2.0 SITE CHARACTERISTICS

Chapter 2, "Site Characteristics," of the Final Safety Analysis Report (FSAR) addresses the geological, seismological, hydrological, and meteorological characteristics of the site and vicinity, in conjunction with present and projected population distribution and land use, and site activities and controls.

2.0.1 Introduction

The site characteristics are reviewed by the Nuclear Regulatory Commission (NRC) staff to determine whether the applