section of the KHNP APR1400 DCD Tier 2 addresses the need for identifying potential hazards in the site vicinity with a statement that a COL applicant referencing the KHNP APR1400 DCD will provide site-specific information related to the location and routes for nearby industrial, transportation, and military facilities, consistent with RG 1.206 under COL 2.2(1).

2.2.2.2 Regulatory Basis

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

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

- 10 CFR 52.47(a)(1) and 10 CFR 52.79(a)(1)(iv), as they relate to the factors to be considered in the evaluation of sites that 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 compliance with 10 CFR Part 100.

The related acceptance criteria include the following:

- The KHNP APR1400 DCD Tier 2 covers adequately that the COL applicant referencing this DCD will address the locations and distances from the plant of nearby industrial, military, and transportation facilities, and such data are in agreement with data obtained from other sources, when available.

- Descriptions of the nature and extent of activities conducted at the site and in its vicinity, including the products and materials likely to be processed, stored, used, or transported, are adequate to permit identification of the possible hazards cited in Section III, “Review Procedures,” of SRP Section 2.2.1-2.2.2, “Identification of Potential Hazards in Site Vicinity.”

- 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 the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information on the identification of potential hazards stemming from the nearby industrial, transportation, and military facilities within the site vicinity. SRP Section 2.2.1-2.2.2 addresses the specific criteria acceptable to meet the relevant requirements. Such requirements typically involve a review of the following:

- The locations and distances of industrial, military, and transportation facilities near 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 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 because it is site specific.

2.2.2.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2 Table 1.8-2. The following table summarizes the COL information item related to Sections 2.2.1 and 2.2.2.

Table 2.2-1 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.2(1)	The COL applicant is to provide site-specific information on nearby industrial, transportation, and military facilities as required in NRC RG 1.206.	2.2 2.2.4

2.2.2.5 Conclusion

As set forth above, the applicant stated in the KHNP APR1400 DCD Tier 2 that the COL applicant will provide the site-specific information in accordance with COL 2.2(1). Because this information is site specific, the staff considers the applicant's statement in the KHNP APR1400 DCD that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.2.1–2.2.2 to be acceptable. For the reasons given above, the staff concludes that it will be addressed by the COL applicant and therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL application.

2.2.3 Evaluation of Potential Accidents

The applicant must identify any design-basis event (DBE) caused by nearby industrial, transportation, and military facilities and must evaluate potential accidents near the plant, including human-related hazards. A DBE is defined as an event with a probability of occurrence greater than an order of magnitude of $1x10^{-7}$ per year, resulting in a radiological dose exceeding the dose criteria in 10 CFR Part 100. If potential accidents having unacceptable probability of occurrence with severe consequences are identified, descriptions of site-specific steps taken to mitigate the consequences are included.

The evaluation of potential accidents considers the applicant's probability analyses of potential accidents involving hazardous materials or activities on site and near the proposed site to confirm that the applicant used appropriate data and analytical models. 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 (i.e., aircraft routes, highways, railways, navigable waters, and pipelines). Each hazard review area includes consideration of the following principal types of hazards:

- Toxic vapors or gases and their potential for incapacitating nuclear plant control room operators.

- 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.

- Missile effects attributable to mechanical impacts (such as aircraft impact), impacts from explosion debris, and impacts from waterborne items (such as barges).

- Thermal effects attributable to fires.

2.2.3.1 Summary of Application

This section of the KHNP APR1400 DCD addressed the need for an evaluation of potential accidents in the plant vicinity with a statement that a COL applicant referencing the KHNP APR1400 DCD will provide site-specific information related to the evaluation of accidents near the plant in accordance with COL 2.2.(2).

2.2.3.2 Regulatory Basis

The applicable regulatory requirements for identifying and evaluating potential accidents include the following:

- 10 CFR 52.47(a)(1) 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 52.47(a)(1) and 10 CFR 52.79(a)(1)(vi), as they relate to compliance with 10 CFR Part 100.

The related acceptance criteria include the following:

- The identification of a DBE resulting from the presence of hazardous materials or activities near the plant or plants of a specified type is acceptable if it includes all postulated types of accidents for which the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the limits in 10 CFR 50.34(a)(1), as it relates to the requirements in 10 CFR Part 100, is estimated to exceed the staff objective of an order of magnitude of $1x10^{-7}$ per year.

- The effects of a DBE have been adequately considered, in accordance with 10 CFR 100.20(b), if the applicant has performed analyses of the effects of those accidents on the safety-related features of the plant or plants of a specified type and has taken measures (e.g., hardening and fire protection) to mitigate the consequences of such events.

- The regulation at 10 CFR 100.20(b) states that the nature and proximity of human-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.

- The regulation at 10 CFR 100.21(e) states that potential hazards associated with nearby transportation routes and industrial and military facilities must be evaluated and site parameters established to ensure that potential hazards from such routes and facilities will not pose undue risk to the type of facility proposed to be located at the site.

2.2.3.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing KHNP APR1400 DCD will address the site-specific information on 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 $1x10^{-7}$ 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 because it is site specific.

2.2.3.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2 Table 1.8-2. The following table summarizes the COL information item related to Sections 2.2.3.

Table 2.2-2 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.2(2)	The COL applicant is to identify the DBE caused by nearby industrial, transportation, and military facilities and determine its design parameters.	2.2 2.2.4

2.2.3.5 Conclusion

As set forth above, the applicant has stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific information under COL 2.2(2). Because this information is site specific, the staff considers the applicant's statement in the KHNP APR1400 DCD that the COL applicant is to supply this site-specific information in accordance with SRP Section 2.2.3 acceptable. For the reasons stated above, the staff concludes that it will be addressed by the COL applicant and therefore, would be reviewed at the COL stage. The COL applicant should include 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 Meteorology

2.3.1 Regional Climatology

2.3.1.1 Introduction

APR1400 DCD Tier 2, Section 2.3.1, "Regional Climatology," describes the regional climatological information to be collected through a site-specific study by a COL applicant referencing the APR1400 DC. The COL applicant is to provide site-specific information on the general climate in the region, including types of air masses and airflow patterns, synoptic features, and influences from regional topography. The applicant should also provide regional climatological conditions, including temperature, humidity, and precipitation statistics, in addition to the frequency of severe weather phenomena (e.g., hurricanes, tornadoes, waterspouts, thunderstorms, severe wind events, lightning, hail, and potential for high levels of air pollution). The applicant should also provide climatological data used to evaluate the performance of the ultimate heat sink (UHS) with respect to maximum evaporation, drift loss (if applicable), and minimum water cooling.

2.3.1.2 Summary of Application

In APR1400 DCD Tier 2, Section 2.3.1, the applicant stated that a COL applicant referencing the APR1400 DC is expected to provide site-specific characteristics for regional climatology. COL 2.3(1) in APR1400 DCD Tier 2, Table 1.8-2, and Section 2.3.6, "Combined License Information," states that the COL applicant is to provide site-specific information on meteorology, including regional climatology.

COL 2.0(1) in APR1400 DCD Tier 2, Table 1.8-2, states that "the COL applicant is also to demonstrate that the APR1400 design meets the requirements imposed by the site-specific parameters and conforms to all design commitments and acceptance criteria if the characteristics of the site fall outside the assumed site parameters in Tier 2, Table 2.0-1."

Site Parameters

The list of APR1400 site parameters presented in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, includes climate-related site parameters related to winter precipitation (for roof loading), extreme wind speed, tornadoes and hurricanes, and ambient air temperatures and atmospheric moisture conditions that affect the design and operation of heating, ventilation, and air conditioning (HVAC) systems, the UHS, and other plant equipment. The staff notes that the climate-related site parameters are the same in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1.

On April 29, 2015, the staff conducted a teleconference with the applicant to clarify information related, in part, to the APR1400 meteorology site parameters referenced in DCD Tier 2, Section 2.3.1, but not rising to the level of design detail. The applicant submitted its responses to the clarifying questions (CQs) on May 12, 2015 (ML15132A598), with the following proposed changes to the DCD:

- In response to CQ 02.03.01-1, the applicant agreed to update DCD Tier 2, Table 2.0-1, to clearly determine that the proposed HVAC outdoor design temperatures (i.e., maximum dry bulb and coincident wet bulb and minimum dry bulb) for the 0-percent, 1-percent, and 5-percent exceedance values are annual exceedance values.

- In response to CQ 02.03.01-3, the applicant agreed to update the format of DCD Tier 2, Table 2.0-1, so that the 5-percent maximum non-coincident wet-bulb temperature, and the 5-percent minimum dry-bulb temperature values proposed for the cooling tower (i.e., the circulating water system (CWS)) are properly aligned with the corresponding parameters.

- In response to CQ 02.03.01-4, the applicant agreed to remove extraneous lines from DCD Tier 1, Table 2.1-1, so that the proposed design dry- and wet-bulb temperatures associated with HVAC systems are consolidated.

- In response to CQ 02.03.01-5, the applicant agreed to update DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 2.1-1, to identify the exposure category for the extreme wind site parameter value.

- In response to CQ 02.03.01-6, the applicant agreed to replace the term "non-concurrent" with "non-coincident" in the DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 2.1-1, description of the 5-percent maximum annual exceedance wet-bulb ambient design temperature for the cooling tower (i.e., the CWS) and the 0-percent maximum annual wet-bulb temperature for the cooling tower (i.e., the essential service water system (ESWS)).

- In response to CQ 02.03.01-7, the applicant agreed to update DCD Tier 2, Table 2.0-1, to distinguish the maximum non-coincident wet-bulb and the minimum dry-bulb ambient 5-percent annual exceedance design temperatures for the cooling tower (i.e., the CWS) from the maximum non-coincident wet-bulb ambient 0-percent annual exceedance design temperature for the cooling tower (i.e., the ESWS).

Based on the review of the DCD, the staff has confirmed incorporation of the changes associated with the CQs discussed above; therefore CQ Confirmatory Item 2.3.1-1 is resolved and closed.

2.3.1.2.1 Winter Precipitation (for Roof Loading)

The site parameters for winter precipitation roof loading (e.g., snow and ice loads) presented in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, are the 100-year snowpack roof load (i.e., less than or equal to 2.873 kilopascals (kPa) or kilonewtons per square meter (kN/m^2) or 60 pounds per square foot (lbf/ft^2)) and the extreme winter precipitation roof load (i.e., less than or equal to 5.985 kPa (5.985 kN/m^2) or 125 lbf/ft^2).

DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, define an additional site parameter for winter precipitation as the depth of the 48-hour probable maximum winter precipitation (PMWP) (i.e., less than or equal to 914.4 millimeters (mm) (36 inches)). Depending on the location of the site, the 48-hour PMWP may not necessarily be in the form of frozen precipitation.

2.3.1.2.2 Extreme Wind Speed

The applicant used the American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard 7-05, "Minimum Design Loads for Buildings and Other Structures," to determine that the site parameter for extreme wind speed, as presented in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, is 64.8 meters per second (m/s) (145 miles per hour

(mph)) for Exposure Category C (as described in DCD Tier 2, Sections 3.3.1.1, “Design Wind Velocity and Recurrence Interval,” and 3.8.4.3, “Loads and Load Combinations”).

The staff confirmed this value using ASCE/SEI Standard 7-05. ASCE/SEI Standard 7-05 describes the basic wind speed as the “three second wind gust speed at 33 ft (10 meters (m)) above the ground in Exposure Category C.” Exposure Category C relies on the surface roughness categories as defined in Chapter 6, “Wind Loads,” of ASCE/SEI Standard 7-05. Exposure Category C is acceptable at many sites because of scattered obstructions of various sizes in the immediate site area. Exposure Category B specifies that there must be urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions that are the size of single-family dwellings or larger and that prevail in the upwind direction for a distance of at least 792 m (2,600 ft) or 20 times the height of the building, whichever is greater. Exposure Category D specifies that there must be flat, unobstructed areas and water surfaces that prevail in the upwind direction for a distance greater than 1,525 m (5,000 ft) or 20 times the building height, whichever is greater. ASCE/SEI Standard 7-05 states that Exposure Category C shall apply for all cases in which Exposure Category B or D do not apply. DCD Tier 2, Section 3.3.1.1, further states that the 64.8 m/s (145 mph) value is based on the 50-year, 3-second gust wind speed and corresponds to the wind speed measured at 10 m (33 ft) above ground.

Footnote 2 to DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, states that the importance factor site parameter value of 1.15 is to be used for the design of seismic Category I and II structures only. APR1400 DCD Tier 2, Section 3.3.1, “Wind Loadings,” states that the operating basis wind speed site parameter value of 64.8 m/s (145 mph) (3-second gust) is based on an annual probability of occurrence of 0.02 (i.e., 50-year return period). Higher winds with an annual probability of occurrence of 0.01 (i.e., 100-year return period) were used in the design of seismic Category I and II structures by applying an importance factor of 1.15.

2.3.1.2.3 Tornado

DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, present the following site parameters for tornadoes:

- The maximum horizontal wind speed is 102.8 m/s (230 mph).
- The rotational speed is 82.2 m/s (184 mph).
- The translational speed is 20.6 m/s (46 mph).
- The radius of maximum rotational speed is 45.7 m (150 ft).
- The maximum pressure differential is 8.274 kPa or 1.2 pounds per square inch (psi) at a rate of 3.447 kPa per second (0.5 psi per second).

DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, state that the tornado site parameter missile spectra were determined by implementing the guidance in RG 1.76, “Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants,” Revision 1, issued March 2007.

2.3.1.2.4 Hurricane

The site parameters for hurricanes, as presented in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, include the maximum 3-second wind gust speed of 116 m/s (260 mph).

Both DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, state that the hurricane site parameter missile spectra were determined by implementing RG 1.221, “Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants,” issued October 2011.

2.3.1.2.5 HVAC Outdoor Design Temperature

The applicant presented the following site parameters for the HVAC outdoor design temperature in APR1400 DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1:

- The 5-percent annual exceedance maximum HVAC outdoor design temperature is 35.0 degrees Celsius (C) (95 degrees Fahrenheit (F)) dry bulb and 25.0 degrees C (77 degrees F) coincident wet bulb.

- The 5-percent annual exceedance minimum HVAC outdoor design temperature is -20.6 degrees C (-5 degrees F) dry bulb.

- The 1-percent annual exceedance maximum HVAC outdoor design temperature is 37.8 degrees C (100 degrees F) dry bulb and 25.0 degrees C (77 degrees F) coincident wet bulb.

- The 1-percent annual exceedance minimum HVAC outdoor design temperature is -23.3 degrees C (-10 degrees F) dry bulb.

- The 0-percent annual exceedance (historical limit excluding peaks of less than 2 hours) maximum HVAC outdoor design temperature is 46.1 degrees C (115 degrees F) dry bulb and 26.7 degrees C (80 degrees F) coincident wet bulb.

- The 0-percent annual exceedance (historical limit excluding peaks of less than 2 hours) minimum HVAC outdoor design temperature is -40 degrees C (-40 degrees F) dry bulb.

2.3.1.2.6 Ultimate Heat Sink Meteorological Conditions

APR1400 DCD Tier 2, Section 9.2.5.1,”Design Bases,” indicates that the safety function of the UHS is to dissipate the maximum heat load and heat rejected from the ESWS during all modes of operation, including that of a loss-of-coolant accident and loss of offsite power under the worst combination of adverse environmental conditions, including freezing. The applicant defined the conceptual design of the UHS as a wet-type mechanical draft cooling tower. DCD Tier 2, Section 9.2.5.2.1, “General Description,” describes the UHS as two independent, redundant, safety-related divisions with each division consisting of two 100-percent capacity cooling towers with one common cooling tower basin, piping, valves, controls, and instrumentation.

APR1400 DCD Tier 1, Section 3.2, “Ultimate Heat Sink,” explains that the UHS provides cooling capacity for at least 30 days without makeup water under worst-case meteorological conditions, consistent with the guidance in RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” Revision 2, issued January 1976.

APR1400 DCD Tier 2, Section 9.2.5.1, states that the UHS is designed to provide the maximum supply water temperature of 33.2 degrees C (91.8 degrees F) to the ESWS and that the design provides isolation between the UHS and the nonsafety-related system. DCD Tier 2, Section 9.2.5.2.2.1, "UHS Cooling Towers," and related Table 9.2.5-3, "Ultimate Heat Sink Design Parameters," identify the same percent annual exceedance temperatures that apply to the UHS cooling towers under normal operating and accident conditions.

APR1400 DCD Tier 2, Section 2.3.1, states that COL applicants referencing the APR1400 DC are to provide meteorological data used to evaluate the performance of the UHS with respect to maximum evaporation, drift loss, and minimum water cooling. APR1400 DCD Tier 2, Table 1.8-2 (COL 9.2(17)), reinforces this by stating that a COL applicant is to provide the UHS-related design information based on the site characteristics, including meteorological conditions.

APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, both include site parameters for the ESWS and the CWS to be used in the evaluation. DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, list the following site parameter values for the ESWS and the CWS under "Ambient Design Temperature for Cooling Tower":

- The ambient 5-percent annual exceedance values for the CWS are a maximum non-coincident wet-bulb temperature of 26.1 degrees C (79 degrees F) and a minimum dry-bulb temperature of -20.6 degrees C (-5 degrees F).

- The ambient 0-percent annual exceedance values for the ESWS are a maximum non-coincident wet-bulb temperature of 27.2 degrees C (81 degrees F) and a minimum dry-bulb temperature of -40.0 degrees C (-40 degrees F).

2.3.1.3 Regulatory Basis

The regulatory requirements for the design-basis climatological site parameters for the APR1400 are based on meeting the relevant requirements in the following NRC regulations:

- General Design Criterion (GDC) 2, "Design Bases for Protection against Natural Phenomena," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," as it relates to consideration of the most severe natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated

- GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to information on tornadoes and, where applicable, hurricane winds that generate missiles that could potentially impact structures, systems, and components (SSCs) important to safety

- GDC 44, "Cooling Water," as it relates to meteorological data used to evaluate the design of the UHS

- 10 CFR 52.47(a)(1), which requires a DC applicant to provide site parameters postulated for the design

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

- 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

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

- the tornado parameters (including maximum wind speed, translational speed, maximum rotational speed, and maximum pressure differential with the associated time interval) to be used in establishing pressure and tornado missile loadings on SSCs important to safety

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

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

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

The regional climate-related site parameters are selected to ensure the facility is being designed such that potential threats from the physical characteristics of a potential site (e.g., regional climatic extremes and severe weather) will not pose an undue risk to the facility. Examples include the following:

- Revision 2 to RG 1.27, which describes the meteorological conditions resulting in the maximum evaporative and, if applicable, drift loss of water from the UHS, as well as the meteorological conditions, resulting in minimum water cooling, that should be considered to ensure that the UHS is able to perform its safety functions

- Revision 1 to RG 1.76, 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 public health and safety

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

- NRC Interim Staff Guidance (ISG) DC/COL-ISG-7, “Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures,” issued June 23, 2009, after the publication of SRP Section 2.3.1 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

2.3.1.4 Technical Evaluation

2.3.1.4.1 Winter Precipitation (for Roof Loading)

APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, each list two site parameters related to winter precipitation: (1) the 100-year snowpack roof load of 2.873 kPa (60 lbf/ft^2) and (2) the extreme winter precipitation roof load of 5.985 kPa (125 lbf/ft^2). The 100-year snowpack roof load, listed as 2.873 kPa (60 lbf/ft^2), is based on the assumed site-related parameters, as stated in DCD Tier 2, Section 3.8.4.3.1, "Normal Loads."

DC/COL-ISG-7 clarifies the guidance in SRP Section 2.3.1 by stating that normal and extreme winter precipitation events should be identified as site parameters and site characteristics for use with SRP Section 3.8.4, "Other Seismic Category I Structures," in determining the normal and extreme winter precipitation loads on the roofs of seismic Category I structures. The normal winter precipitation roof load is a function of the normal winter precipitation event, whereas extreme winter precipitation roof loads are based on the weight of the antecedent snowpack resulting from the normal winter precipitation event plus the larger resultant weight from either (1) an extreme frozen winter precipitation event or (2) an extreme liquid winter precipitation event. The snow or ice, or both, from the extreme frozen winter precipitation event is assumed to accumulate on the roof on top of the snow or ice, or both, from the earlier normal winter precipitation event. However, the water from the extreme liquid winter precipitation event may or may not accumulate on the roof, depending on the geometry of the roof and the type of drainage provided. DC/COL-ISG-7 further includes the following information:

- The normal winter precipitation event should be the highest ground-level weight (in pounds per square foot) among (1) the 100-year return period snowpack, (2) the historical maximum snowpack, (3) the 100-year return period 2-day snowfall event, or (4) the historical maximum 2-day snowfall event in the site region.

- The extreme frozen winter precipitation event should be the higher ground-level weight (in pounds per square foot) between (1) the 100-year return period 2-day snowfall event and (2) the historical maximum 2-day snowfall event in the site region.

- The 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.

The staff issued Request for Additional Information (RAI) 8012, Question 02.03.01-4 (ML15295A386), to ask the applicant to describe in the DCD how the snow load parameters in APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, are connected to specific SSCs or roof loads. In Revision 2 of its response to RAI 126-8012, Question 02.03.01-4 (ML16053A352), the applicant stated that the APR1400 DCD does not identify any association between the extreme winter precipitation roof load in the DCD Tier 1 and Tier 2 tables and seismic Category I structures because SRP Section 3.8.4, as referenced in DC/COL-ISG-7, currently provides no guidance on how to use extreme winter precipitation events for the design of seismic Category I structures.

However, the applicant's RAI response also stated that "mass equivalent to 75 percent of the roof design snow load is included in addition to the structural mass of the seismic analysis models of seismic Category I structures in accordance with SRP Section 3.7.2, "Seismic System

Analysis." Since the extreme environmental loads do not occur simultaneously, the snow load considered in the seismic analysis models is the normal winter precipitation roof load." The staff considers the applicant's characterization of the extreme environmental loads to be acceptable because the extreme environmental loads do not occur simultaneously and the consideration of the 75-percent design snow load in its analysis of the seismic Category I structures is consistent with the guidance in SRP Section 3.7.2. Therefore, the staff considers RAI 126-8012, Question 02.03.01-4, to be resolved and closed.

The staff performed an independent confirmatory analysis of the applicant's proposed extreme and normal winter precipitation roof load site parameters to determine whether these site parameter values bound a reasonable number of sites that may be considered for a COL application. The staff used the map of ground snow loads that are based on the maximum observed ground snow load recorded at 204 National Weather Service locations throughout the contiguous United States, as reported in ASCE/SEI Standard 7-05, Chapter 7, "Snow Loads," Table C7-1, "Ground Snow Loads at 204 National Weather Service Locations Where Load Measurements Are Made." The staff noted that no stations had a maximum observed ground snow load that exceeded 5.985 kPa (125 lbf/ft^2), which is the extreme winter precipitation roof load. However, the staff did note that a minor number of sites in a portion of northeastern New England and portions of northern Minnesota and Michigan did exceed the 100-year snowpack roof load of 2.873 kPa (60 lbf/ft^2).

The applicant also identified a 48-hour PMWP liquid event (i.e., the extreme liquid winter precipitation event as defined in DC/COL-ISG-7) as 914.4 mm (36 inches) of liquid water. DC/COL-ISG-7 states that 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. DC/COL-ISG-7 also states that the extreme liquid winter precipitation event should be determined in accordance with the hydrometeorological reports published by the National Oceanic and Atmospheric Administration's Hydrometeorological Design Studies Center.

The staff also reviewed many winter precipitation site characteristics for previously submitted COLs and early site permits (ESPs) and winter precipitation site parameters for previously certified designs and compared them to the extreme winter precipitation roof load site parameter currently listed in the APR1400 DCD. The staff found that the extreme winter precipitation roof load site parameter of 5.985 kPa (125 lbf/ft^2) in APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table-2.0-1, bounds nearly all winter precipitation site parameters for previously certified designs and nearly all winter precipitation site characteristics for previously submitted COL and ESP applications. As such, the staff agrees that the site parameters related to roof loading are representative of a reasonable number of sites in the contiguous United States that have been or may be considered for a COL application. The staff, therefore, finds the winter precipitation site parameters in the APR1400 DCD to be reasonable.

2.3.1.4.2 Extreme Wind Speed

SRP Section 2.3.1 recommends that the straight-line 100-year return period 3-second gust wind speed be based on appropriate standards, such as ASCE/SEI Standard 7-05. Because this

standard was the basis for the applicant's extreme wind speed site parameter, the staff finds that the applicant has provided an adequate basis for this site parameter.

Figure 6-1, "Basic Wind Speed," in ASCE/SEI Standard 7-05 displays contours of 50-year return period 3-second wind gust speeds across the continental United States. Based on ASCE/SEI Standard 7-05, a small portion of the coastal south and southeastern United States could potentially exceed the applicant's extreme wind speed site parameter of 64.8 m/s (145 mph). Because the 3-second gust wind speed for a large portion of the country is below the applicant's proposed site parameter, the staff finds the applicant's extreme wind speed value representative of a reasonable number of potential COL sites.

Footnote 2 to APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, also identified an importance factor of 1.15 to be used in the design of safety-related SSCs. The staff finds this importance factor value acceptable because it is consistent with the value defined for Category IV building and structure classification (i.e., buildings and structures designated as essential facilities) in ASCE/SEI Standard 7-05, Table 6-1, "Importance Factor, I (Wind Loads)." The staff finds the extreme wind speed site parameters in the APR1400 DCD acceptable.

2.3.1.4.3 Tornado

The tornado site parameters proposed in APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1 (i.e., maximum wind speed, maximum rotational speed, translational speed, radius of maximum rotational speed, maximum pressure drop, and rate of pressure drop), are equal to the Tornado Intensity Region I design-basis tornado characteristics specified in RG 1.76, Revision 1. The staff finds that the applicant has provided an adequate basis for the tornado site parameters.

Region I, as specified in RG 1.76, Revision 1, 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 applicant's tornado site parameters should be representative of a reasonable number of potential COL sites. APR1400 DCD Tier 2, Section 3.5.1.4, "Missiles Generated by Tornadoes and Extreme Winds," discussed an analysis of the tornado missile spectra; the corresponding SER section further discussed the analysis. Therefore, the staff finds the tornado-related site parameters in the APR1400 DCD acceptable.

2.3.1.4.4 Hurricane

The maximum 3-second hurricane wind gust speed site parameter at a height of 10 meters (33 feet) proposed in APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, is equal to one of the highest design-basis hurricane wind gust speed contour lines found along the East and Gulf coasts of the United States, as listed in RG 1.221. The design-basis hurricane wind speeds for the eastern and western Gulf of Mexico and southeastern Atlantic U.S. coastlines represent exceedance probabilities of 1×10^{-7} per year and are based on the contour maps in RG 1.221.

The staff reviewed the hurricane wind speed contour maps in RG 1.221 and concludes that a design-basis hurricane wind gust speed site parameter value of 116 m/s (260 mph) is bounding for a reasonable number of potential COL sites in the United States. APR1400 DCD Section 3.5.1.4 discussed an analysis of the hurricane missile spectra; the corresponding SER

section further discussed the analysis. Therefore, the staff finds the hurricane wind gust speed site parameter in the APR1400 DCD acceptable.

2.3.1.4.5 HVAC Outdoor Design Temperature

APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, each state that the maximum outdoor design ambient temperature corresponding to a 1-percent annual exceedance HVAC value is 37.8 degrees C (100 degrees F) dry bulb with a coincident wet-bulb temperature of 25.0 degrees C (77 degrees F). The minimum outdoor design temperature corresponding to a 1-percent annual exceedance value is given as -23.3 degrees C (-10 degrees F) dry bulb. The maximum outdoor design temperature corresponding to a 0-percent annual exceedance HVAC value (historical limit excluding peaks less than 2 hours) is 46.1 degrees C (115 degrees F) dry bulb with a coincident wet-bulb temperature of 26.7 degrees C (80 degrees F). The minimum outdoor design temperature corresponding to a 0-percent annual exceedance value is -40.0 degrees C (-40 degrees F) dry bulb.

The staff confirmed that the applicant corrected a temperature conversion for the "HVAC Outdoor Design Maximum 1% Exceedance Dry-Bulb Temperature," in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, consistent with its response to RAI 126-8012, Question 02.03.01-2 (ML15280A329). Therefore, the staff considers RAI 126-8012, Question 02.03.01-2, to be resolved and closed.

The applicant also included a 5-percent annual exceedance HVAC outdoor design temperature of 35.0 degrees C (95 degrees F) dry bulb with a coincident wet-bulb temperature of 25.0 degrees C (77 degrees F). The minimum HVAC outdoor design temperature corresponding to a 5-percent annual exceedance value is -20.6 degrees C (-5 degrees F) dry bulb.

DCD Tier 2, Section 9.2.5.2.2.1, and related Table 9.2.5-3 identified the percent annual exceedance levels that apply to the UHS cooling towers under normal operating and accident conditions. In contrast, the introduction to DCD Tier 2, Section 9.4, "Heating, Ventilation and Air Conditioning Systems," merely stated that "the HVAC outdoor air design temperature conditions are shown in Table 2.0-1." Three distinct annual percent exceedance levels are associated with various (presumably safety- and non-safety-related) HVAC systems. For COL applicants to properly associate site characteristic values with the corresponding design ambient temperature site parameter values listed in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, and to be consistent with the guidance in SRP Section 2.3.1 that calls for applicants to identify the "FSAR sections in which these conditions are used" (i.e., linked to specific SSCs), the staff issued RAI 126-8012, Question 02.03.01-3c (ML15295A386), requesting that the applicant update the DCD to identify where these associations exist.

In its response to RAI 126-8012, Question 02.03.01-3c, (ML15308A236), the applicant committed to updating DCD Tier 2, Section 9.4, to identify the percent annual exceedance values that are applied to the safety-related and nonsafety-related HVAC systems. The staff accepts the additional text proposed by KHNP for inclusion in DCD Tier 2, Section 9.4, because it allows COL applicants to properly associate site characteristic values with the corresponding design ambient temperature site parameter values listed in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1. The staff confirmed that DCD Tier 2 was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 126-8012, Question 02.03.01-3c, to be resolved and closed.

In addition, the staff confirmed that the minimum dry-bulb temperature values in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, were consistent with KHNP's response to RAI 126-8012, Question 02.03.01-3d (ML15308A236). Therefore, the staff considers RAI 126-8012, Question 02.03.01-3d, to be resolved and closed.

0-Percent Exceedance Dry- and Coincident Wet-Bulb Temperatures for HVAC System Design

The staff believes that the COL site characteristic values to be compared with the postulated 0-percent annual exceedance site parameter values should be either a 100-year return period or a historic extreme value, whichever is bounding. 10 CFR 52.79(a)(1)(iii) states, in part, that COL applicants must identify the meteorological characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. Temperatures based on a 100-year return period are considered to provide margin for the limited accuracy, quantity, and period of time in which historical data have been accumulated, as required by the regulation.

As indicated previously, the DCD defines 0-percent exceedance values as an historical limit excluding peaks of less than 2 hours. For the purpose of this review, the staff relied on 1-hour historical peaks based on available data. This would result in slightly higher maximums and slightly lower minimums (i.e., relatively more conservative values), to help ensure that the proposed site parameters are representative of a reasonable number of potential COL sites.

In evaluating the applicant's postulated 0-percent annual exceedance maximum and minimum dry-bulb temperature site parameter values, the staff determined 100-year return period dry-bulb temperatures based on data compiled by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) as referenced in SRP Section 2.3.1. The staff used ASHRAE's "Weather Data Viewer," Version 3.0, to obtain dry- and wet-bulb temperature data for over 650 weather observing stations throughout the contiguous United States.

The ASHRAE Weather Data Viewer provides for the calculation of a 100-year return period maximum dry-bulb temperature for each station. The staff found that about 8 percent of the weather stations in the database had a 100-year return period maximum dry-bulb temperature greater than the value of 46.1 degrees C (115 degrees F) in DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1. Thus, the staff accepts the applicant's 0-percent annual exceedance maximum dry-bulb temperature as bounding a reasonable number of potential COL sites.

The ASHRAE Weather Data Viewer also provides for the calculation of a 100-year return period minimum dry-bulb temperature for each station. The staff found that about 13 percent of the weather stations in the database had a calculated 100-year return period minimum dry-bulb temperature less than the value of -40.0 degrees C (-40 degrees F) in DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1. Thus, the staff accepts the applicant's 0-percent annual exceedance minimum dry-bulb temperature as bounding a reasonable number of potential COL sites.

In evaluating the applicant's postulated wet-bulb temperature of 26.7 degrees C (80 degrees F) coincident with the 0-percent annual exceedance maximum dry-bulb temperature site parameter value, the staff considered temperature and moisture data from the then National Climatic Data Center's Solar and Meteorological Surface Observational Network for the 1961 through 1990 period of record. Based on dry-bulb temperature, dew point temperature, 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 generally result in the highest wet-bulb temperatures. For all 75 locations, the staff determined that the highest recorded dry-bulb temperatures all fell below the 0-percent annual exceedance value of 46.1 degrees C (115 degrees F). Nevertheless, the staff derived the coincident wet-bulb temperature for each station at the corresponding hour with the highest dry-bulb temperature(s) at each location. The applicant's postulated coincident wet-bulb temperature site parameter of 26.7 degrees C (80 degrees F) was exceeded at only one location. Thus, the staff accepts the wet-bulb temperature coincident with 0-percent annual exceedance maximum dry-bulb temperature site parameter value.

1-Percent Exceedance Dry- and Coincident Wet-Bulb Temperatures for HVAC System Design

As with the proposed 0-percent annual exceedance site parameter design temperature values, the staff evaluated the applicant's postulated 1-percent annual exceedance maximum dry-bulb temperature of 37.8 degrees C (100 degrees F) and the wet-bulb temperature of 25.0 degrees C (77 degrees F) coincident with the 1-percent annual exceedance maximum dry-bulb temperature site parameter value, as well as the 1-percent annual exceedance minimum dry-bulb temperature value of -23.3 degrees C (-10 degrees F) using meteorological data from the ASHRAE Weather Data Viewer.

As an individual statistic, the 1-percent annual exceedance maximum dry-bulb temperature value of 37.8 degrees C (100 degrees F) was found to be exceeded at only about 4 percent of the weather stations in the ASHRAE database. Also, as an individual statistic, the mean coincident wet-bulb temperature (25.0 degrees C (77 degrees F)) associated with the 1-percent annual exceedance maximum dry-bulb temperature was found to be exceeded at only about 9 percent of the weather stations in the ASHRAE database. As a simple composite then (i.e., without determining whether these dry- and mean coincident wet-bulb temperature exceedances occurred at the same station), no more than about 13 percent of the weather stations in the database showed such exceedances. As a result, the staff considers that the postulated 1-percent exceedance dry- and mean coincident wet-bulb temperatures for the HVAC system design would likely bound a reasonable number of potential COL sites.

Similarly, the postulated 1-percent annual exceedance minimum dry-bulb temperature value of -23.3 degrees C (-10 degrees F) was exceeded at only about 10 percent of the weather stations in the ASHRAE database. Thus, the staff accepts this site parameter value as bounding a reasonable number of potential COL sites.

5-Percent Exceedance Dry- and Coincident Wet-Bulb Temperatures for HVAC System Design

The ASHRAE Weather Data Viewer does not directly summarize 5-percent annual exceedance maximum and minimum dry-bulb temperatures or the mean coincident wet-bulb temperature associated with a 5-percent annual exceedance maximum dry-bulb temperature; rather it provides statistics based on a 2-percent annual exceedance.

The staff did not evaluate, in detail, the applicant's postulated site parameter values associated with a 5-percent annual exceedance provided in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1. However, the preceding results for the 1-percent annual exceedance maximum and minimum dry-bulb temperatures and the mean coincident wet-bulb temperature associated with a 1-percent annual exceedance maximum dry-bulb temperature along with an indication

from the 2-percent annual exceedance statistics suggest, in terms of the relatively small percent of observing stations where those values were exceeded, that the 5-percent annual exceedance site parameter values for HVAC system design can be accommodated at a reasonable number of potential COL sites. Nevertheless, the staff notes that, if a COL applicant referencing the APR1400 design encounters dry- or wet-bulb temperatures, associated with a 5-percent annual exceedance (or any other exceedance level), as a characteristic of its proposed site and they are not bounded by the corresponding site parameter value(s) in the APR1400 DC, then the applicant must provide sufficient justification (e.g., by requesting an exemption from or amendment to the DC) that the proposed facility is acceptable at the proposed site.

2.3.1.4.6 Ultimate Heat Sink Meteorological Conditions

Revision 2 to RG 1.27 states that the UHS should be capable of providing sufficient cooling for at least 30 days. This means that a 30-day cooling water supply should be available and that the design-basis temperatures of safety-related equipment being served should not be exceeded. Therefore, the meteorological conditions resulting in the maximum evaporative and, if applicable, drift loss of water from the UHS, as well as the meteorological conditions resulting in minimum water cooling, should be considered to ensure that the UHS is available to perform its safety functions.

Consistent with RG 1.27, the essential service water pumps are designed to have sufficient net positive suction head to remain functional at the lowest probable water level of the UHS to meet the 30-day water supply requirements without makeup water. APR1400 DCD Tier 2, Section 9.2.1.1.1, “Design Basis,” addresses this safety function.

The applicant provided a design-basis meteorological condition for the UHS cooling tower (i.e., a non-coincident ambient wet-bulb temperature of 27.2 degrees C (81 degrees F) for the ESWS designated as a 0-percent annual exceedance value), as well as a site parameter corresponding to normal plant operating conditions (i.e., a non-coincident ambient wet-bulb temperature of 26.1 degrees C (79 degrees F) for the CWS designated as a 5-percent annual exceedance value). APR1400 DCD Tier 1, Table 2.1-1; Tier 2, Table 2.0-1; and Section 9.2.5.2.2.1 list each of these values.

The applicant also provided an ambient 5-percent annual exceedance minimum dry-bulb temperature value of -20.6 degrees C (-5 degrees F) for the CWS design under normal operating conditions and an ambient 0-percent annual exceedance minimum dry-bulb temperature value of -40 degrees C (-40 degrees F) for the ESWS corresponding to design-basis accident (DBA) conditions. DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, also list these site parameter values.

The staff requested, in RAI 126-8012, Question 02.03.01-3e (ML15295A386), that the applicant confirm whether the 0-percent annual exceedance values for the ESWS listed in DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, represent an historical limit or limits excluding peaks less than 2 hours as shown for the 0-percent annual exceedance values for HVAC systems. In its response to RAI 126-8012, Question 02.03.01-3e (ML15308A236), the applicant committed to updating DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, to indicate that the 0-percent annual exceedance values for the ESWS represent historical limits excluding peaks less than 2 hours. The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 126-8012, Question 02.03.01-3e, to be resolved and closed.

To determine whether the applicant's postulated ambient (design) site parameter for the ESWS is representative of a reasonable number of sites that may be considered for a COL application (in accordance with SRP Section 2.3.1), the staff compared the applicant's 0-percent annual exceedance non-coincident wet-bulb temperature (i.e., 27.2 degrees C (81 degrees F)) to corresponding site parameter values accepted under previous DCs and site characteristics submitted under various docketed ESP and COL applications. In making this comparison, the staff determined that the non-coincident ambient wet-bulb temperature postulated for the design of the ESWS was exceeded by a number of these corresponding site characteristic and site parameter values.

As a result, the staff issued RAI 126-8012, Question 02.03.01-3a (ML15295A386), which indicates that many of the previously reviewed DC applications for other new reactor designs initially referenced the Electric Power Research Institute (EPRI) Utility Requirements Document (URD) for the same design ambient temperature site parameters postulated for the APR1400 design. In many cases, applicants subsequently revised several of these site parameter values, including the 0-percent exceedance non-coincident wet-bulb temperature. The staff further noted that almost all of the COL and ESP applications previously reviewed identified 0-percent exceedance non-coincident wet-bulb temperatures greater than the corresponding site parameter value listed in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1. Consequently, the staff asked the applicant to either update the DC application, where applicable, by justifying the selection of the 0-percent annual exceedance non-coincident wet-bulb temperature (i.e., 27.2 degrees C (81 degrees F)), or to revise the indicated site parameter value.

In its response to RAI 126-012, Question 02.03.01-3a (ML15308A236), the applicant stated that the NRC had certified the U.S. Advanced Boiling-Water Reactor (ABWR) design in May 1997 and had recently performed a detailed review of the U.S. Evolutionary Power Reactor (EPR) design, both of which use 27.2 degrees C (81 degrees F) for the non-coincident wet-bulb temperature site parameter. The applicant also stated that the "APR1400 design ambient temperature site parameters and values for all percent exceedance levels are the same as those specified in the Electric Power Research Institute (EPRI) Utility Requirements Document (URD) for Advanced Light Water Reactors. Therefore, the 0 percent exceedance wet bulb temperature of 27.2° C (81° F) used in the APR1400 DCD is reasonable and valid for use today." The applicant also stated in its RAI response that "KHNP believes that a wet bulb temperature of 27.2° C (81° F) is sufficient for building a plant in a reasonable amount of locations across the US."

The staff acknowledges the applicant's statement that a previous DC (i.e., the ABWR) has used a site parameter value equal to the 0-percent annual exceedance non-coincident wet-bulb temperature applicable to the ESWS. The staff also found that about 33 percent of weather stations in the 48 contiguous United States (as reported in a 2005 database of climatic design information by ASHRAE) had reported an extreme historical maximum wet-bulb temperature less than (or equal to) 27.2 degrees C (81 degrees F). The ASHRAE extreme maximum wet-bulb temperature represents a single peak hourly observed value, whereas the 0-percent annual exceedance non-coincident wet-bulb temperature proposed for the APR1400 design represents an historical limit excluding peaks of less than 2 hours. The staff also notes that these extreme conditions do not appear to occur throughout the year but typically occur during the summer months.

While the staff finds that this site parameter should allow a plant referencing the APR1400 design to be sited at a reasonable number of locations, it does not take into account other siting considerations (e.g., availability of water; seismic conditions; other meteorological, hydrological,

and environmental conditions) in making that determination. Consequently, the staff considers RAI 126-8012, Question 02.03.01-3a, resolved and closed. However, the staff also notes that, if a COL applicant referencing the APR1400 design encounters a 0-percent annual exceedance non-coincident wet-bulb temperature as a characteristic of its proposed site that is not bounded by the corresponding site parameter value in the APR1400 DC, then the applicant must provide sufficient justification (e.g., by requesting an exemption from or amendment to the DC) that the proposed facility is acceptable at the proposed site.

Based on the review of the 2005 ASHRAE climatic design database mentioned above, the staff finds the postulated site parameter for the CWS under normal plant operating conditions (i.e., the 5-percent annual exceedance non-coincident wet-bulb temperature of 26.1 degrees C (79 degrees F)) to be reasonable. Several other new reactor designs specified the minimum ambient 5-percent annual exceedance dry-bulb temperature for the CWS design (i.e., -20.6 degrees C (-5 degrees F)) and the minimum ambient 0-percent annual exceedance dry-bulb temperature for the ESWS design (i.e., -40 degrees C (-40 degrees F)), and the staff found them acceptable.

2.3.1.5 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2, Table 1.8-2. The COL information items in the table below are related to Section 2.3.1.

Table 2.3-1 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.0(1)	The COL applicant is to demonstrate that the APR1400 design meets the requirements imposed by the site-specific parameters and conforms to all design commitments and acceptance criteria if the characteristics of the site fall outside the assumed site parameters in Table 2.0-1.	2.0 2.0.1
COL 2.3(1)	The COL applicant is to provide site-specific information on meteorology, including regional climatology, local meteorology, an onsite meteorological measurements program, estimated short-term atmospheric dispersion for accident releases, and long-term atmospheric dispersion estimates for routine release as addressed in RG 1.206.	2.3 2.3.6

2.3.1.6 Conclusions

The regional climatology is site specific and will be addressed by the COL applicant (DCD Tier 2, Table 1.8-2, COL 2.0(1)). The 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 in the APR1400 DCD. In accordance with SRP Section 2.3.1, the staff evaluated the postulated site parameters and, in general, considers that they are representative of a reasonable number of sites that have been or may be considered for a COL application and that each site parameter has a technical basis.

2.3.2 Local Meteorology

2.3.2.1 Introduction

APR1400 DCD Tier 2, Section 2.3.2, "Local Meteorology," describes the local meteorological information to be collected through a site-specific study by a COL applicant referencing the APR1400 DC. The COL applicant is to provide summaries of the local (site) meteorology, including normal and extreme values for meteorological parameters, an assessment of the construction and operational impacts of the plant and its facilities on local meteorology, and a topographical description of the site and its surroundings.

2.3.2.2 Summary of Application

In APR1400 DCD Tier 2, Section 2.3.2, the applicant stated that a COL applicant referencing the APR1400 DC is expected to provide site-specific characteristics related to local meteorology, including local meteorological conditions and a topographical description of the site area both before construction and during the operation of a plant that may be constructed on the proposed site. APR1400 DCD COL 2.3(1), listed in Tier 2, Table 1.8-2, and Section 2.3.6, states that the COL applicant is to provide site-specific information on meteorology, including local meteorology.

2.3.2.3 Regulatory Basis

The applicable regulatory requirements for describing local meteorological conditions include the following:

- 10 CFR 52.79(a)(1)(vi), as it relates to using site meteorology to evaluate offsite radiological consequences caused by postulated fission product releases
- 10 CFR 100.20(c)(2) and 10 CFR 100.21(d) with respect to the consideration given to the local meteorological characteristics of the site

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

- summaries of local meteorological data based on onsite measurements and National Weather Service station summaries or other standard installation summaries from appropriate locations in proximity
- a discussion and evaluation of the impact of the plant and its facilities on the local meteorological and air quality conditions and identification of potential changes in normal and extreme values resulting from plant construction and operation
- a complete topographical description of the site and the associated environment out to a distance of 80 km (50 miles) from the plant

DC applications do not contain this type of information because this information is site specific. A COL applicant referencing the APR1400 DC will address this information.

2.3.2.4 Technical Evaluation

The APR1400 DC has no postulated site parameters 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 caused by plant operation) are site specific and should be presented by a COL applicant referencing the APR1400 DC. As discussed in Section 2.3.1, the staff finds COL 2.3(1), requiring the COL applicant to provide site-specific information on local meteorology, acceptable.

2.3.2.5 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2, Table 1.8-2. The COL information item in the table below relates to DCD Tier 2, Section 2.3.2.

Table 2.3-2 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.3(1)	The COL applicant is to provide site-specific information on meteorology, including regional climatology, local meteorology, an onsite meteorological measurements program, estimated short-term atmospheric dispersion for accident releases, and long-term atmospheric dispersion estimates for routine release as addressed in RG 1.206.	2.3 2.3.6

2.3.2.6 Conclusions

A DC has no postulated site parameters related to local meteorology. The staff acknowledges that local meteorological conditions are site specific and will be addressed by a COL applicant referencing the APR1400 DC.

2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Introduction

A review of the onsite meteorological measurements program covers the following specific areas:

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

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

These areas of review are relevant to both the preoperational and operational phases of a proposed facility.

2.3.3.2 Summary of Application

APR1400 DCD Tier 2, Section 2.3.6, states, in part, that the "COL applicant is to provide site-specific information on meteorology, including [an] onsite meteorological measurement program." COL 2.3(1) in DCD Tier 2, Table 1.8-2, includes this statement. DCD Tier 2, Section 2.3.3, "Onsite Meteorological Measurements Program," and Section 2.3.6 briefly discuss the information on the onsite meteorological measurements program, which the COL applicant will provide, and the document appropriately references the information, as indicated in SER Section 2.3.3.4.

2.3.3.3 Regulatory Basis

From a preoperational standpoint, an acceptable onsite meteorological measurements program provides necessary input to satisfy the requirements in 10 CFR 100.20(c)(2). The onsite meteorological measurements program supports safety analyses that rely on a site's meteorological conditions or that may have an impact on plant design. Onsite meteorological data are also used to satisfy the requirements in 10 CFR 100.21(c) to evaluate site atmospheric dispersion characteristics and to establish dispersion parameters so that (1) the plant can meet radiological effluent release limits associated with normal operation for any individual located off site and (2) radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and outer boundary of the LPZ.

During the operational phase, the applicant relies on information about, and data from, an established and acceptably maintained onsite meteorological measurements program to meet the following regulatory requirements:

- 10 CFR 50.47(b)(4), 50.47(b)(8), and 50.47(b)(9), and Sections IV.E.2 and VI.2(a) of Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," to 10 CFR Part 50, with respect to available meteorological equipment and information necessary for determining the magnitude and continuously assessing the impact of releases of radioactive materials to the environment during a radiological emergency

- GDC 19, "Control Room," with respect to the evaluation of personnel exposures inside the control room during radiological and airborne hazardous material accident conditions

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

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

Regulatory guidance to be considered in establishing and maintaining an acceptable onsite meteorological measurements program and its description includes the following:

- RG 1.23, “Meteorological Monitoring Programs for Nuclear Power Plants,” Revision 1, issued March 2007

- RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” issued June 2007

2.3.3.4 Technical Evaluation

The staff reviewed the APR1400 DC application in accordance with SRP Section 2.3.3. This guidance recognizes that DCD Tier 2, Section 2.3.3, has no postulated site parameters and that the onsite meteorological monitoring program is site specific and will be addressed by a COL applicant.

Consistent with that understanding, DCD Tier 2, Section 2.3.3, acknowledged the COL applicant’s need for preoperational and operational monitoring programs for measuring meteorological conditions at a site, consistent with the guidance in RG 1.23. Further, DCD Tier 2, Section 2.3.6, reiterated COL 2.3(1) in DCD Tier 2, Table 1.8-2, on the site-specific nature of the meteorological measurements program (along with other climatological, meteorological, and atmospheric dispersion-related information under Section 2.3), consistent with the guidance in RG 1.206 for preparation of this information by a COL applicant.

The staff also notes that the APR1400 DC applicant identified relationships between the onsite meteorological measurements program and the systems, equipment, and information required for emergency preparedness planning and for availability in the appropriate emergency response facilities under those conditions (i.e., as part of the Emergency Response Data System in DCD Tier 2, Section 7.5.1.6, “Information Systems Associated with the Emergency Response Facility and Emergency Response Data System,” and Section 13.3, “Emergency Planning”). This is responsive to the cited regulations at 10 CFR 50.47(b)(4), 50.47(b)(8), and 50.47(b)(9); Sections IV.E.2 and VI.2(a) of Appendix E to 10 CFR Part 50; and GDC 19.

Finally, the DC applicant established linkages between the onsite meteorological measurements program and the radiological environmental monitoring program in various chapters of the APR1400 DC application (e.g., Chapter 9, “Auxiliary Systems”; Chapter 10, “Steam and Power Conversion System”; Chapter 11, “Radioactive Waste Management”; Chapter 12, “Radiation Protection”; and Chapter 16, “Technical Specifications”). This is responsive to the cited regulations at Appendix I to 10 CFR Part 50 and Subpart D of 10 CFR Part 20.

2.3.3.5 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2, Table 1.8-2. The COL information item in the table below relates to DCD Tier 2, Section 2.3.3.

Table 2.3-3 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.3(1)	The COL applicant is to provide site-specific information on meteorology, including regional climatology, local meteorology, an onsite meteorological measurements program, estimated short-term atmospheric dispersion for accident releases, and long-term atmospheric dispersion estimates for routine release as addressed in RG 1.206.	2.3 2.3.6

The staff evaluates the acceptability of this COL information item in the preceding section and concludes that no additional COL information items are needed.

2.3.3.6 Conclusions

There are no postulated site parameters for a DC related to the onsite meteorological measurements program. In addition, consistent with COL 2.3(1) in DCD Tier 2, Table 1.8-2, detailed descriptions of the onsite meteorological measurements program and the resulting database are site specific and will be addressed by COL applicants referencing the APR1400 DC.

Based on the above information, the staff finds the applicant's discussions in DCD Tier 2, Sections 2.3.3 and 2.3.6 to be adequate. Further, other sections and chapters of the DC application identify appropriate relationships, as referenced in SER Section 2.3.3.4, between the onsite meteorological measurements program and the related regulatory requirements for emergency preparedness planning and routine radiological monitoring activities. Although separate reviews will occur under those sections and chapters, the linkages are responsive to the review interfaces identified under Section I of SRP Section 2.3.3. Therefore, the staff finds the discussions on the onsite meteorological measurements program acceptable.

2.3.4 Short-Term Atmospheric Dispersion Estimates for Accident Releases

2.3.4.1 Introduction

Short-term dispersion estimates are used to determine the amount of airborne radioactive materials expected to reach a specific location during an accident situation. These estimates address the requirements for developing conservative atmospheric dispersion factors (relative concentrations or χ/Q values) at the EAB, at the outer boundary of the LPZ, and at the control room and Technical Support Center (TSC) for postulated DBA radioactive airborne releases. APR1400 DCD Tier 2, Section 2.3.4, "Short-Term Atmospheric Dispersion Estimates for Accident Releases," describes the short-term atmospheric dispersion factors at the EAB, the outer boundary of the LPZ, and at onsite locations such as the air intakes to the main control room (MCR), the auxiliary building, and the TSC.

2.3.4.2 Summary of Application

DCD Tier 2, Section 2.3.6, states, in part, that the "COL applicant is to provide site-specific information on meteorology, including regional climatology, local meteorology, onsite meteorological measurement program, estimated short-term atmospheric dispersion for accident releases, and long-term atmospheric dispersion estimates for routine releases as addressed in NRC RG 1.206."

The applicant listed as site parameters in DCD Tier 2, Table 2.0-1, a reference to accident-related atmospheric dispersion factors (χ/Q values) provided in DCD Tier 2, Table 2.3-2, "Onsite χ/Q for Reactor Containment Building Release to MCR and TSC North, and South Intakes and Roof Centerline"; Table 2.3-3, "Effective Onsite χ/Q for Reactor Containment Building Release to Auxiliary Building Intakes"; Table 2.3-4, "Onsite χ/Q for North and South Main Steam Valve Room Direct and Cross Releases to MCR and TSC North and South Intakes"; Table 2.3-5, "Effective Onsite χ/Q for North and South Main Steam Valve Room Releases to Auxiliary Building Intakes"; Table 2.3-6, "Onsite χ/Q for North and South Atmospheric Dump Valve Direct and Cross Releases to MCR and TSC North and South Intakes"; Table 2.3-7, "Onsite χ/Q for North and South Main Steam Safety Valve Direct and Cross Releases to MCR and TSC North and South Intakes"; Table 2.3-8, "Effective Onsite χ/Q for North and South Atmospheric Dump Valve Releases to Auxiliary Building Intakes"; Table 2.3-9, "Effective Onsite χ/Q for North and South Main Steam Safety Valve Releases to Auxiliary Building Intakes"; Table 2.3-10, "Effective Onsite χ/Q for Auxiliary Building North and South Exhaust Release to MCR and TSC Intakes"; Table 2.3-11, "Effective Onsite χ/Q for Auxiliary Building North and South Exhaust Release to Auxiliary Building Intakes"; and Table 2.3-12, "(Effective) Onsite χ/Q for Fuel Handling Area Exhaust Release to MCR and TSC North and South Intakes, and Auxiliary Building Intakes." Furthermore, the applicant provided accident release χ/Q values at the EAB and LPZ in DCD Tier 2, Tables 2.0-1 and 2.3-1. DCD Tier 1, Table 2.1-1, also lists these same postulated site parameters for the EAB and LPZ and cross-references the preceding Tier 2 tables for accident-related releases to the MCR, TSC, and auxiliary building intakes.

Site Parameters

The list of site parameters presented in APR1400 DCD Tier 1, Table 2.1-1, and DCD Tier 2, Tables 2.0-1 and 2.3-1, includes accident-related (short-term) χ/Q values for the EAB and outer boundary of the LPZ. The EAB and LPZ χ/Q site parameter values specified in DCD Tier 1, Table 2.1-1, are also given in DCD Tier 2, Tables 2.0-1 and 2.3-1. The list of site parameters referenced from DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 2.1-1 (i.e., DCD Tier 2, Tables 2.3-2 through 2.3-12), also include accident releases to the MCR and TSC. The TSC employs the same intake points as the MCR; therefore, the χ/Q values derived at the MCR are applicable to the TSC. The applicant's DBA radiological consequence analyses, which are presented in DCD Tier 2, Section 15.0.3, "Design-Basis Accident Radiological Consequence Analyses for Advanced Light-Water Reactors," used both the offsite (EAB and LPZ) and onsite (MCR, TSC, and auxiliary building intakes) site parameter values.

One set of EAB and LPZ χ/Q values was used to model the offsite dose consequences for all DBAs, whereas several sets of χ/Q values representing different release pathways to the MCR/TSC/auxiliary building intake locations were used in estimating potential doses for the MCR and TSC. The following are the assumed potential release pathways for modeling doses to the MCR and TSC:

- two main steam valve room vents
- two atmospheric dump valve vents
- two main steam safety valve vents
- two auxiliary building vents
- a fuel-handling area vent
- the containment building surface

With the exception of onsite meteorological data, DCD Tier 2, Table 2.3-13, “Design Input for ARCON96 Calculation,” and DCD Tier 2, Figure 2.3-1, “Locations of Post-Accident Gaseous Releases and Intakes,” present the information necessary to calculate χ/Q values at the MCR and TSC for each release pathway and receptor combination. DCD Tier 2, Figure 2.3-1, shows the relative locations of the release points and receptors with respect to Plant North. Any COL applicant referencing the APR1400 design will provide onsite meteorological data specific to the proposed site.

DCD Tier 2, Section 6.4, “Habitability Systems,” and Section 9.4 describe the MCR habitability systems, and DCD Tier 2, Section 15.0.3.6, “Analytical Models for Loss-of-Coolant Accidents,” presents the analytical assumptions for developing the atmospheric dispersion factors used in the radiological consequence analysis for DBAs. The MCR habitability systems protect both the plant operators in the MCR and TSC personnel from the effects of accidental releases of radioactive material and smoke. The TSC is contained within the control room envelope (CRE).

APR1400 DCD Tier 2, Section 2.3.4, states that the 2-hour EAB χ/Q value was selected from the EPRI URD for enveloping U.S. sites. The DCD also states that the χ/Q values for the outer boundary of the LPZ were selected to be conservative values applicable to the U.S. sites.

On April 29, 2015, the staff conducted a teleconference with the applicant to clarify information related, in part, to the APR1400 atmospheric dispersion meteorology-related site parameters in DCD Tier 2, Section 2.3.4, but not rising to the level of design detail. The applicant submitted its responses to the CQs (ML15132A598) with proposed changes to the DCD as follows:

- In response to CQ 02.03.04-1, the applicant agreed to update DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 2.1-1, to include a footnote to those tables that cross-reference DCD Tier 2, Tables 2.3-2 through 2.3-12, for the control room and TSC χ/Q values.

- In response to CQ 02.03.04-2, the applicant agreed to update DCD Tier 2, Figure 2.3-1, to show the MCR roof centerline as an intake point and the containment building surface as a release point. The staff notes that the distance and relative orientation of the containment building surface varies depending on the intake receptor location being evaluated.

- In response to CQ 02.03.04-3, the applicant agreed to update DCD Tier 2, Table 2.3-13, with a footnote that describes how the meteorological data set from the Prairie Island nuclear power plant was selected from among several other data sets for use in the ARCON96 dispersion modeling analyses (SER Section 2.3.4.4 provides further details).

- In response to CQ 02.03.04-4, the applicant agreed to update DCD Tier 2, Figure 2.3-1, to clarify the location of the MCR envelope and auxiliary building HVAC intakes.

Based on a review of the DCD, the staff has confirmed incorporation of the changes associated with the CQs discussed above; therefore, CQ Confirmatory Item 2.3.4-1 is resolved and closed.

2.3.4.3 Regulatory Basis

The acceptance criteria and information needed to evaluate an applicant’s analysis of short-term atmospheric dispersion conditions for postulated accidental radiological releases are based on meeting the relevant requirements in 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100, as well as the guidance in NUREG-0696, “Functional Criteria for Emergency

Response Facilities, Final Report," issued February 1981, and NUREG-0737, "Clarification of TMI [Three Mile Island] Action Plan Requirements," Supplement No. 1, issued February 1989. The staff considered the following regulatory requirements and guidance in reviewing the applicant's estimates of atmospheric dispersion for accidental releases:

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

- 10 CFR 52.79(a)(1)(vi), with respect to a safety assessment of the site, including consideration of major facility SSCs and site meteorology, to evaluate the offsite radiological consequences at the EAB and the outer boundary of the LPZ

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

- NUREG-0696, which states, in part, that "TSC personnel shall be protected from radiological hazards, including direct radiation and airborne radioactivity from in plant sources under accident conditions, to the same degree as control room personnel"

- Supplement 1 to NUREG-0737, Section 8.2.1. Item (f), which states, in part, that the TSC will be "[p]rovided with radiological protection and monitoring equipment necessary to assure that radiation exposure to any person working in the TSC would not exceed 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident"

SRP Section 2.3.4 calls for a COL applicant to provide the following information to support the staff's review and evaluation of whether the applicable acceptance criteria are met:

- A description of the atmospheric dispersion models used to calculate χ/Q values for accidental releases of radioactive and hazardous materials to the atmosphere. The models should be documented in detail and substantiated within the limits of the models so that the staff can evaluate their appropriateness of use with regard to release characteristics, plant configuration, plume density, meteorological conditions, and site topography.

- Meteorological data used for the evaluation (as input to the dispersion models) that represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release. Any dispersion estimates should be calculated from the most representative meteorological data available for the site.

- A discussion of the atmospheric diffusion parameters, such as lateral and vertical plume spread (σ_y and σ_z, respectively) as a function of distance, topography, and atmospheric conditions, as they relate to the measured meteorological data. The methodology for establishing these relationships should be appropriate for estimating the consequences of accidents within the range of distances that are of interest with respect to site characteristics and established regulatory criteria.

- Constructing hourly cumulative frequency distributions of χ/Q values from the effluent release point(s) to the EAB and outer boundary of the LPZ to describe the probabilities

of these χ/Q values being exceeded. All cumulative frequency distributions of χ/Q values should be presented for appropriate distances (as indicated above) and time periods as specified in Section C.I.2.3.4.2 of Part I of RG 1.206. The applicant should adequately describe the methods used for generating these distributions.

- Atmospheric dispersion factors used to assess consequences related to atmospheric radioactive releases to the MCR and TSC for DBA, other accidents, and onsite and offsite releases of hazardous airborne materials.

- For the MCR habitability analysis, a site plan drawn to scale showing True North and potential atmospheric accident release pathways, the MCR air intake(s), and unfiltered in-leakage pathways.

The staff's review of APR1400 DCD Tier 2, Section 2.3.4, also considered the following RGs and other related guidance documents (as applicable):

- RG 1.23, Revision 1, which includes guidance on the measurement and processing of onsite meteorological data for use as input to atmospheric dispersion models in support of plant licensing and operation

- RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Revision 1, issued February 1983, which provides guidance on appropriate dispersion models for estimating offsite χ/Q values as a function of downwind direction and distance (i.e., at the EAB and outer boundary of the LPZ) for various short-term time periods (up to 30 days) after an accident, provisions and guidance to account for ground-level and elevated releases, meteorological conditions, and modified plume dispersion caused by building wake effects, plume meander under low wind speed conditions, nonstraight plume trajectories, and fumigation conditions for stack (elevated) releases at coastal and inland site locations

- RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis-Accidents at Nuclear Power Reactors," issued July 2000, which discusses the need to provide an evaluation of the radiological consequences of DBAs at emergency response facilities (such as the MCR and TSC)

- RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," which discusses acceptable approaches for estimating short-term (i.e., 2 hours to 30 days after an accident) average χ/Q values near the buildings at MCR ventilation air intakes and at other locations of significant air in-leakage to the CRE caused by postulated DBA radiological airborne releases, provisions and guidance for determining release point characteristics, receptors, source-receptor distances and directions, and meteorological input data

- RG 1.206, which summarizes the types of information identified in SRP Section 2.3.4 that an applicant should provide in Section 2.3.4 for estimating χ/Q values used to assess the consequences of design-basis and other atmospheric radiological releases on MCR habitability

- NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations," issued November 1982 (prepared by Pacific Northwest Laboratory (PNL) (PNL-4413)),

which is the user's manual for the NRC-sponsored PAVAN dispersion model that implements the guidance in RG 1.145

- NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes," Revision 1, issued May 1997 (prepared by PNL (PNNL-10521)), which is the user's manual for the NRC-sponsored ARCON96 dispersion model that is referenced in RG 1.194

2.3.4.4 Technical Evaluation

The staff performed its review of the APR1400 DC application in accordance with SRP Section 2.3.4 and other relevant guidance by ensuring that (1) the DCD included EAB, LPZ, and MCR χ/Q values in the list of site parameters, (2) the DCD contained figures and tables describing the design features that would be used by COL applicants to generate MCR and TSC χ/Q values, (3) the applicant provided a basis for each of the EAB, LPZ, and MCR/TSC site parameter χ/Q values, and (4) the EAB, LPZ, and MCR/TSC site parameter χ/Q values were representative of a reasonable number of sites that may be considered within a COL application. The staff also reviewed the radiological consequence analyses in DCD Tier 2, Section 15.0.3, and the MCR habitability systems described in DCD Tier 2, Section 6.4, to determine whether the assumed fission product transport to the environment for each DBA was compatible with the χ/Q values used to model the release pathway.

The staff issued RAI 174-8211, Question 02.03.04-4 (ML15295A498), to confirm that the intakes (receptors) used for the MCR are the same receptors used for the TSC. Before the issuance of this RAI, the applicant had not discussed the TSC in DCD Tier 2, Section 2.3.4, or any of the associated tables and figures. In its response to RAI 174-8211, Question 02.03.04-4 (ML15269A030), the applicant confirmed that the TSC is located in the same CRE with the MCR; therefore, the radiological impact on the TSC is considered to be the same as that on the MCR. The applicant committed to updating DCD Tier 2, Section 2.3.4, and the relevant DCD tables to indicate that the short-term onsite atmospheric dispersion factors for the MCR also apply to the TSC. The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 174-8211, Question 02.03.04-4, to be resolved and closed.

2.3.4.4.1 Offsite Accident-Related 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 noted that the applicant included the EAB and LPZ χ/Q values as site parameters in the APR1400 DCD Tier 1, Table 2.1-1, and in DCD Tier 2, Tables 2.0-1 and 2.3-1.

APR1400 DCD Tier 2, Section 2.3.4, states that the accident χ/Q values were extracted from the EPRI Advanced Light-Water Reactor URD or were selected to be conservative values applicable to U.S. sites. In RAI 20-7912, Question 02.03.04-3 (ML15152A519), the staff requested that KHNP describe how it determined the χ/Q values or that it provide input/output files so that the staff could perform an independent confirmatory analysis. In its response to RAI 20-7912, Question 02.03.04-3 (ADAMS Accession No. ML15197A368), KHNP stated that "[s]ince the site-specific meteorological conditions are not available in the design certification (DC) application stage, the accident χ/Q values for APR1400 were selected to bound the recommended values in EPRI URD and the other previous DC applications. Therefore, no specific calculation using site-specific meteorological data was conducted." In its response,

KHNP also included Table 2, "Comparison of APR1400 Accident χ/Q Values with Other DC Applications and EPRI-URD," which compared the χ/Q values at both the EAB and LPZ from the Advanced Passive 1000 (AP1000) certified design, U.S. EPR, U.S. Advanced Pressurized-Water Reactor (US-APWR), and APR1400 DC applications, as well as the EPRI URD. The table shows that the χ/Q values for the APR1400 design are either equal to, or greater than, the highest values for each time interval from among the referenced DCDs and the EPRI URD. As such, the staff considers this response acceptable and, therefore, RAI 20-7912, Question 02.03.04-3, is resolved and closed.

To determine whether the APR1400 EAB and LPZ site parameter χ/Q values bound a reasonable number of sites that may be considered in a COL application, the staff compared the APR1400 EAB and LPZ site parameters to the site parameter χ/Q values in the AP1000 DC and to the EAB and LPZ χ/Q site characteristic values provided in COL and ESP applications that the staff had then reviewed and approved. The EAB and LPZ χ/Q values presented in these COL, ESP, and DC submittals were developed in accordance with current regulatory guidance, and have been reviewed and approved by the staff. The staff's comparison showed that the APR1400 EAB and LPZ site parameter χ/Q values bound all the site parameter χ/Q values in the AP1000 DC and the EAB and LPZ χ/Q site characteristic values provided in the approved COL and ESP submittals.

When comparing the APR1400 site parameter χ/Q values with the COL and ESP site characteristic χ/Q values, the COL and ESP sites are acceptable for the APR1400 design if the COL and ESP site characteristic χ/Q values are smaller than the corresponding APR1400 site parameter χ/Q values. Such a comparison would show that these COL and ESP sites have better dispersion characteristics than those provided by the APR1400 DCD postulated site parameters. The staff's comparison indicates that the APR1400 EAB and LPZ site parameter χ/Q values bound a reasonable number of potential COL and ESP sites. 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, therefore, are acceptable.

2.3.4.4.2 Onsite Accident-Related χ/Q Values

SRP Section 2.3.4 states that "atmospheric dispersion factors used for the assessment of consequences related to atmospheric radioactive releases to the MCR for design basis, other accidents, and for onsite and offsite releases of hazardous airborne materials should be provided."

To verify the technical acceptability of the applicant's estimates of onsite χ/Q values, the staff issued RAI 20-7912, Question 02.03.04-1 (ML15152A519), requesting the applicant to provide ARCON96 dispersion model input and output files for all source-receptor pairs evaluated so that it could independently conduct the confirmatory analysis described below. The applicant provided the requested information in the attachments to its response (ML15197A368). Accordingly, the staff considers RAI 20-7912, Question 02.03.04-1, to be resolved and closed.

APR1400 DCD Tier 2, Table 2.3-13, "Design Input for ARCON96 Calculation" (one of six), lists the meteorological data from Prairie Island Nuclear Generating Plant (Prairie Island) for use in the design input for the ARCON96 calculations. The staff issued RAI 20-7912, Question 02.03.04-2 (ML15152A519), requesting that the applicant provide the hourly onsite meteorological data from Prairie Island so that it could independently conduct a confirmatory analysis to verify the technical acceptability consistent with RG 1.194. In its response to

RAI 20-7912, Question 02.03.04-2 (ML15197A368), the applicant provided meteorological data in ARCON96 format for Prairie Island (1993–1997). To determine the adequacy of the meteorological data used in short-term atmospheric dispersion estimates for accident releases, the staff performed a routine quality assurance check. This evaluation included a check of the wind speed and wind direction at both the upper and lower levels of the Prairie Island meteorological tower and a summary of the stability class categories. The staff compared the results against the onsite meteorological summaries provided in previous versions of the Prairie Island updated SAR to ensure consistent conditions at the site. Based on this evaluation, the staff finds that the Prairie Island onsite meteorological data are acceptable for use in the applicant's atmospheric dispersion estimates. Therefore, the staff considers RAI 20-7912, Question 02.03.04-2, resolved and closed.

In reviewing the APR1400 DCD, the staff noted that DCD Tier 2, Table 2.3-13 (page one of six), included a parameter designated as "Meteorological Data" with an entry of "Prairie Island (1993–1997)." In CQ 02.03.04-3, the staff asked the applicant to explain the purpose of its inclusion in this table listing various design inputs for the onsite modeling analyses. In Enclosure 1 to its response to CQ 02.03.04-3 (ML15132A600), the applicant stated that it "conducted an analysis to establish a conservative basis for the onsite χ/Q s for the APR1400 DC application to support the control room habitability analyses. All publicly available meteorological data in the NRC ADAMS database for Alternative Source Term license amendment submittals were collected for the analysis. The meteorological data for six (6) U.S. sites, namely San Onofre (Pacific Ocean), Hope Creek (Delaware River), Prairie Island (Mississippi River), Quad Cities (Mississippi River), Limerick (Schuylkill River), and J.A FitzPatrick (Lake Ontario) were formatted for the ARCON96 calculations." Using these data and the APR1400 design-specific source-receptor design parameters, the applicant conducted a sensitivity analysis to identify the most conservative meteorological data for the control room habitability analysis. As a result, the applicant determined that the 5-year meteorological data for Prairie Island measured in 1993–1997 would bound the data of the other five sites, with a 50-percent margin also applied to attain the resulting onsite χ/Q s. As stated in COL 2.3(1) and in RGs 1.206 and 1.23, COL applicants are expected to provide site-specific information on meteorology, including estimated short-term atmospheric dispersion estimates for accident releases.

The staff issued RAI 174-8211, Question 02.03.04-5 (ML15295A498), to request that the applicant (1) identify the source-receptor pairs in ARCON96 that had not been evaluated and included in the DCD, and (2) explain in more detail the scope and limitations of the sensitivity analysis that considered the meteorological data from six site locations. In its response to Part (1) of RAI 174-8211, Question 02.03.04-5 (ML15269A030), the applicant provided a summary list of all the source-receptor combinations and identified which DCD tables contain the relevant χ/Q values. The staff accepts the response as informational and considers Part (1) of RAI 174-8211, Question 02.03.04-5, to be resolved and closed.

In Part (2) of RAI 174-8211, Question 02.03.04-5 (ML15295A498), the staff reiterated that six site locations (i.e., San Onofre Nuclear Generating Station, Hope Creek Generating Station, Prairie Island, Quad Cities Nuclear Power Station, Limerick Generating Station, and James A. FitzPatrick Nuclear Power Plant) were considered part of the applicant's MCR habitability analysis. The staff requested that the applicant explain in more detail the scope and limitations of this sensitivity analysis. In its response to Part (2) of RAI 174-8211, Question 02.03.04-5 (ML15269A030), the applicant stated that determining the most limiting meteorological data set for use in calculating the site parameter χ/Q values was necessary. This was done by developing the design-specific source-receptor pairs for the MCR north intake, the MCR south

intake, and the releases from the north and south main steam valve room release points. The RAI response included seven tables (e.g., Table 5, "χ/Q Values for North & South Main Steam Valve Room Releases to North & South Control Room Intakes using Prairie Island Met Data Files") of χ/Q values derived from the different meteorological datasets for the four source-receptor pairs.

In its response to Part (2) of RAI 174-8211, Question 02.03.04-5, the applicant also stated that "it was found that no single site-specific meteorological condition provided the limiting χ/Qs for all four source-receptor geometries. To address the absence of a single site providing limiting χ/Q values for APR1400 source-receptor geometries, the onsite χ/Q values were analyzed using the 5-year Prairie Island meteorological hourly data, and the resulting χ/Q values are increased by 50 percent such that the modeled onsite χ/Q values become bounding for the US site meteorological conditions as indicated in Table 9." The staff copied all the data into a spreadsheet to confirm the applicant's statement. The staff found that the χ/Q values resulting from the Prairie Island χ/Q increase of 50 percent bounds nearly all the time periods for all of the source-receptor pairs. The only instances in which this did not bound the other datasets is for the north main steam valve room to the MCR south intake. For this source-receptor pair, the meteorological dataset from the Salem/Hope Creek Generating Station site is the bounding scenario for the periods of 2–8 hours, 8–24 hours, 24–96 hours, and 96–720 hours. However, this scenario is not a significant concern to the staff because the controlling source is the south main steam valve room for the MCR south intake.

The applicant used the Prairie Island χ/Q values as the basis for all the ARCON96 computer model runs to evaluate MCR and TSC habitability. The applicant then reduced these χ/Q values by a factor of 8 for all MCR intakes and by a factor of 2 for all auxiliary building intakes (infiltration pathway), as provided in APR1400 DCD Tier 2, Table 2.3-16 (page 1 of 6), "Design Input for ARCON96 Calculation." The staff evaluated RG 1.194 to determine the applicability of these reduction factors as they pertain to the KHNP design.

Section 3.3.2.4 of RG 1.194 states the following in regard to the MCR intake reduction factor of 8:

> If the ventilation system design provides for automatic selection of the least contaminated outside air intake, the χ/Q values for the favorable intake should be calculated for each time interval as described elsewhere in this guide. The χ/Q values may be reduced by a factor of 10 to account for the ability to automatically select a "clean" intake. This protocol should be used only if the dual intakes are in different wind direction windows, there are redundant ESF [Engineered Safety Feature] grade radiation monitors within each intake, and an ESF-grade control logic and actuation circuitry is provided for the automatic selection of a clean intake throughout the event.

APR1400 DCD Tier 2, Section 6.4.1, "Design Basis," states that the control room HVAC system is capable of isolating the outside air intake upon detection of high radiation by the MCR supply air intake radiation monitors. DCD Tier 2, Section 6.4.2.2, "Ventilation System Design," also explains that the control room HVAC system consists of two redundant divisions. Each division has an outside air intake equipped with redundant radiation monitors and a smoke detector, dampers, an air cleaning unit, two air-handling units, ductwork, and instrumentation and controls. Upon receipt of an ESF actuation system/safety injection actuation signal or ESF actuation system/control room emergency ventilation actuation signal, the system would enter an emergency mode. This emergency mode would ensure that the CRE maintains habitability,

in part, by signaling the HVAC system to automatically select the outside air intake that has the lower radioactive contamination level and by opening the associated outside air intake isolation dampers. This description of the HVAC is consistent with the guidance in RG 1.194, which states that an applicant may reduce the χ/Q values by a factor of 10 to account for the ability to automatically select a "clean" intake. In its response to RAI 20-7912, Question 02.03.04-1 (ML15197A368), the applicant included in a footnote to Table 1, "ARCON96 I/O Filenames and the Relevant Information," that a "factor of 10 is applied to account for the ability to automatically select a 'clean' MCR intake per RG 1.194, Section 3.3.2.4, but for the conservatism, a factor of 8 is used." The staff agrees that, because the guidance allows a reduction factor of 10 to be applied, the use of a reduction factor of 8 is conservative and, therefore, is acceptable.

In regard to the auxiliary building intake reduction factor of 2, Section 3.3.2.3 of RG 1.194 states the following:

> If the ventilation system design allows the operator to manually select the least contaminated outside air intake as a source of outside air makeup and close the other intake, the χ/Q values for each of the outside air intakes should be calculated for each time interval as described elsewhere in this guide. The χ/Q value for the limiting intake should be used for the time interval prior to intake isolation. This χ/Q value may be reduced by a factor of 2 to account for dilution by the flow from the other intake (see Equation 6a).
>
> This protocol should be used only if the dual intakes are in different wind direction windows and if there are redundant, ESF-grade radiation monitors within each intake, with control room indication and alarm, to monitor the intakes.

APR1400 DCD Tier 2, Section 6.4.2.1, "Definition of Control Room Envelope," states that the CRE is located in the auxiliary building and that, in an emergency, it can be isolated from other plant areas and from the environment external to the CRE. DCD Tier 2, Chapter 9, "Auxiliary Systems," discusses, among other topics, the control room HVAC system. DCD Tier 2, Section 9.4.1.2, "System Description," describes the control room HVAC system. The applicant stated in this section that each air intake has redundant radiation monitoring devices. Isolation of the outside air intake occurs automatically upon detection of high radioactive contamination air or smoke in the outside air intake. This description of the auxiliary building HVAC system is consistent with the guidance provided in RG 1.194, which states that an applicant may reduce the χ/Q values by a factor of 2 to account for the ability of the ventilation system to allow the operator to select the least contaminated outside air intake as a source of outside air makeup and to close the other intake.

In response to RAI 20-7912, Question 02.03.04-1 (ML15197A368), the applicant included a footnote to Table 1 of the response that stated that a "factor of 2 is applied for Auxiliary Building intakes since the two intakes are located in a different wind direction window per RG 1.194, Section 3.3.2.2, Equation 6a." After a thorough review of the source-receptor locations depicted in DCD Tier 2, Figure 2.3-1, the staff did not agree with the applicant that the auxiliary building intakes are located in different 90-degree wind direction windows and, therefore, found that the aforementioned guidance is not applicable. The staff conveyed these concerns to the applicant in a clarification call on February 3, 2016. The applicant updated its response (Revision 2) to RAI 20-7912, Question 02.03.04-1 (ML16159A246), by including updated χ/Q values for DCD Tables 2.3-2 through 2.3-12 and by including new source-receptor information in DCD Table 2.3-13.

As part of its revised response to RAI 20-7912, Question 02.03.04-1 (ML16159A246), the applicant removed the factor of 2 reduction and included the use of effective onsite χ/Q values, as described in Equation 5a in Section 3.3.2.1 of RG 1.194. The guidance states, "[i]f both of the dual intakes are located within the same wind direction window, both intakes could be contaminated. In this case, the χ/Q values for each air intake should be calculated using ARCON96 as described in other sections of this guide and an effective χ/Q value calculated. Equation 5a should be used if the intake flow rates are equal." Effective χ/Q values were provided in DCD Tier 2, Table 2.3-3, Table 2.3-5, Table 2.3-8, Table 2.3-9, Table 2.3-10, Table 2.3-11, and Table 2.3-12, when the MCR, TSC, or auxiliary building intakes are located in the same 90-degree window. The following is Equation 5a from Section 3.3.2.1 of RG 1.194:

$$\overline{\chi/\mathrm{Q}} = \frac{1}{2}[(\chi/\mathrm{Q})_1 + (\chi/\mathrm{Q})_2],$$

where:

$\overline{\chi/\mathrm{Q}}$ = effective χ/Q, s·m^{-3}

$(\chi/\mathrm{Q})_1 + (\chi/\mathrm{Q})_2 =$ χ/Q value for outside air intakes 1 and 2, s·m^{-3}

In a conversation with the applicant, the staff requested that the applicant update the proposed DCD tables to include a short discussion on the use of effective onsite χ/Q. The applicant committed to updating DCD Tier 2, Tables 2.3-3, 2.3-5, 2.3-8, 2.3-9, 2.3-10, 2.3-11, and 2.3-12, to include a short definition of the phrase "effective χ/Q." The applicant committed to these changes in a second revision of RAI 20-7912, Question 02.03.04-1 (ML16159A246). The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 20-7912, Question 02.03.04-1, to be resolved and closed.

DCD Tier 2, Section 2.3.4, states that onsite χ/Q values for the APR1400 are calculated using the guidance in RG 1.194, the NRC-approved ARCON96 computer code, and representative meteorological data selected from the publicly available meteorological data.

In RAI 20-7912, Question 02.03.04-1 (ML15152A519), the staff requested that the applicant provide the input and output files for all source-receptor pairs in the ARCON96 analysis so that it could independently conduct a confirmatory analysis to verify the technical acceptability, consistent with the guidance in RG 1.194. In its response to RAI 20-7912, Question 02.03.04-1 (ML15197A368), the applicant stated that "the onsite atmospheric dispersion factors used for control room habitability analysis were evaluated using APR1400 design-specific source-receptor design parameters and the meteorological data for Prairie Island during the time period from 1993 to 1997." Table 1 of the response letter shows the names of ARCON96 input and output files used for the calculations and other information relevant to the modeling analysis, such as source-receptor locations, adjustment factors, and the corresponding table numbers in the DCD. Attachment 1 to the applicant's response contained the input and output files for all source-receptor pairs in the ARCON96 in ASCII text format.

The staff reviewed the overall quality of the meteorological data for Prairie Island from 1993 to 1997 and found the data to be consistent with the guidance in RG 1.23. Therefore, the staff finds the data acceptable for use in calculating the onsite χ/Q values. The staff reviewed the applicant's ARCON96 MCR/TSC atmospheric dispersion estimates, including the inputs and assumptions, which the staff found to be generally consistent with the updated site configuration drawings and input tables and with the staff's general practice. In addition, the staff generated sample comparative χ/Q estimates and found that the resultant χ/Q values were consistent

with the values calculated by the applicant. The staff's confirmatory analysis included running the ARCON96 model for the case presented in the DCD only (i.e., source-receptor orientations with respect to Plant North). The confirmatory analysis did not consider any other orientations of the site layout with respect to True North (to which wind direction measurements are referenced). However, it is understood that each potential COL applicant may orient the APR1400 design differently at its proposed site. Nevertheless, any COL applicant referencing the APR1400 DCD must compare the COL site-specific χ/Q values against the MCR and TSC site parameter χ/Q values in DCD Tier 2, Tables 2.3-2 through 2.3-12.

Based on the applicant's evaluation and selection of the Prairie Island meteorological data set from among several meteorological data sets, and by adding 50-percent margin to the estimated χ/Q values (see ML16119A121), the staff finds the applicant's onsite χ/Q values to be reasonable for use as site parameters in onsite dose assessments.

2.3.4.5 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2, Table 1.8-2: The COL information items in the table below are related to DCD Tier 2, Section 2.3.4.

Table 2.3-4 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.3(1)	The COL applicant is to provide site-specific information on meteorology, including regional climatology, local meteorology, an onsite meteorological measurements program, estimated short-term atmospheric dispersion for accident releases, and long-term atmospheric dispersion estimates for routine release as addressed in RG 1.206.	2.3 2.3.6
COL 2.3(2)	The COL applicant is to perform the radiological consequence analysis and demonstrate that the related dose limits specified in 10 CFR 50.34, "Contents of Applications; Technical Information," and Appendix I to 10 CFR Part 50 are not exceeded if the site-specific χ/Q values exceed the bounding values described in Tables 2.3-1 to 2.3-12.	2.3 2.3.6

2.3.4.6 Conclusions

The staff concludes that the applicant appropriately selected the short-term (postaccident) site parameters referenced above for plant design inputs. In addition, the staff agrees that these site parameter values should be representative of a reasonable number of sites that have been or may be considered for a COL application. The short-term atmospheric dispersion characteristics for accidental release are site specific and will be addressed by the COL applicant. The COL applicant should include information sufficient to demonstrate that the actual site characteristics fall within the values of the site parameters in the APR1400 DCD.

2.3.5 Long-Term Atmospheric Dispersion Estimates for Routine Releases

2.3.5.1 Introduction

Atmospheric dispersion and deposition factors (D/Qs) are a direct input to the calculation of the long-term (annual) radiological dose at offsite locations to individual members of the public and,

in some cases, to members of the public located on the plant site (e.g., during construction of additional units at, or adjacent to, an operating facility).

2.3.5.2 Summary of Application

The applicant listed, as site parameters in DCD Tier 2, Table 2.0-1, annual average atmospheric dispersion factors (χ /Q values) that (1) reflect neither radioactive decay nor depletion by deposition effects, (2) include a decay half-life of 2.26 days but without depletion, and (3) account for a decay half-life of 8 days but with depletion effects consistent with the guidance in RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, issued July 1977. DCD Tier 2, Table 2.0-1, also includes an annual average atmospheric D/Q site parameter value. DCD Tier 1, Table 2.1-1, also lists these same postulated site parameters.

DCD Tier 2, Section 2.3.5, indicates that no site-specific meteorological data are available at the DC stage to calculate atmospheric dispersion and relative deposition. Consequently, the applicant stated it chose a set of bounding (conservative) χ /Q and D/Q values based on a review of χ /Q and D/Q values reported for a number of U.S. sites.

2.3.5.3 Regulatory Basis

The acceptance criteria for evaluating an applicant's analysis of long-term atmospheric dispersion and deposition conditions for routine releases of radiological effluents to the atmosphere during normal plant operation are based on meeting the relevant requirements in 10 CFR Part 20, 10 CFR Part 50, and 10 CFR Part 100. The staff considered the following regulatory requirements in its review of the applicant's postulated site parameter values for atmospheric dispersion and deposition:

- Subpart D to 10 CFR Part 20, with respect to establishing atmospheric dispersion-related site parameters for demonstrating compliance with dose limits for individual members of the public

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

- 10 CFR 100.21(c)(1), with respect to establishing atmospheric dispersion-related site parameters so that the plant can meet radiological effluent release limits associated with normal operation for any individual located off site

DC applications do not contain general descriptions of site characteristics because this information is site specific and will be addressed by a COL applicant. However, under 10 CFR 52.47(a)(1), a DC applicant must provide site parameters postulated for the design. In accordance with Item 5(b) in Section III, "Review Procedures," of SRP Section 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases," the staff's review of a standard DC application under 10 CFR Part 52 verifies the following factors:

- The postulated site parameters are representative of a reasonable number of sites that have been or may be considered for a COL application.

- The application include the appropriate site parameters as Tier 1 information.
- A site parameter summary table shows the pertinent parameters.
- The applicant has provided a basis for each of the site parameters.

The following guidance includes information that the staff generally considers in its review of DCD Tier 2, Section 2.3.5:

- Revision 1 to RG 1.23 includes guidance on the measurement and processing of onsite meteorological data for use as input to atmospheric dispersion models in support of plant licensing and operation.
- 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," Revision 1, issued October 1977, includes guidance on identifying the location of potential receptors of interest.
- Revision 1 to RG 1.111 discusses different types of atmospheric transport and diffusion models and criteria for characterizing long-term (annual) average atmospheric dispersion and deposition conditions.
- RG 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," Revision 1, issued March 2007, includes guidance on identifying release point characteristics.
- NUREG/CR-2919, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," issued September 1982 (prepared by PNL (PNL-4380)), is the user's manual for the NRC-sponsored XOQDOQ dispersion model, which is intended to implement portions of RG 1.111.

The staff notes that the DC applicant did not perform any atmospheric dispersion modeling in deriving its χ/Q and D/Q site parameter values. Instead, the applicant based its proposed site parameter values on χ/Q and D/Q values reported at a selected number of operating plant sites and on two other reactor designs submitted to the NRC for certification.

2.3.5.4 Technical Evaluation

The staff reviewed DCD Tier 2, Section 2.3.5, in accordance with Revision 3 to SRP Section 2.3.5. DCD Tier 2, Section 2.3.6, identifies two COL information items (i.e., COL 2.3(1) and COL 2.3(2)) that relate to the evaluation of airborne radiological releases caused by routine plant operations. SER Section 2.3.5.5 reiterates these information items and provides additional details on them.

DCD Tier 2, Section 2.3.5, indicated that no site-specific meteorological data are available at the DC stage to calculate atmospheric dispersion and relative D/Qs. Consequently, the applicant did not base its proposed site parameter values on its own modeling analysis; instead, it took the approach of estimating "bounding conservative χ/Q and D/Q values…reviewed from the U.S. sites." DCD Tier 2, Section 2.3.5, does not identify the specific sites. Because the applicant did not provide additional details on how it determined the routine release site parameter values, the staff issued RAI 21-7913, Question 02.03.05-1 (ML15152A520),

requesting the XOQDOQ dispersion model input and output files and meteorological information so that it could conduct a confirmatory analysis.

In its response to RAI 21-7913, Question 02.03.05-1 (ML15182A395), the applicant reiterated the brief explanation from DCD Tier 2, Section 2.3.5, but also provided site parameter values for four operating U.S. nuclear power plants and two DC applications then under the staff's review. The applicant stated that XOQDOQ calculations using site-specific meteorological data were not performed for the DCD; therefore, it could not provide any XOQDOQ dispersion model input and output files. Instead, the applicant presented the χ/Q and D/Q values, which the staff has listed below in SER Table 2.3.5-1, and indicated that the χ/Q and D/Q DCD site parameter values (i.e., 2.0×10^{-5} seconds per cubic meter (s/m^3) and 2.0×10^{-7} $1/m^2$, respectively) were selected to bound those values. The staff notes that the NRC has not yet certified the US-APWR design and that the review of the U.S. EPR design has been suspended at the request of the applicant.

Table 2.3.5-1 Applicant's Comparison of APR1400 Annual Average χ/Q and D/Q Values with Other U.S. Nuclear Power Plant and DC Applications

Plant	EAB Site Boundary (m)	χ/Q (s/m^3)	D/Q ($1/m^2$)
Ginna	500	1.10×10^{-5}	1.80×10^{-7}
Cook	610	1.13×10^{-5}	----
Kewaunee	400	1.20×10^{-6}	----
Point Beach	1,200	1.50×10^{-6}	----
U.S. EPR	804	5.00×10^{-6}	5.00×10^{-8}
US-APWR	800	5.00×10^{-6}	4.00×10^{-8}
APR1400	800	2.00×10^{-5}	2.00×10^{-7}

The column headings in SER Table 2.3.5-1 are directly based on the applicant's response to RAI 21-7913, Question 02.03.05-1 (ML15182A395). The staff notes that the applicant, in its response, apparently used the phrases "exclusion area boundary" and "site boundary" interchangeably, although these phrases are not necessarily the same for all facilities. The staff also notes that the annual average site parameter χ/Q and D/Q values listed in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, appropriately associate these site parameter values with the "site boundary." More importantly, however, from an atmospheric dispersion standpoint, the χ/Q and D/Q values still allow for a comparison of the two site parameters at the distance shown for the APR1400 design relative to the corresponding values for the selected operating plant sites and the other two reactor designs at their respective boundary distances. The discussion related to SER Table 2.3.5-3 contains a further explanation on understanding the distance relationships when making comparisons between the site parameter χ/Q and D/Q values proposed for the APR1400 design and those for other facilities and designs.

Neither DCD Tier 2, Section 2.3.5, nor the applicant's response to RAI 21-7913, Question 02.03.05-1 (ML15182A395), provides any additional discussion of the range of meteorological conditions represented by these four sites and two designs. The "conservatively

selected" site parameter values postulated for the APR1400 design are apparently based on DCD Tier 2, Section 1.2.2, which states that "the site interface parameters presented in Chapter 2 are conservative enough to envelop most potential sites in the United States."

Compared to the summary above, the applicant listed an expanded set of postulated site parameters in DCD Tier 2, Table 2.0-1 (reproduced in SER Table 2.3.5-2 below), which includes, as indicated previously, annual average χ/Q values that (1) reflect no radioactive decay or depletion by deposition effects, (2) include a decay half-life of 2.26 days but without depletion, and (3) account for a decay half-life of 8 days but with depletion effects in accordance with RG 1.111. DCD Tier 2, Table 2.0-1, also included an annual average D/Q site parameter value, as did DCD Tier 1, Table 2.1-1.

Table 2.3.5-2 APR1400 Annual Average χ/Q and D/Q Site Parameter Values

Site Boundary Annual Average χ/Q (s/m^3) (No Decay/Undepleted)	Site Boundary Annual Average χ/Q (s/m^3) (2.26-Day Decay/Undepleted)	Site Boundary Annual Average χ/Q (s/m^3) (8.00-Day Decay/Depleted)	Site Boundary Annual Average D/Q ($1/m^2$) (Relative Deposition)
2.00×10^{-5}	1.99×10^{-5}	1.84×10^{-5}	2.00×10^{-7}

Relative to the procedures for the standard DC application reviews in Item 5(b) in Section III of SRP Section 2.3.5, the applicant has identified and summarized site parameters relevant to long-term atmospheric dispersion and deposition conditions for routine releases of radiological effluents to the atmosphere during normal plant operation. The applicant has also specified the same set of site parameters as both Tier 2 and Tier 1 design values.

The staff reviewed the annual average χ/Q and D/Q site parameter values proposed by the applicant relative to corresponding site parameters for two other reactor designs submitted to the staff for review (i.e., the U.S. EPR and US-APWR). For its comparison, the applicant also identified χ/Q and D/Q values for three plants in the existing fleet—that is, R.E. Ginna in New York State (on the south shore of Lake Ontario), D.C. Cook in Michigan (on the eastern shore of Lake Michigan), and Point Beach in Wisconsin (on the western shore of Lake Michigan), and for the former Kewaunee Power Station (located near, but inland of, the Point Beach Nuclear Plant). SER Table 2.3.5-1 lists these sites. The staff notes that the χ/Q attributed by KHNP to the US-APWR design (i.e., 5.00×10^{-6}) is specified in DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, of the US-APWR DC application and represents an annual average value for a "food production area." However, the staff further notes that Tier 2, Table 2.0-1, of the US-APWR DC application also lists a higher postulated annual average χ/Q value for the EAB (i.e., 1.60×10^{-5}). This Tier 2 US-APWR site parameter value is still bounded by the χ/Q postulated for the APR1400 design.

Given this limited comparison by the applicant, the staff also identified site characteristics in other NRC reviewed and approved ESP and COL applications covering more diverse geographic settings, as well as the site parameter values specified for the NRC-approved AP1000 plant design. SER Table 2.3.5-3 makes these comparisons with the site parameter values proposed for the APR1400 design. This table shows that the APR1400 design bounds the site characteristics for most of the COL and ESP sites and equals the site boundary site parameter values for the AP1000 design. The term "bounds" means that a given APR1400 site parameter is greater than, or equal to, the value that it is being compared to. More importantly,

the higher χ/Q and D/Q values indicate that the applicable dose limits can be met under relatively poorer atmospheric dispersion conditions for the APR1400 design.

SER Table 2.3.5-3 entries shaded in gray designate χ/Q and D/Q values that are less than (i.e., bounded by) the corresponding APR1400 site parameter values. In cases for which the distance to the site boundary is equal or nearly equal to the site boundary distance assumed for the APR1400 design (i.e., 805 m), the numerical comparison is straightforward (e.g., see the entries for Virgil C. Summer Nuclear Station, Vogtle Electric Generating Plant, and the AP1000 DC). For COL and ESP site boundary distances that are less than 805 m and have an already lower χ/Q or D/Q, the APR1400 value would likely be bounding because dispersion generally increases with greater downwind distance (i.e., lowering the χ/Q or D/Q value even further).

SER Table 2.3.5-3 contains some entries for which the COL and ESP site boundary distances are greater than 805 m, but the χ/Q or D/Q values are still less than the APR1400 site parameter values. Dispersion at closer-in travel distances would generally tend to be less, such that the χ/Q or D/Q values at 805 m would be higher than those listed in the table for the indicated site boundary distance. In these cases (and in cases for which output was available in the application), the staff checked the XOQDOQ dispersion model output at the 805-m (0.5-mile) standard distance to confirm that the χ/Q or D/Q values were still less than the APR1400 site parameter values. If so, those values are shaded in the table as well (e.g., entries for the Clinton Power Station ESP and the North Anna Power Station ESP).

For those table entries not shaded in gray, either they were not bounded by the proposed APR1400 site parameter values (based on the difference between the 805-m distance assumed for the APR1400 design and the indicated site boundary distance for the COL or ESP application) or no XOQDOQ dispersion model output was readily available to make that judgement (e.g., entries for the Fermi and Grand Gulf Nuclear Station ESPs).

Geographically, the COL and ESP application sites listed in SER Table 2.3.5-3 include coastal and interior locations as far west as Illinois (the Clinton Power Station ESP) and Texas (South Texas Project) and extend from Lake Erie (Fermi) to the southeast (Virgil C. Summer Nuclear Station and Vogtle Electric Generating Plant) in the United States. Based on the comparison results presented in SER Table 2.3.5-3, the staff finds that the applicant's offsite χ/Q and D/Q site parameter values are reasonable for use in offsite dose assessments.

Table 2.3.5-3 Postulated Site Parameter Values for APR1400 Compared to Corresponding Site Characteristics and Other Design Site Parameter Values

Site/ Design	Site Boundary Annual Average χ/Q (s/m^3) (No Decay/ Undepleted)	Site Boundary Annual Average χ/Q (s/m^3) (2.26-Day Decay/ Undepleted)	Site Boundary Annual Average χ/Q (s/m^3) (8.00-Day Decay/ Depleted)	Site Boundary Annual Average D/Q (1/m^2) (Relative Deposition)
APR1400	**2.00×10^{-5}**	**1.99×10^{-5}**	**1.84×10^{-5}**	**2.00×10^{-7}**
	805 m	**805 m**	**805 m**	**805 m**
Fermi (RWB Vent Stack)	1.1×10^{-5}	1.1×10^{-5}	1.0×10^{-5}	4.6×10^{-8}
	981 m	981 m	981 m	772 m
South Texas Project	8.10×10^{-6}	8.10×10^{-6}	7.30×10^{-6}	6.40×10^{-8}
	1,115 m	1,115 m	1,115 m	1,115 m
V.C. Summer	5.80×10^{-6}	5.80×10^{-6}	5.30×10^{-6}	1.60×10^{-8}
	805 m	805 m	805 m	805 m
Vogtle	5.5×10^{-6}	5.5×10^{-6}	5.0×10^{-6}	1.7×10^{-8}
	800 m	800 m	800 m	800 m
Clinton ESP	2.04×10^{-6}	2.04×10^{-6}	1.84×10^{-6}	1.46×10^{-8}
	1,025 m	1,025 m	1,025 m	1,025 m
Grand Gulf ESP	8.8×10^{-6}	-----	-----	1.2×10^{-8}
	1368 m	-----	-----	933 m
North Anna ESP	3.7×10^{-6}	3.7×10^{-6}	3.3×10^{-6}	1.2×10^{-8}
	1,416 m	1,416 m	1,416 m	998 m
PSEG Nuclear ESP	1.0×10^{-5}	1.0×10^{-5}	9.5×10^{-6}	4.1×10^{-8}
	386 m	386 m	386 m	386 m
AP1000 DCD	<= 2.0×10^{-5}	-----	-----	-----
	805 m	-----	-----	-----

The shaded values in SER Table 2.3.5-3 indicate instances where the χ/Q and D/Q values are bounded by the APR1400 design.

2.3.5.5 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2, Table 1.8-2. The COL information items in the table below are related to DCD Tier 2, Section 2.3.5.

Table 2.3-5 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.3(1)	The COL applicant is to provide site-specific information on meteorology, including regional climatology, local meteorology, an onsite meteorological measurements program, estimated short-term atmospheric dispersion for accident releases, and long-term atmospheric dispersion estimates for routine release as addressed in RG 1.206.	2.3 2.3.6
COL 2.3(2)	The COL applicant is to perform the radiological consequence analysis and demonstrate that the related dose limits specified in 10 CFR 50.34, "Contents of Applications; Technical Information," and Appendix I to 10 CFR Part 50 are not exceeded if the site-specific χ/Q values exceed the bounding values described in Tables 2.3-1 to 2.3-12.	2.3 2.3.6

With respect to COL 2.3(2), the staff notes that the referenced DCD Tier 2, Tables 2.3-1 to 2.3-12, only provide input information for accident-related dispersion estimates. DCD Tier 2, Section 11.3.3, "Radioactive Effluent Releases," provides information on the routine release points of radioactive material to the atmosphere. COL 2.3(2) appropriately cites Appendix I to 10 CFR Part 50. DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 2.1-1, provide site parameters relevant to long-term atmospheric dispersion and deposition conditions for routine radiological releases to the atmosphere during normal plant operation.

2.3.5.6 Conclusions

The DC applicant stated that no site-specific meteorological data related to potential COL applicants are available at the DC stage to calculate atmospheric dispersion and relative deposition. As a result, the applicant did not base its proposed site parameter values on its own modeling analysis; instead, it estimated "bounding conservative χ/Q and D/Q values" from among a selected number of operating plant sites and two other reactor designs submitted to the NRC for certification.

The staff's safety review focused on comparing the χ/Q and D/Q site parameter values proposed by the applicant with corresponding values proposed as site parameters for other designs or identified as site characteristics in other approved COL and ESP applications. Using this information, the staff considers the results of the applicant's approach reasonable given the number of DC, COL, and ESP applications submitted to the NRC, to date, under 10 CFR Part 52.

The applicant has selected the long-term (routine release) site parameters listed in the preceding sections for plant design inputs. The staff agrees that they are representative of a reasonable number of sites that have been or may be considered for a COL application. Long-term atmospheric dispersion and deposition characteristics are site specific and will be addressed by the COL applicant. The COL applicant should include information sufficient to demonstrate that the design of the plant can accommodate the values of the actual site characteristics specified in the application

2.4 Hydrologic Engineering

In DCD Tier 2, Section 2.4, the applicant provided information to allow an independent hydrologic engineering review to be made of all hydrologically related design bases, performance requirements, and bases for the operation of SSCs important to safety. The staff conducted its review consistent with the guidance in the SRP. This safety evaluation is based on the review of the KEPCO of the APR1400 DC application. The staff used DCD Tier 2, Table 2.0-1, which includes COL information items, to determine the adequacy of the application. The review areas included the hydrological description, floods, probable maximum flood on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami flooding, ice effects, cooling water channels and reservoirs, channel diversion, flooding protection requirements, low water considerations, ground water, accidental release of liquid effluents in ground and surface waters, and TS and emergency operation requirements. For the DC review, site-specific issues will be deferred to the COL applicant. This section reviews the hydrological parameters that constitute the APR1400 standard plant design bases for siting suitability presented by a COL applicant under 10 CFR Part 52 or included in an application under 10 CFR Part 50.

2.4.1 Hydrologic Description

2.4.1.1 Summary of Application

APR1400 DCD Tier 2, Table 2.0-1, indicates that the maximum ground water level considered in the plant design is 0.61 meter (2 feet) below plant grade near the SSCs important to safety. Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore, is site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.1.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.1, “Hydrologic Description,” using the guidance in SRP Section 2.4.1, “Hydrologic Description.” The staff considers an applicant’s hydrological description adequate if it meets the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

- GDC 44 in Appendix A to 10 CFR Part 50 states that a system must be provided to transfer heat from SSCs important to safety to a UHS. The system’s safety function must be to transfer the combined heat load of these SSCs under normal operating and accident conditions.

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

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

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

2.4.1.3 Technical Evaluation

The DCD applicant stated that future COL applicants will be responsible for demonstrating that the site parameters for a specific reactor location are within the limits specified for the APR1400 standard design. The specific site is acceptable if the site characteristics are within the APR1400 plant site design parameters detailed in DCD Tier 2, Table 2.0-1. DCD Tier 2, Chapter 2, provides additional information on the site interface parameters.

The COL applicant will provide the site-specific information in accordance with SRP Section 2.4.1, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and which forms the basis for the hydrologic engineering design. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures required by COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0.

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

2.4.1.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-1 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.1.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.2 Floods

2.4.2.1 Summary of Application

APR1400 DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the standard plant design is 0.3 meter (1 foot) below plant grade near SSCs important to safety. Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore, is site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.2.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.2, "Floods," using the guidance provided in SRP Section 2.4.2, "Floods." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

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

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

2.4.2.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.2, which is used to satisfy the requirements in

10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that the standard plant design-basis flood elevation is not exceeded. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.2.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-2 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.2.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.3 Probable Maximum Flood on Streams and Rivers

2.4.3.1 Summary of Application

APR1400 DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the power plant design is 0.3 meter (1 foot) below plant grade near SSCs important to safety. Table 2.0-1 also indicates a maximum rainfall rate of 49.27 centimeters per hour (cm/h) (19.4 inches per hour (in/h)) and a maximum short-term (5-minute) rainfall rate of 15.7 cm/h (6.2 in/h) in the power plant design. The APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.3.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.3, "Probable Maximum Flood on Streams and Rivers," using the guidance provided in SRP Section 2.4.3, "Probable Maximum Flood (PMF) on Streams and Rivers." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

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

2.4.3.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.3, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from the overflow of streams and rivers will not exceed the standard plant design-basis flood elevation.

The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.3.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-3 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.3.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.4 Potential Dam Failures

2.4.4.1 Summary of Application

APR1400 DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the power plant design is 0.3 meter (1 foot) below plant grade near SSCs important to safety. Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore, is site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.4.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.4, "Potential Dam Failures," using the guidance in SRP Section 2.4.4, "Potential Dam Failures." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

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

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

2.4.4.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.4, which is used to satisfy the requirements in

10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from seismically induced dam failure will not exceed the standard plant design-basis flood elevation. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, Revision 1, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.4.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-4 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.4.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.5 Probable Maximum Surge and Seiche Flooding

2.4.5.1 Summary of Application

APR1400 DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the power plant design is 0.3 meter (1 foot) below plant grade near SSCs important to safety. Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore, is site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.5.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.5, "Probable Maximum Surge and Seiche Flooding," using the guidance in SRP Section 2.4.5, "Probable Maximum Surge and Seiche Flooding." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

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

2.4.5.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.5, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from maximum surge and seiche flooding will not exceed the standard plant design-basis flood elevation. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.5.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-5 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.5.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.6 Probable Maximum Tsunami Flooding

2.4.6.1 Summary of Application

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the plant design is 0.3 meter (1 foot) below plant grade near SSCs important to safety. Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore, is site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.6.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.6, "Probable Maximum Tsunami Hazards," using the guidance provided in SRP Section 2.4.6, "Probable Maximum Tsunami Hazards." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

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

2.4.6.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.6, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that any flood resulting from tsunami flooding will not exceed the standard plant design-basis flood elevation. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL

applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.6.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-6 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.6.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.7 Ice Effects

2.4.7.1 Summary of Application

DCD Tier 2, Table 2.0-2, indicates that the specific plant design does not include a safety-related service water system that could be affected by ice-induced flooding or blockage and, therefore, defers the presentation of site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.7.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.7, "Ice Effects," using the guidance provided in SRP Section 2.4.7, "Ice Effects." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and

regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 44 in Appendix A to 10 CFR Part 50, which states that a system must be provided to transfer heat from SSCs important to safety to a UHS and that the system's safety function must be to transfer the combined heat load of these SSCs under normal operating and accident conditions

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

2.4.7.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. In regard to the applicability of the relevant requirements of GDC 44, the staff considered the information in Table 2.0-1, which stated that no safety-related service water systems exist that could be subjected to ice flooding or blockage.

If an external water source is used to meet the requirements in GDC 44, the COL applicant will need to provide site-specific information in accordance with SRP Section 2.4.7, which is to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 related to flooding, low water, or ice damage to safety-related SSCs. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.7.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-7 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.7.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the

KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.8 Cooling Water Channels and Reservoirs

2.4.8.1 Summary of Application

DCD Tier 2, indicates that the plant design does not include a safety-related service water system that requires transport and impoundment of plant cooling water and, therefore, defers the presentation of site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.8.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.8, “Cooling Water Canals and Reservoirs,” using the guidance in SRP Section 2.4.8, “Cooling Water Canals and Reservoirs.” The staff considers the applicant’s flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 1, “Quality Standards and Records,” in Appendix A to 10 CFR Part 50, which states that SSCs important to safety must be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed

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

- GDC 44 in Appendix A to 10 CFR Part 50, which states that a system must be provided to transfer heat from SSCs important to safety to a UHS and that the system’s safety function must be to transfer the combined heat load of these SSCs under normal operating and accident conditions

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

2.4.8.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.8, which is used to satisfy the requirements in

10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that the capacities of the cooling water canals and reservoirs are adequate. This information is not available at the DC stage. In view of the relevant requirements, the staff considered the fact that the regulations concerning safety-related service water systems require transport and impoundment of plant cooling water (i.e., DCD Tier 1, Section 4.1, "Site Specific Structures"). The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.8.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-8 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.8.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.9 Channel Diversion

2.4.9.1 Summary of Application

DCD Tier 2, Table 2.0-2, indicates that the plant design does not include a safety-related service water system that could be adversely affected by natural stream channel diversion and, therefore, defers the presentation of site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.9.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.9, "Channel Diversions," using the guidance in SRP Section 2.4.9, "Channel Diversions." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 1 in Appendix A to 10 CFR Part 50, which states that SSCs important to safety must be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed
- GDC 2 in Appendix A to 10 CFR Part 50, which states that SSCs important to safety must be designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches, without loss of capability to perform their safety functions
- GDC 44 in Appendix A to 10 CFR Part 50, which states that a system must be provided to transfer heat from SSCs important to safety to a UHS and that the system's safety function must be to transfer the combined heat load of these SSCs under normal operating and accident conditions
- 10 CFR 52.17(a) and 10 CFR 100.20(c), which state that consideration of the acceptability of a site will include the physical characteristics of the site, including seismology, meteorology, geology, and hydrology

2.4.9.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.9, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate that the capacities of cooling water canals and reservoirs are adequate. This site-specific information is not likely to be available at the DC stage. In view of the relevant requirements in GDC 1, GDC 2, and GDC 44, the staff considered the fact that the regulations regarding safety-related service water systems require transport of plant cooling water that would be affected by natural stream channel diversion. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.9.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-9 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.9.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.10 Flooding Protection Requirements

2.4.10.1 Summary of Application

DCD Tier 2, Table 2.0-1, indicates that the maximum flood level considered in the plant design is 0.3 meter (1 foot) below plant grade. Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore, is site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.10.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.10, "Flooding Protection Requirements," using the guidance in SRP Section 2.4.10, "Flooding Protection Requirements." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 1 in Appendix A to 10 CFR Part 50, which states that SSCs important to safety must be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed

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

- GDC 44 in Appendix A to 10 CFR Part 50, which states that a system must be provided to transfer heat from SSCs important to safety to a UHS and that the system's safety function must be to transfer the combined heat load of these SSCs under normal operating and accident conditions

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

2.4.10.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.10, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and to demonstrate the topography and geology of the site and their applicability to damage as a result of flooding. Flooding protection requirements for the standard design have two parts: one is based on site-specific conditions; and the other is based on the measures taken by the standard plant design features, such as watertight access doors, qualification of equipment that may be subject to inundation caused by external flooding, and flood elevation warning systems (if any). The first part relates to the criteria of GDC 1, GDC 2, and GDC 44, and the applicant has specified a design-basis flood elevation. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.10.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-10 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.10.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in

accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.11 Low Water Considerations

2.4.11.1 Summary of Application

DCD Tier 2, indicates that the plant design does not include a safety-related service water system that requires a water supply to operate the plant or maintain safe shutdown under normal and emergency conditions and, therefore, defers the presentation of site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.11.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.11, "Low Water Considerations," using the guidance in SRP Section 2.4.11, "Low Water Considerations." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

- GDC 44 in Appendix A to 10 CFR Part 50, which states that a system must be provided to transfer heat from SSCs important to safety to a UHS and that the system's safety function must be to transfer the combined heat load of these SSCs under normal operating and accident conditions

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

2.4.11.3 Staff Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.11, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 associated with likely land use changes and changes in water demand that could alter the frequency of low-flow conditions and the related minimum water elevation for the safety-related water use at a plant. In view of the relevant requirements in GDC 44 and the information provided in DCD Tier 2, Section 4.1, the staff considered the fact that the site-specific service water system will require transport or impoundment of plant cooling water and determined that the COL applicant is responsible for this issue. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy

of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.11.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-11 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.11.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.12 Ground Water

2.4.12.1 Summary of Application

DCD Tier 2, Table 2.0-1, indicates that the maximum ground water level considered in the plant design is 0.61 meter (2 feet) below plant grade near SSCs important to safety. Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.12.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.12, "Groundwater," using the guidance in SRP Section 2.4.12, "Groundwater." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the

following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

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

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

2.4.12.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.12, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and which includes site-specific local hydrogeological information and hydraulic parameters that govern contaminant transport. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.12.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-12 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.12.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1).

Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.13 Accidental Releases of Liquid Effluent in Ground and Surface Water

2.4.13.1 Summary of Application

DCD Tier 2, indicates that the source term to be used in the radionuclide transport analysis (accidental release) can be found in Table 11.2-9, "Inventory of Radionuclides That Could Seep into the Groundwater." Because the standard plant design basis is intended to be suitable for varied site conditions and, therefore, is site independent, APR1400 DCD Tier 2, defers the presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.13.2 Regulatory Basis

The staff reviewed APR1400 DCD Tier 2, Section 2.4.13, "Accidental Releases of Liquid Effluents in Ground and Surface Water," using the guidance provided in SRP Section 2.4.13, "Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters." The staff considers the applicant's flood design basis for safety-related plant features adequate if the features meet the codes, standards, and regulatory guidance commensurate with the safety function to be performed, thus ensuring that the following relevant requirements are met as they relate to identifying and evaluating the hydrologic features of the site:

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

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

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

- 10 CFR 100.21, which provides nonseismic siting criteria

2.4.13.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.13.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-13 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.13.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.4.14 Technical Specification and Emergency Operation Requirements

2.4.14.1 Summary of Application

DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 5.1-1, indicate the basic hydrologic design bases related to the maximum ground water level considered in the plant design. Because the site-specific hazards related to any emergency condition for plant operation or limiting conditions of operation are not available at the DC stage, APR1400 DCD Tier 2, defers the

presentation of the required site-specific information on this hydrologic design topic to the COL applicant.

Furthermore, consistent with COL 2.4(1), the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.

2.4.14.2 Regulatory Basis

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

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

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

2.4.14.3 Technical Evaluation

The applicant stated, in the KHNP APR1400 DCD Tier 2, that a COL applicant referencing the KHNP APR1400 DCD will address the site-specific information pertaining to flooding and other related hydrodynamic phenomena. Accordingly, the COL applicant will provide the site-specific information in accordance with SRP Section 2.4.14, which is used to satisfy the requirements in 10 CFR Part 52 and 10 CFR Part 100 and to describe the site-specific emergency conditions of operation. The need for this information is identified as COL 2.4(1) in APR1400 DCD Tier 2, which notes that the COL applicant is to describe the basic physical characteristics of the reactor site and vicinity. The need for this information is also identified because it will be used to demonstrate the adequacy of flood protection/mitigation measures as called for in COL 3.4(1) and COL 3.4(4) in APR1400 DCD Tier 2, Revision 0. The COL applicant should provide information sufficient to demonstrate that the power plant design falls within the values of the actual site characteristics specified in any COL application.

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

2.4.14.4 Combined License Information Items

As part of its review of this portion of the application, the staff considered the adequacy of the

COL information items presented in DCD Tier 2, Table 1.8-2. The following COL information item is related to this section:

Table 2.4-14 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.4(1)	The COL applicant is to describe the basic physical characteristics of the reactor site and vicinity.	2.4 2.4.15

2.4.14.5 Conclusion

As set forth above, the applicant stated, in the KHNP APR1400 DCD Tier 2, that the COL applicant will provide the site-specific hydrologic information in accordance with COL 2.4(1). Because this information is site-specific, the staff considers the applicant's statement in the KHNP APR1400 DCD Tier 2 that the COL applicant will supply this site-specific information in accordance with SRP Section 2.1.2 to be acceptable. For the reasons given above, the staff concludes that, because this information is site-specific, it will be addressed by the COL applicant and, therefore, would be reviewed at the COL stage. The COL applicant should include information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics as specified in a COL application.

2.5 Geology, Seismology, and Geotechnical Engineering

2.5.1 Introduction

APR1400 DCD Tier 2, Section 2.5.1, "Basic Geology and Seismic Information," describes the regional and site geologic and seismic information to be collected by a COL applicant during site-specific and regional investigations. The purpose of the required COL application site investigations is to determine geologic and seismic suitability of the site and the basis for plant design and to determine whether there is significant new tectonic, nontectonic, or ground motion information that could impact the seismic design basis.

APR1400 DCD Tier 2, Section 2.5.2, "Vibratory Ground Motion," describes the design-basis peak ground acceleration (PGA) and design response spectra of the design vibratory ground motion for the APR1400 plant. The section also describes the seismological, geological, geophysical, and geotechnical investigations that COL applicants must perform to determine the site-specific ground motion response spectrum (GMRS), the foundation input response spectra (FIRS), and the safe-shutdown earthquake (SSE) ground motion for the site. The development of the GMRS is based on a detailed evaluation of earthquake potential at the COL applicant's site, taking into account the regional and local geology, quaternary tectonics, seismicity, and site-specific geotechnical engineering characteristics of the site subsurface material.

APR1400 DCD Tier 2, Section 2.5.3, "Surface Faulting," describes the site-specific information related to surface deformation as a result of tectonic and nontectonic processes to be collected by a COL applicant during site characterization investigations. The purpose of these investigations is to determine site suitability when there is a possibility of surface deformation that could have adverse impact on the design bases. The APR1400 standard plant design is based on the premise that there is no potential for tectonic surface deformation under the foundations of seismic Category I structures and adjacent seismic Category II structures.

APR1400 DCD Tier 2, Section 2.5.4, "Stability of Subsurface Materials and Foundations," describes the site-specific geotechnical and geophysical information and investigations that COL applicants must provide to determine the properties and the stability of subsurface materials and foundations that could affect the safe design and siting of the plant. The

APR1400 standard plant design specifies key site parameters related to the stability of the subsurface materials and foundations that were used as design bases.

APR1400 DCD Tier 2, Section 2.5.5, “Stability of Slopes,” describes the type of site-specific geologic and geotechnical information and investigations that the COL applicant must provide to determine the stability of all slopes, both natural and manmade, where failure under any of the conditions to which they could be exposed during the life of the plant could adversely affect the safety of the plant. The APR1400 standard plant design is based on the premise that there is no site-specific potential for slope failure that could jeopardize a safety-related SSC.

APR1400 DCD Tier 2, Section 2.5.6, “Combined License Information,” only identifies DCD Section 2.5-related COL information items that are listed in APR1400 DCD, Tier 2, Table 1.8-2, “Combined License Information Items,” and therefore, this section does not require a technical evaluation.

2.5.2 Summary of Application

2.5.2.1 Basic Geologic and Seismic Information, DCD Section 2.5.1

DCD Tier 1: There are no DCD Tier 1 entries for this area of review.

DCD Tier 2: The applicant described the basic geologic and seismic information required of a COL applicant in DCD Tier 2, Section 2.5.1, as summarized below.

DCD Section 2.5.1 describes the basic geologic, seismic, and geophysical information that COL applicants must provide through investigations that they must conduct to estimate the potential for strong earthquake ground motions at the site. DCD Tier 2, Section 2.5.1, does not have any postulated APR1400 site parameters.

ITAAC: There are no ITAAC for this area of review.

TS: There are no TS for this area of review.

COL Information or Action Items: See SER Section 2.5.5.

Technical Reports: There are no technical reports associated with this area of review.

Topical Reports: There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

2.5.2.2 Vibratory Ground Motion, DCD Section 2.5.2

DCD Tier 1: The Tier 1 information associated with this section is found in DCD Tier 1, Section 2.1. DCD Section 2.1, Table 2.1-1, and DCD Section 2.1, Figure 2.1-1 and Figure 2.1-2, provide the design-basis parameters of PGA and horizontal and vertical CSDRS for the APR1400 plant. DCD Table 2.1-1 specifies a PGA value of 0.3g for the SSE ground motion. In addition, DCD Table 2.1-1; Figure 2.1-3, “Horizontal HRHF Response Spectra”; and Figure 2.1-4, “Vertical HRHF Response Spectra,” provide the hard rock high frequency (HRHF) response spectra for situations in which the high-frequency portion of the site response

spectrum exceeds the CSDRS. As specified in DCD Table 2.1-1, the APR1400 HRHF has a PGA value of 0.46g.

DCD Tier 2: The applicant described the APR1400 DCD design-basis vibratory ground motion and the process for determining the site-specific design-basis vibratory ground motion required of a COL applicant in Section 2.5.2, as summarized, in part, below.

DCD Section 2.5.2 briefly describes the geologic, seismic, geophysical, and geotechnical investigations that COL applicants must provide to determine the site-specific vibratory ground motion information and the SSE for their site. The SSE represents the design earthquake ground motion at the site and is the vibratory ground motion for which certain SSCs are designed to remain functional. DCD Section 2.5.2 also describes the design spectra for the APR1400 and the comparison between the site-specific GMRS and the CSDRS, which is required to show that the site meets the design requirements. DCD Section 2.5.2 contains provisions for site-specific analysis in the event that the CSDRS does not envelop the site-specific GMRS. Finally, DCD Section 2.5.2 contains provisions for ensuring site uniformity, based on geologic and geophysical properties.

ITAAC: There are no ITAAC for this area of review.

TS: There are no TS for this area of review.

COL Information or Action Items: See SER Section 2.5.5.

Technical Reports: There are no technical reports associated with this area of review.

Topical Reports: There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

2.5.2.3 Surface Faulting, DCD Section 2.5.3

DCD Tier 1: The Tier 1 information associated with this section is found in DCD Tier 1, Section 2.1. The design-basis parameter of potential surface deformation for the APR1400 plant is provided in DCD Section 2.1, Table 2.1-1. The DCD states that a COL applicant's site for construction of an APR1400 plant will be acceptable if its potential for surface deformation is within the design parameter shown in DCD Section 2.1, Table 2.1-1, which specifies that no tectonic and nontectonic surface deformation potential be present.

DCD Tier 2: The applicant described the process for determining the site-specific design-basis surface faulting potential required of a COL applicant in Section 2.5.3, as summarized, in part, below.

DCD Section 2.5.3 and DCD Section 2.0, Table 2.0-1, describe the site-specific geologic and seismic information that COL applicants must provide through required investigations to determine the potential for surface deformation at the site. DCD Section 2.5.3 also states that there should be no potential for surface tectonic and nontectonic deformation at the site.

ITAAC: There are no ITAAC for this area of review.

TS: There are no TS for this area of review.

COL Information or Action Items: See SER Section 2.5.5.

Technical Reports: There are no technical reports associated with this area of review.

Topical Reports: There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

2.5.2.4 Stability of Subsurface Materials and Foundations, DCD Section 2.5.4

DCD Tier 1: The Tier 1 information associated with this section is found in DCD Tier 1, Section 2.1. DCD Tier 1, Section 2.1, Table 2.1-1, provides the design-basis parameters of subsurface stability for maximum static and dynamic bearing demand, minimum shear wave velocity, maximum dip angle for soil uniformity, liquefaction potential, maximum differential settlement inside and between buildings, minimum soil angle of internal friction, and backfill material properties for the APR1400 plant.

Table 2.1-1 provides site acceptability requirements for COL applicants referencing an APR1400. A COL applicant's site will be acceptable if the site characteristics are bounded by the postulated site parameters identified in the aforementioned table.

DCD Tier 2: The applicant described the process for determining the site-specific design-basis subsurface material stability information required of a COL applicant in Section 2.5.4, as summarized, in part, below.

The APR1400 DCD Tier 2, Section 2.5.4, contains the requirements for stability of subsurface materials and foundations. This section describes the site-specific geotechnical and geophysical information that COL applicants must provide through required investigations to determine the properties of all soils and rock, which may affect the nuclear power plant facilities under both static and dynamic conditions.

The DCD states that the COL applicant would need to verify whether the site rock and soil material properties are consistent with those assumed in DCD Tier 2, Section 3.7.1, "Seismic Design Parameters." DCD Tier 2, Section 3.8.5, "Foundations," discusses the analyses related to the foundation and factors of safety (FOS) for stability for the APR1400 standard plant design.

DCD Tier 2, Table 2.0-1, which provides the APR1400 site design parameters, specifies that the maximum static bearing demand for the APR1400 design is 957.6 kPa (20 kilopounds per square foot (ksf)) and that the maximum dynamic bearing demand is 2,872.8 kPa (60.0 ksf). The DCD applicant specified that the allowable static and dynamic bearing capacities, including FOS of 3 and 2, respectively, shall be greater than, or equal to, the maximum static and dynamic bearing demands specified in the table. DCD Tier 2, Table 2.0-1, also specifies the minimum shear wave velocity as 304.8 m/s (1,000 ft/s). DCD Tier 2, Table 2.0-1, postulates a maximum dip angle for soil uniformity of 20 degrees with respect to the horizontal and no liquefaction potential for seismic Category I structures. In addition, DCD Tier 2, Table 2.0-1, specifies a maximum allowable differential settlement inside buildings of 12.7 mm (0.5 inch) per 15.24 m (50 ft) in any direction for all seismic Category I structures for site suitability determination purposes. The applicant recommended a maximum allowable differential settlement of 76.2 mm (3.0 inches) between buildings; specifically, between the nuclear island (NI) common basemat and the emergency diesel generator building (EDGB), between the NI

and the diesel fuel oil storage tank (DFOT), and between the EDGB and the DFOT for site suitability determination purposes. DCD Tier 2, Table 2.0-1, specifies several parameters for backfill material that include a material density of 2,195 kilograms per cubic meter (kg/m^3) (137 pound-force per cubic foot (pcf)), a dynamic Poisson's ratio of 0.33, strain-compatible minimum shear wave velocity of 155.4 m/s (510 feet per second (fps)), and a range for minimum dynamic shear moduli.

ITAAC: There are no ITAAC for this area of review.

TS: There are no TS for this area of review.

COL Information or Action Items: See Section 2.5.5.

Technical Reports: There are no technical reports associated with this area of review.

Topical Reports: There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

2.5.2.5 Stability of Slopes, DCD Section 2.5.5

DCD Tier 1: The Tier 1 information associated with this section is found in DCD Tier 1, Section 2.1. DCD Tier 1, Section 2.1, Table 2.1-1, provides the design-basis parameters for stability of slopes for slope failure potential and the minimum FOS for slopes for static and dynamic conditions for the APR1400 plant. A COL applicant's site for construction of an APR1400 will be acceptable if the site characteristics are bounded by the postulated site parameters identified in Table 2.1-1.

DCD Tier 2: The applicant described the type of site-specific geologic and geotechnical information and required investigations to determine the stability of all slopes, both natural and manmade, where failure under any of the conditions to which they could be exposed during the life of the plant could adversely affect the safety of the plant.

DCD Tier 2, Table 2.0-1, which provides the APR1400 site design parameters, specifies no slope failure potential, a minimum FOS for slopes for static conditions of 1.5, and a minimum FOS for slopes for dynamic conditions of 1.2.

ITAAC: There are no ITAAC for this area of review.

TS: There are no TS for this area of review.

COL Information or Action Items: See Section 2.5.5 below.

Technical Reports: There are no technical reports associated with this area of review.

Topical Reports: There are no topical reports associated with this area of review.

APR1400 Interface Issues Identified in the DCD: There are no APR1400 interface issues associated with this area of review.

2.5.3 Regulatory Basis

The relevant NRC regulations for these areas of review and the associated acceptance criteria are given in SRP Section 2.5.1, “Basic Geologic and Seismic Information”; Section 2.5.2, “Vibratory Ground Motion”; Section 2.5.3, “Surface Faulting”; Section 2.5.4, “Stability of Subsurface Materials and Foundations”; and Section 2.5.5, “Stability of Slopes,” and are summarized below. Review interfaces with other SRP sections can be found in SRP Sections 2.5.1, 2.5.2, 2.5.3, 2.5.4, and 2.5.5.

- The regulation in 10 CFR 52.47(a)(1) requires a DC applicant to provide site parameters postulated for the design and an analysis and evaluation of the design in terms of those site parameters. However, DC applications do not include general descriptions of site characteristics because this information is site specific and is addressed by the COL applicant. There are no postulated site parameters for a DC related to SRP Sections 2.5.1 and 2.5.5 (applies to DCD Sections 2.5.1 and 2.5.5 only).

- The regulation in 10 CFR 52.47(a)(1) requires a DC applicant to provide site parameters postulated for the design and an analysis and evaluation of the design in terms of those site parameters. However, DC applications do not include general descriptions of site characteristics because this information is site specific and is addressed by the COL applicant. The postulated site parameters for a DC related to SRP Sections 2.5.2, 2.5.3, and 2.5.4 must be representative of a reasonable number of sites that may be considered for a COL application, and the DC applicant must provide a basis for the site parameters (applies to DCD Sections 2.5.2, 2.5.3, and 2.5.4).

- GDC 1 requires that SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. It also requires that appropriate records of the design, fabrication, erection, and testing of SSCs important to safety be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

- GDC 2 applies 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.

- GDC 44 requires that a system be provided with the safety function of transferring the combined heat load from SSCs important to safety to a UHS under normal operating and accidental conditions.

- 10 CFR 100.23 requires an evaluation for suitability of a proposed site based on the 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 nontectonic deformation. The site-specific GMRS satisfies the requirements in 10 CFR 100.23 with respect to the development of the SSE.

- Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” to 10 CFR Part 50 applies to the design of nuclear plant SSCs important to safety to withstand the effects of earthquakes and to the minimum requirement for FIRS.

In addition, the geologic characteristics should be consistent with the appropriate sections from the following RGs:

- RG 1.60, “Design Response Spectra for Seismic Design of Nuclear Power Plants,” Revision 2, issued July 2014
- RG 1.208, “A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion,” issued March 2007
- RG 1.132, “Site Investigations for Foundations of Nuclear Power Plants,” Revision 2, issued October 2003
- RG 1.138, “Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants,” Revision 3, issued December 2014
- RG 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites,” issued November 2003
- RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations,” Revision 3, issued March 2014
- RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” issued June 2007

2.5.4 Technical Evaluation

The staff discusses its evaluation of the information in DCD Tier 2, Section 2.5, and the applicant’s responses to RAIs below. In addition to the RAIs that address specific technical issues regarding DCD Tier 2, Section 2.5, and discussed in detail below, the staff prepared several editorial RAIs to clarify certain descriptive statements made by the applicant in DCD Tier 2, Section 2.5. This technical evaluation does not discuss these editorial RAIs.

2.5.4.1 Basic Geologic and Seismic Information, DCD Section 2.5.1

The staff reviewed the regulatory guidance and basic geologic and seismic information requirements provided in DCD Tier 2, Section 2.5.1, for COL applicants referencing the APR1400 DCD. Although this information is not required for a DC and although it is entirely site specific, the applicant needs to provide such information to ensure that COL applicants referencing the APR1400 DCD can meet the relevant requirements of GDC 2 and 10 CFR 100.23. The staff determined that the applicant adequately described the necessary geologic and seismic information and investigations, as well as the applicable regulations and RGs that potential COL applicants must address when submitting a COL application; therefore, the staff concludes that APR1400 DCD Tier 2, Section 2.5.1, is acceptable.

2.5.4.2 Vibratory Ground Motion, DCD Section 2.5.2

The staff reviewed the regulatory guidance and geologic, seismic, geophysical, and geotechnical information and investigation requirements in DCD Tier 2, Section 2.5.2, for COL applicants referencing the APR1400 DCD. The purpose of the staff’s review of DCD Tier 2, Section 2.5.2, was to determine the adequacy of the requirements for determining the site-specific GMRS and FIRS. The staff reviewed the SSE parameters specified in DCD Tier 1, Section 2.1, Table 2.1-1, to determine whether the CSDRS meet the regulatory requirements.

The applicant stated that the CSDRS are anchored at a PGA of 0.3g for the APR1400 and that the design spectra are described in DCD Section 3.7.1 and shown in DCD Figure 3.7-1, "Horizontal CSDRS," and Figure 3.7-2, "Vertical CSDRS." The APR1400 design response spectra used a modified high-frequency approach to the spectra in Revision 1 to RG 1.60. The staff focused its review on the applicant's description of the GMRS and FIRS. The GMRS is a site-specific response spectrum defined as a free-field motion. The location of the GMRS is at either the ground surface or the top of the uppermost in situ competent material; therefore, its control point location may vary from site to site. The FIRS are the site-specific GMRS at the foundation level, and the CSDRS are site-independent seismic design response spectra for the APR1400 scaled to a PGA value of 0.3g. The standard design also includes an HRHF response spectrum for determining the suitability of a site with a layer of material overlying hard rock. The HRHF serves as an additional design parameter to ensure that the APR1400 standard design accounts for high-frequency ground motions.

In DCD Tier 2, Section 2.5.2.6, "Ground Motion Response Spectrum," the applicant provided a list of four criteria that need to be met to ensure that the site-specific GMRS falls within the design parameters of the DCD. The applicant also provided for an additional analysis if these criteria are not met. In RAI 9-7848, Question 2.5.2-2, the staff asked the applicant to clarify (1) whether all four requirements must be met at once and (2) whether an additional analysis can be done in the event that the HRHF does not envelop the site-specific GMRS when the site is classified as a hard rock site.

In its response to RAI 9-7848, Question 2.5.2-2, dated June 15, 2015 (ML15166A295), the applicant provided the following additional information:

- A COL applicant's site does not need to meet all four requirements in DCD Tier 2, Section 2.5.2.6, at once.

- A COL applicant will perform a site-specific screening of components sensitive to high-frequency motions in the event that the HRHF does not envelop the site-specific GMRS when the site is classified as a hard rock site.

The applicant also proposed modifications to DCD Tier 2, Section 2.5.2, to incorporate the RAI response into the DCD. Because the RAI response clarifies the conditions that a COL applicant must meet to avoid additional site-specific evaluations, the staff considered the RAI response acceptable. The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 9-7848, Question 2.5.2-2, closed.

In DCD Section 2.5.2.6, the applicant provided a criterion for soil sites; specifically, "the lower bound of the site-specific strain-compatible soil profile is greater than the lower bound of the generic strain-compatible soil profiles used in the APR1400 seismic analyses." The staff reviewed the DCD criterion for soil sites and determined that the provision in the DCD did not accomplish the following:

- Account for sites with velocity reversals in the soil profile or variations in other parameters, such as shear modulus or hysteretic damping, which are realisms that will likely occur within the parameters of the COL site-specific soil profiles.

- Provide sufficient requirements to ensure that a COL applicant would need to ensure that the parameters of each site-specific soil profile (the lower bound (LB), best estimate (BE), and upper bound (UB)) are consistent with one of the generic soil profiles in the

DCD. This is required to ensure that a COL applicant's site-specific parameters are consistent with those of the DCD; otherwise, the COL applicant would need to perform a site-specific soil-structure interaction (SSI) analysis.

- Address the need for the COL site-specific strain-compatible soil properties to be consistent with the assumptions used in the DCD SSI analysis. This assumption is needed to ensure that a COL applicant's site-specific parameters are consistent with those used in the DCD SSI analysis; otherwise, a COL applicant needs to perform a site-specific SSI analysis.

- Specify that the minimum strain shear wave velocity should only be imposed up to the structural foundation elevation.

- Provide an appropriate reference to SRP Section 3.7.2 for the methodology used to define a COL applicant's LB and UB site-specific soil profiles.

Based on the staff's review of DCD Tier 2, Section 2.5.2.6, the staff issued RAI 9-7848, Question 2.5.2-3; RAI 137-8102, Question 2.5.2-4; and RAI 366-8406, Question 2.5.2-5, requesting that the applicant provide more comprehensive requirements for comparing the site-specific soil profile to the generic profiles presented in the DCD (as described above) and, where appropriate, modify COL information item(s).

In its responses to RAI 9-7848, Question 2.5.2-3 (ML15166A295); RAI 137-8102, Question 2.5.2-4 (ML15261A624); and RAI 366-8406, Question 2.5.2-5 (ML16062A224), the applicant provided the following additional information:

- Site-specific velocity profiles should increase with depth, have no velocity reversals, and have a minimum soil density of 2,002.3 kg/m^3 (125 pounds per cubic foot (lb/ft^3)).

- All site-specific soil profiles (LB, BE, and UB) should be consistent with one of the generic soil profiles S1-S4 and S6-S9 shown in DCD Tables 3.7A-1 through 3.7A-9.

- Site-specific strain-compatible properties are developed using assumptions consistent with the assumptions in the SSI analysis used to support the DCD.

- The minimum shear wave velocity requirement applies up to the elevation of the structural foundation.

- UB and LB shear wave velocity profiles are developed in accordance with SRP Section 3.7.2 and maintain the minimum variation of $1.5G_{BE}$ for the UB and $G_{BE}/1.5$ for the LB, where G_{BE} is the BE low-strain shear modulus.

- For a rock site, the site-specific shear wave velocity profile must be consistent with the generic profile provided in Table 3.7B-4 in the DCD, and the GMRS should be enveloped by the APR1400 HRHF. In addition, the FIRS of seismic Category I structures are completely enveloped by the HRHF compatible free-field response motions at the bottom elevation of each seismic Category I structure.

- Requirements in DCD Tier 2, Section 2.5.2.6, apply to each seismic Category I structure.

The applicant also proposed modifications to Section 2.5.2.6 and COL 2.5(2) through 2.5(6) to incorporate the RAI responses into the DCD. The staff reviewed the responses to RAI 9-7848,

Question 2.5.2-3; RAI 137-8102, Question 2.5.2-4; and RAI 366-8406, Question 2.5.2-5, and concludes that the applicant's response and accompanying DCD modifications will ensure that a COL applicant can adequately compare its site-specific soil profiles to the generic profiles contained in the DCD to determine whether a site-specific SSI analysis is required. Therefore, the staff finds the applicant's RAI response acceptable. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, the staff considers the following RAI resolved and closed: RAI 9-7848, Question 2.5.2-3; RAI 137-8102, Question 2.5.2-4; and RAI 366-8406, Question 2.5.2-5.

Based on its review of the APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Section 2.5.2, the staff concludes that the APR1400 CSDRS are determined by following the guidelines of Revision 2 to RG 1.60, with an HRHF to account for high-frequency vibratory ground motion at rock sites and considered potential nuclear power plant sites in the United States. The staff concludes that the applicant adequately described the geologic, seismic, geophysical, and geotechnical information and investigations that a COL applicant needs to perform for detailed site-specific analyses. In addition, the staff concludes that the applicant adequately specified the redesign or modification requirement that a COL applicant must meet when the site-specific FIRS exceed the CSDRS or when verification analysis results indicate that the seismic design may be inadequate for a particular site to meet the relevant requirements of GDC 2 and 10 CFR 100.23. Accordingly, the staff concludes that APR1400 DCD Tier 2, Section 2.5.2, is acceptable.

2.5.4.3 Surface Deformation, DCD Section 2.5.3

The staff reviewed the regulatory guidance and the descriptions provided in APR1400 DCD Tier 2, Table 2.0-1, and Section 2.5.3, on the site-specific geologic and seismic information and investigation requirements necessary for potential COL applicants referencing the APR1400 DCD to determine the potential for surface deformation. The applicant described the provisions for ensuring that there was no potential for tectonic deformation at the site; however, the applicant proposed no criteria for the potential of nontectonic deformation at the site. In RAI 3-7829, Question 2.5.3-1, the staff asked the applicant to clarify whether the APR1400 is designed for a site with the potential for nontectonic deformation and whether the design limits regarding tectonic and nontectonic deformation should be tracked as a COL information item.

In its response to RAI 3-7829, Question 2.5.3-1 (ML15132A594), the applicant provided the following additional information:

- The APR1400 is not designed to accommodate nontectonic deformation beneath the foundations of seismic Category I and adjacent seismic Category II structures.
- The COL applicant should evaluate the potential future surface deformation of tectonic and nontectonic origin at the site as part of COL 2.5(9).
- If the potential for surface deformation is present, the COL applicant will demonstrate that this deformation is within the design limits of the APR1400 plant as part of COL 2.5(10).

The applicant also proposed modifications to DCD Tier 2, Table 2.0-1; Section 2.5.3; and Section 2.5.6 to incorporate the RAI response into the DCD. Because the RAI response and proposed modification address the potential for both tectonic and nontectonic surface deformation at the plant site, the staff finds the RAI response acceptable. The staff confirmed

that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 3-7829, Question 2.5.3-1, closed.

The staff determined that the DCD applicant clearly specified that there should be no potential for surface tectonic or nontectonic deformation at the site. The applicant also adequately described the site-specific geologic and seismic information and investigations necessary for a COL applicant to determine the potential for surface deformation and to ensure that there is no surface deformation at the site that could have an adverse impact on the structural integrity of safety-related SSCs. Accordingly, the staff concludes that the applicant adequately used no potential for surface deformation at the site as the design basis and that it provided the requirements that a COL applicant referring to the APR1400 DCD must meet to ensure that there is no surface deformation at the site. Because the "no surface deformation design basis" will ensure that the structural integrity of safety-related SSCs meets the relevant requirements of GDC 2 and 10 CFR 100.23 and because the potential for surface deformation is not present at many sites in the United States, the staff determined that this basis for design is reasonable and, therefore, concludes that APR1400 DCD Tier 2, Section 2.5.3, is acceptable.

2.5.4.4 Stability of Subsurface Materials and Foundations, DCD Section 2.5.4

The staff reviewed the regulatory guidance and the APR1400 standard design site parameters and description in DCD Tier 2, Section 2.5.4, of the site-specific geotechnical and geophysical information and investigations that COL applicants must provide to determine the properties and stability of soil and rock under both static and dynamic loading conditions. The staff reviewed this information to ensure that the APR1400 DCD met the requirements of GDC 1, GDC 2, and GDC 44; Appendix S to 10 CFR Part 50; and 10 CFR Part 100. The staff focused its review on the APR1400 DCD standard design site parameters; in particular, the information provided in DCD Tier 2, Table 2.0-1. During the review, the staff issued several RAIs addressing specific technical issues related to the APR14000 DCD application. The staff discusses its evaluation of the applicant's responses to these RAIs below. The staff also prepared a number of editorial RAIs and clarification RAIs that it did not discuss in this technical evaluation.

In RAI 1-7827, Question 2.5.4-1, the staff asked the applicant to provide or properly cross-reference the soil or rock uniformity requirements needed for the foundation of safety-related structures. In its response to RAI 1-7827, Question 2.5.4-1 (ML15132A592), the applicant stated that there is no requirement for soil uniformity except that the dip angle in the soil layer shall be less than 20 degrees. The applicant proposed revisions to DCD Tier 2, Table 2.0-1, and DCD Tier 1, Table 2.1-1, with this information. Based on its review, the staff concludes that the applicant's response to RAI 1-7827, Question 2.5.4-1, properly described the soil or rock uniformity requirements needed to characterize the properties of underlying materials and is, therefore, acceptable. The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 1-7827, Question 2.5.4-1, closed.

In RAI 8-7847, Question 2.5.4-3, and RAI 149-8147, Question 2.5.4-12, the staff asked the applicant to provide the basis and applicability of the minimum soil angle of internal friction and to include associated information in the DCD. In its response to RAI 8-7847, Question 2.5.4-3 (ML15166A292), and RAI 149-8147, Question 2.5.4-12 (ML15260B316), the applicant stated that the basis for the selection of 35 degrees as the angle of friction comes from the Uniform Building Code (1997) and the Geotechnical Engineering Investigation Manual (Hunt 1984). The applicant stated that the shear wave velocity of soil in the generic soil profiles for the APR1400 is a minimum of 304.8 m/s (1,000 ft/s). The applicant indicated that, based on the site

categorization (Uniform Building Code 1997), the soil for a shear wave velocity of 600 to 1,200 ft/s is considered a stiff soil, which is medium dense to dense soil, and that Hunt 1984 suggests that the medium dense to dense soil has the internal friction angle between 32 and 40 degrees. The applicant stated that the minimum soil angle of internal friction is applied below the footprint of the seismic Category I structures at its excavation depth. As a result of these questions, the applicant included COL 2.5(15), tasking the COL applicant to confirm that the soil angle of internal friction below the footprint of the seismic Category I structures at their excavation depth is a minimum of 35 degrees.

Based on its review of the applicant's response and associated references, the staff concludes that the applicant provided a comprehensive response for the basis and applicability for the selection of 35 degrees as the minimum soil angle of internal friction. Based on the review, the staff concludes that the applicant's response properly describes the requirements needed to characterize the properties of underlying materials (in this case the basis and applicability of the minimum soil angle of friction) and, therefore, is acceptable. The staff verified the incorporation of related information on the markups and considers RAI 8-7847, Question 2.5.4-3, and RAI 149-8147, Question 2.5.4-12, resolved. The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 8-7847, Question 2.5.4-3 and RAI 149-8147, Question 2.5.4-12, closed.

In RAI 8-7847, Question 2.5.4-4, the staff asked the applicant to provide the basis and applicability of the structural fill granular (SFG) parameters, including backfill density, Poisson's ratio, minimum dynamic shear modulus, minimum damping ratio, and strain-compatible minimum shear wave velocity. In its response to RAI 8-7847, Question 2.5.4-4, dated June 15, 2015 (ML15166A292), the applicant provided the basis and applicability for each of the aforementioned SFG parameters. For the backfill density, the applicant stated that the SFG backfill is a well-graded, dense gravelly soil and that, based on Hunt 1984, it selected the design density value as 137 pcf (2.21 g/cm^3). For the Poisson's ratio, the applicant selected 0.33, based on the report, "Foundation of Machines" (Prakash and Puri 1988), which provides a range of dynamic Poisson's ratios for soils of 0.3 to 0.35. The staff noted that the applicant selected, as the representative value of the dynamic Poisson's ratio for backfill material, an average value of the specified range. For the dynamic shear modulus, the applicant referenced the report entitled, "Soil Moduli and Damping Factors for Dynamic Response Analysis" (Seed and Idriss 1970), in which a relationship between the dynamic shear modulus and the confining pressure is suggested as follows: $G = 1{,}000*K_2*(\sigma_m)^{1/2}$ at low strains of the order of $1x10^{-4}$ percent in psf units and $G = 22.1*K_2*(\sigma_m)^{1/2}$ kilograms per square centimeter (kg/cm^2), where σ_m is the average confining pressure of soil, and K_2 is the coefficient, which ranges from 80 to 180 for gravelly soil. The applicant selected 90 as a representative value for K_2, and the dynamic shear modulus becomes $G = 2{,}000*(\sigma_m)^{1/2}$ kg/cm^2. The applicant applied the average damping ratio to the APR1400, as suggested by Seed and Idriss (1976) in "Moduli and Damping Factor for Dynamic Analyses of Cohesionless Soils." The applicant obtained the strain-compatible minimum shear wave velocity of 510 fps for backfill from the computed low-strain shear wave velocity and the backfill degradation curve (G/G_{max}), as presented in DCD Tier 2, Table 2.0-1, and by using the averaged horizontal shear strains in the generic site profiles S1–S9. The applicant stated that all parameters discussed above are applicable to backfill on the sides of and in between seismic Category I structures.

The staff reviewed the applicant's response to RAI 8-7847, Question 2.5.4-4, and acknowledged that the applicant used state-of-the-practice methods and the proper basis for the selection of the SFG parameters. Based on its review, the staff concludes that the applicant's response properly described the requirements needed to characterize the properties of underlying

materials (in this case the basis and applicability of the SFG parameters) and, therefore, is acceptable. Consequently, the staff considers RAI 8-7847, Question 2.5.4-4, resolved and closed.

In RAI 8-7847, Question 2.5.4-5, the staff asked the applicant to provide or cross-reference details on the properties of the lean concrete backfill in DCD Tier 2, Section 2.5.4.5. In its response to RAI 8-7847, Question 2.5.4-5 (ML15166A292), the applicant indicated that, under the NI common basemat of the APR1400 standard plant, a layer of approximately 0.91-m-thick (3-ft-thick) lean concrete with a minimum compressive strength of 140 kg/cm^2 (2,000 psi) will be backfilled between the bottom of the basemat and the base of the soil/rock excavation pit. The applicant stated that it will revise COL 2.5(8) in accordance with the wording in DCD Tier 2, Section 2.5.4.5. The staff reviewed the applicant's response and noted that the applicant provided markups with the planned revisions and its intention of incorporating the description of the lean concrete backfill under the NI common basemat into DCD Section 2.5.4.5. Based on its review, the staff concludes that the applicant's response properly described the requirements needed to characterize the properties of underlying materials (in this case, the properties of the lean concrete backfill). The staff considers RAI 8-7847, Question 2.5.4-5, resolved. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, the staff considers RAI 8-7847, Question 2.5.4-5, resolved and closed.

In RAI 1-7827, Question 2.5.4-2; RAI 8-7847, Questions 2.5.4-8 and 2.5.4-9; and RAI 149-8147, Question 2.5.4-15, the staff asked the applicant to clarify various aspects of the calculations of static and dynamic bearing capacity for safety-related structures, including their associated FOS. In its responses to RAI 1-7827, Question 2.5.4-2 (ML15132A592); RAI 8-7847, Questions 2.5.4-8 and 2.5.4-9 (ML15166A292); and RAI 149-8147, Question 2.5.4-15 (ML15260B316), the applicant provided the requested information on the static and dynamic bearing capacity along with updates to the APR1400 DCD, including (1) two new sections with additional information, Section 2.5.4.10.1 and Section 2.5.4.10.2, (2) changes to Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, and (3) new COL information items. In its responses, the applicant indicated that the previously labeled items, "Minimum Allowable Static Bearing Demand," and "Minimum Allowable Dynamic Bearing Demand," in Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, were revised to "Allowable Static Bearing Capacity" and "Allowable Dynamic Bearing Capacity," respectively. Furthermore, in response to RAI 255-8285, Question 3.8.5-16 (ML17256A179), the applicant revised the names of these parameters in Chapter 3, "Design of Structures, Systems, Components, and Equipment," as, "Allowable Static Bearing Capacity for Seismic Category 1 Structures (Dead and Live Load)," and "Allowable Dynamic Bearing Capacity for Seismic Category 1 Structures (Design Load Combination including SSE load)." In the aforementioned edits, the applicant indicated that the allowable bearing capacities for all safety-related buildings, including buildings within the NI basemat, the EDGB, and the DFOT room, shall be greater than, or equal to, the maximum bearing demands, including an FOS appropriate to the design load combination for both static and dynamic cases.

DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, which also provide the APR1400 site design parameters, specify that the maximum static bearing demand for the APR1400 design is 957.6 kPa (20.0 ksf) and that the maximum dynamic bearing demand is 2,872.8 kPa (60.0 ksf). As a result of these questions, the applicant included COL 2.5(11), tasking the COL applicant to evaluate the allowable bearing capacity of the subsurface based on the site-specific properties of underlying materials, including appropriate laboratory test data to evaluate strength, and to consider local site effects, such as fracture spacing, variability in properties, and evidence of shear zones.

The staff reviewed the applicant's response to RAI 1-7827, Question 2.5.4-2; RAI 8-7847, Questions 2.5.4-8 and 2.5.4-9; RAI 149-8147, Question 2.5.4-15; and applicable information on RAI 255-8285, Question 3.8.5-16, on the determination of the static and dynamic bearing capacity and associated FOS for the safety-related structures. The staff concludes that the applicant provided appropriate foundation-bearing capacity requirements both under static and dynamic loading conditions. In addition, the applicant specified requirements that the COL applicant must apply to ensure adequate FOS when determining site-specific bearing capacity; therefore, the staff finds the site parameters for minimum allowable bearing capacity and the related requirements for the COL applicant reasonable. The staff concludes that the applicant provided adequate information to address all areas of concern identified in the aforementioned questions. The FOS for both the dynamic and static cases are conservative and used in state-of-the-practice methods. Consequently, the staff considers RAI 1-7827, Question 2.5.4-2; RAI 8-7847, Questions 2.5.4-8 and 2.5.4-9; and RAI 149-8147, Question 2.5.4-15, resolved. The updates to the DCD in a future revision are to include the information related to the aforementioned questions and applicable information from RAI 255-8285, Question 3.8.5-16. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, the staff considers RAI 255-8285, Question 3.8.5-16, resolved and closed.

In RAI 8-7847, Questions 2.5.4-8 and 2.5.4-10, and RAI 149-8147, Question 2.5.4-14, the staff asked the applicant to provide information on various aspects of the calculation of differential settlements for structures located inside the NI basemat and for safety-related structures outside the NI basemat, mainly the EDG and DFOT. In its response to RAI 8-7847, Questions 2.5.4-8 and 2.5.4-10 (ML15166A292), and RAI 149-8147, Question 2.5.4-14 (ML15260B316), the applicant provided the requested information on differential settlement, along with updates to the APR1400 DCD; changes to DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1; and new COL information items. Furthermore, in response to Chapter 3, RAI 255-8285, Question 3.8.5-7 (ADAMS Accession No. ML18142A297), the applicant revised the scope of the differential settlement assessment for several buildings and provided additional information about settlement characteristics as it relates to the structural stability of the foundation. The appropriate sections of APR1400 DCD Tier 2, Section 3.8.5, and applicable chapters of this SER discuss and evaluate this information, respectively.

In its responses, the applicant updated applicable sections of DCD Tier 1, Table 2.1-1, and DCD Tier 2, Table 2.0-1, with information about the maximum allowable differential settlements for various scenarios. The applicant reported that the "maximum allowable differential settlement between buildings" is 76.2 mm (3.0 inches) between the NI and EDGB, NI and DFOT, and EDGB and DFOT under static load. The applicant reported that the "maximum allowable differential settlement inside buildings" applicable for all seismic Category I structures is 12.7 mm (0.5 inch) per 15.24 m (50 ft) in all directions. Additionally, as part of the response to Chapter 3, RAI 255-8285, Question 3.8.5-7, the applicant indicated that the aforementioned values of differential settlement are to be used for "site suitability determination" purposes only and provided additional settlement criteria in Table 3.8-12 through Table 3.8-14 that any future COL applicant shall satisfy. The applicant updated COL 2.5(14), tasking the COL applicant to verify whether the predicted settlement exceeds the maximum differential settlement within and between buildings for site suitability determination, as specified in Tier 2, Table 2.0-1. In addition, if the predicted settlement exceeds the maximum value in Table 2.0-1, a COL applicant shall perform a detailed site-specific evaluation to demonstrate acceptability. Furthermore, the COL applicant shall meet the settlement criteria specified in COL 3.8(18) for construction sequence and postconstruction settlement limits.

The staff reviewed the applicant's response to RAI 8-7847, Questions 2.5.4-8 and 2.5.4-10; RAI 149-8147, Question 2.5.4-14; and the applicable information in RAI 255-8285, Question 3.8.5-7, on the calculation of differential settlements for the NI basemat and for safety-related structures outside the NI basemat. In particular, the staff focused its review on the information provided in DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1. The staff reviewed the basis for the values of "maximum allowable differential settlement inside buildings" and "maximum allowable differential settlement between buildings" against various industry standard publications; for example, U.S. Army Corps of Engineers (USACE) manual, "Engineering and Design, Settlement Analysis." In accordance with the USACE manual guidelines for differential settlement, the staff finds that a "maximum allowable differential settlement inside buildings" for all seismic Category I structures of 12.7 mm (0.5 in) per 15.24 m (50 ft) in all directions and a maximum allowable settlement between buildings of 76.2 mm (3.0 in), represents acceptable values for site suitability determination for the type of foundation and evaluated soil profiles. The staff evaluated additional settlement criteria presented in RAI 255-8285, Question 3.8.5-7, Table 3.8-12 through Table 3.8-14, and APR1400 DCD Tier 2, Section 3.8.5, in Chapter 3 of this SER.

The staff concludes that the applicant specified appropriate and adequate foundation settlement limits as one of the measures that will ensure an adequate site suitability determination. The staff further concludes that the applicant provided adequate information to address all areas of concern identified in the aforementioned questions. Consequently, the staff considers RAI 8-7847, Questions 2.5.4-8 and 2.5.4-10, and RAI 149-8147, Question 2.5.4-14, resolved. The updates to the DCD in a future revision are to include the information related to the aforementioned questions and applicable information from RAI 255-8285, Question 3.8.5-7. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, the staff considers RAI 255-8285, Question 3.8.5-7, resolved and closed.

In RAI 8-7847, Question 2.5.4-13, and RAI 367-8436, Question 2.5.4-16, the staff asked the applicant to clarify statements that were made related to backfill material dynamic properties. In its response to RAI 8-7847, Question 2.5.4-13 (ML15260B316), and RAI 367-8436, Question 2.5.4-16 (ML16047A005), the applicant provided the requested information along with updates to the APR1400 DCD and changes to DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1. In its response to RAI 8-7847, Question 2.5.4-13, the applicant stated, "For clarification to COL applicants, the shear moduli values are defined as the minimum and damping values are the maximum values." The staff needed more clarification in this statement because it may imply that the maximum values for backfill damping can be greater than 15 percent, as is the case for strains larger than 0.1 percent, as stated in Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1. In addition, SRP Section 3.7.1, "Seismic Design Parameters," states that "the maximum soil damping value acceptable to the staff is 15 percent." To avoid confusion with a COL applicant referencing the APR1400 design, the staff asked the applicant to clarify the purpose of the damping values listed. In its response, the applicant stated that the backfill material dynamic properties in the aforementioned tables are used as input to calculate the shear strain-compatible shear wave velocity profiles for the SFG backfill and that the strain-compatible shear strain values of the backfill cannot be greater than 15 percent.

The staff reviewed the applicant's response to RAI 367-8436, Question 2.5.4-16, and RAI 8-7847, Question 2.5.4-13, and concludes that the applicant provided adequate information to address all areas of concern identified in the aforementioned questions. Based on its review, the staff concludes that the applicant's response properly described the requirements needed to characterize the properties of underlying materials (in this case the backfill material dynamic properties). Consequently, the staff considers RAI 367-8436, Question 2.5.4-16, and

RAI 8-7847, Question 2.5.4-13, resolved. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, the staff considers RAI 367-8436, Question 2.5.4-16, and RAI 8-7847, Question 2.5.4-13, resolved and closed.

In RAI 8-7847, Question 2.5.4-7, the staff asked the applicant to "clarify the locations where no potential for liquefaction is allowed and to provide requirements for liquefaction potential for seismic Category II structures that could degrade seismic Category I structures." In its response to RAI 8-7847, Question 2.5.4-7 (ML15166A292), the applicant stated that no liquefaction potential is allowed adjacent to and under seismic Category I structures. In addition, the applicant stated that new COL applicants address the liquefaction potential of seismic Category II structures that have the potential to degrade seismic Category I structures to an unacceptable safety level. The applicant provided changes to the DCD sections and COL 2.5(13) to address the aforementioned issues.

The staff reviewed the applicant's response to RAI 8-7847, Question 2.5.4-7, and concludes that the applicant provided adequate information to address all areas of concern identified in the aforementioned question. The staff considers that "no liquefaction potential is allowed" adjacent to and under seismic Category I structures is a reasonable and conservative design basis. Consequently, the staff considers RAI 8-7847, Question 2.5.4-7, resolved. The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 8-7847, Question 2.5.4-7, closed.

Based on its review of the APR1400 DCD Tier 1, Table 2.1-1; Tier 2, Table 2.0-1; and Section 2.5.4, the staff concludes that the applicant provided adequate descriptions of the site-specific geotechnical and geophysical information and investigations that COL applicants must provide to determine the properties and stability of all soils and rock, which may affect the safety of nuclear power plant facilities under both static and dynamic loading conditions. The staff further concludes that the site-specific information and site investigation requirements and the design site parameters, as specified in Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, are reasonable, representative of a reasonable number of sites that may be considered for a COL application, consistent with general engineering practices, and sufficient to ensure that COL applicants can meet the relevant requirements of GDC 2 and 10 CFR Part 100. Accordingly, the staff concludes that APR1400 DCD Tier 2, Section 2.5.4, is acceptable.

2.5.4.5 Stability of Slopes, DCD Section 2.5.5

The staff reviewed the regulatory guidance and the description provided in DCD Tier 2, Section 2.5.5, on the site-specific information that COL applicants referencing the APR1400 design must provide to determine the stability of all slopes.

APR1400 DCD Tier 2, Section 2.5.5, states that no assumptions in regard to slope stability are used in the evaluation of the standard design and that the stability of all slopes will be a site-specific issue. Consequently, in RAI 58-8018, Question 2.5.5-1, the staff asked the applicant to provide a COL information item requesting COL applicants referencing the APR1400 DCD to provide site-specific information in accordance with SRP Section 2.5.5 and to determine the static and dynamic stability of all natural and manmade slopes to ensure that the failure of any slope will not adversely affect the safety of the plant. In its response to RAI 58-8018, Question 2.5.5-1 (ML15223B183), the applicant included COL 2.5(14), tasking the COL applicant to provide site-specific information about the static and dynamic stability of all natural and manmade soil and rock slopes, including embankments and dams. The applicant

also stated that the APR1400 standard plant design is based on the premise that there is no site-specific potential for slope failure that could adversely affect the NI.

The staff reviewed the applicant's response and verified the incorporation of the related information on the markups. Therefore, the staff considers RAI 58-8018, Question 2.5.5-1, resolved. The staff confirmed that the DCD was revised as the applicant committed in the RAI response. Accordingly, the staff considers RAI 58-8018, Question 2.5.5-1, closed.

Based on its review of the APR1400 DCD Tier 1, Table 2.1-1, and Tier 2, Table 2.0-1, Section 2.5.5, the staff concludes that the applicant provided adequate requirements that COL applicants must meet to determine the stability of all slopes, both natural and manmade, and to ensure that no slope at the site will adversely affect the safety of the plant facilities during the life of the plant. The staff further concludes that ensuring that no slope failure at the site will adversely affect the safety of the plant facilities during the life of the plant is a reasonable design basis and that the related COL application requirements are consistent with the guidance in SRP Section 2.5.5 and are in accordance with the relevant requirements of GDC 2 and 10 CFR Part 100. Accordingly, the staff concludes that the APR1400 DCD Tier 2, Section 2.5.5, is acceptable.

2.5.5 Combined License Information Items

Table 2.5.5-1 provides the COL information item number and description pertinent to DCD Tier 2, Section 2.5, from Table 1.8-2 of the DCD.

Table 2.5.5-1 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 2.5(1)	The COL applicant is to provide the site-specific information on geology, seismology, and geotechnical engineering required by RG 1.206. The COL applicant is to conduct the probabilistic seismic hazard analysis (PSHA) and develop the site-specific GMRS using the PSHA results required by RG 1.208.	2.5 2.5.2 2.5.6
COL 2.5(2)	The COL applicant is to confirm that the FIRS of each seismic Category I structure are completely enveloped by the CSDRS compatible free field response motions at the bottom elevation of each seismic Category I structure for a site with a low strain shear wave velocity greater than 304.8 m/s (1,000 ft/s) at the finished grade in the free field. Alternately, the COL applicant is to confirm that the FIRS of each seismic Category I structure are completely enveloped by the CSDRS for a hard rock site with a low strain shear wave velocity of supporting medium for each seismic Category I structure greater than 2,804 m/s (9,200 ft/s).	2.5.2.6 2.5.6
COL 2.5(3)	The COL applicant is to confirm that (1) the requirement for the site-specific weight densities of subsurface soils is no less than 2,002.3 kg/m^3 (125 lb/ft^3), (2) soil profiles are generally increasing with depth from the ground surface in a manner similar to the general profile shapes shown in Tables 3.7A-1 through 3.7A-9 and Figures 3.7A 3 through 3.7A 11, (3) the site-specific soil profiles have no inverse condition (i.e., the soil properties of a deeper soil layer are less than the properties of the soil layer above it), and (4) the site-specific BE, LB, and UB strain compatible soil shear wave velocity	2.5.2.6 2.5.6

Item No.	Description	Section
	profiles, including backfill, are consistent with one of the APR1400 generic site conditions, S1 through S4 and S6 through S9, considered for the standard design, as shown in Tables 3.7A-1 through 3.7A-9 and Figures 3.7A-3 through 3.7A-11. The LB and UB shear wave velocity profiles are obtained, as defined in SRP Section 3.7.2, from the mean properties plus or minus 1 standard deviation, maintaining the minimum variation of 1.5 GBE for the UB range and GBE/1.5 for the LB range, where GBE denotes the BE low strain shear modulus. The LB low strain shear wave velocity for the site specific soil profile must not be less than 304.8 m/s (1,000 ft/s) up to the structural foundation elevation.	
COL 2.5(4)	The COL applicant is to confirm that the site-specific profile for a HRHF site is consistent with the generic profile provided in Table 3.7B-3 and that the site-specific GMRS determined at the finished grade are completely enveloped by the APR1400 HRHF response spectra shown in Figures 3.7-12 and 3.7-13. In addition, the COL applicant is to confirm that the FIRS of the seismic Category I structures are completely enveloped by the HRHF compatible free field response motions at the bottom elevations of each seismic Category I structure.	2.5.2.6 2.5.6
COL 2.5(5)	The COL applicant is to perform a site-specific seismic analysis to develop in structure response spectra at key locations using the procedure described in DCD Appendix 3.7A if COL Information Items 2.5(2) and 2.5(3) are not met. The COL applicant's site-specific strain compatible properties are to be consistent with the assumptions used in the SSI analyses, including embedment and the extent of backfill, as described in DCD Appendix 3.7A. The COL applicant is to confirm that the five-percent damped site-specific in structure response spectra so generated are enveloped by the corresponding five-percent damped in structure response spectra provided in DCD Appendix 3.7A. If this requirement is not satisfied, the COL applicant is to calculate the site-specific member forces and compare them with CSDRS member forces at key locations to determine whether further site-specific seismic design is required.	2.5.2.6 2.5.6
COL 2.5(6)	The COL applicant is to perform a site-specific seismic response analysis using the procedure described in Appendix 3.7B and the EPRI white paper, "Seismic Screening of Components Sensitive to High Frequency Vibratory Motions," if COL Information Item 2.5(4) is not met. The COL applicant is to develop the site-specific in structure response spectra and compare them with the corresponding HRHF-based in structure response spectra to determine whether further structural integrity (including member forces) and functionality evaluations are required.	2.5.2.6 2.5.6
COL 2.5(7)	The COL applicant is to perform an evaluation of the subsurface conditions within the standard plant structure footprint based on the geologic investigation consistent with the guidance in RG 1.132.	2.5.2.7 2.5.6
COL 2.5(8)	The COL applicant is to evaluate the potential future surface deformation of tectonic and nontectonic origin.	2.5.3 2.5.6

Item No.	Description	Section
COL 2.5(9)	If the potential for future surface deformation exists, the COL applicant needs to demonstrate the potential effects of surface deformation are within the design basis of the facility.	2.5.3 2.5.6
COL 2.5(10)	The COL applicant is to confirm that the soil angle of internal friction below the footprint of the seismic Category I structures at their excavation depth is a minimum of 35 degrees.	2.5.4.2 2.5.6
COL 2.5(11)	The COL applicant is to confirm that the dynamic properties of SFG and the compressive strength of lean concrete to be used in construction of the APR1400 seismic Category I structures satisfy the SFG requirements provided in Table 2.0-1 and the minimum compressive strength of 140 kg/cm2 (2,000 psi) for the lean concrete.	2.5.4.5 2.5.6
COL 2.5(12)	The COL applicant is to evaluate the potential for liquefaction occurring at the site adjacent to and under seismic Category I structures in accordance with NRC RG 1.198. In addition, the COL applicant is to evaluate the liquefaction potential for those seismic Category II structure foundations that, if failed, could degrade the function of a seismic Category I SSC to an unacceptable safety level.	2.5.4.8 2.5.6
COL 2.5 (13)	The COL applicant will evaluate the allowable bearing capacity of the subsurface based on the site-specific properties of the underlying materials, including appropriate laboratory test data to evaluate strength, and considering local site effects, such as fracture spacing, variability in properties, and evidence of shear zones. If the site-specific allowable bearing capacity is less than the maximum bearing demands specified in Table 2.0-1, a site-specific evaluation shall be performed by a COL applicant using the APR1400 basemat model and methodology described in Section 3.8.5.	2.5.4.10.1 2.5.6
COL 2.5 (14)	The COL applicant will verify whether the predicted settlements within each building and between buildings exceed the maximum differential settlement specified in Table 2.0-1 for site suitability determination. If the predicted settlement exceeds the maximum value in Table 2.0-1, a detailed site-specific evaluation shall be performed by a COL applicant to demonstrate acceptability. The COL applicant will also meet settlement criteria specified in COL 3.8(18) for construction sequence and postconstruction settlement limits.	2.5.4.10.2 2.5.6
COL 2.5(15)	The COL applicant is to provide site-specific information about the static and dynamic stability of all natural and man-made soil and rock slopes, including embankments and dams.	2.5.5 2.5.6

2.5.6 Conclusion

Based on its review of DCD Section 2.5, the staff concludes that the applicant provided an adequate description of the site-specific information on geology, seismology, and geotechnical engineering to ensure that potential COL applicants can meet the relevant requirements of GDC 2, 10 CFR 100.23, and Appendix S to 10 CFR Part 50. The DCD applicant adequately followed the applicable regulations and RGs.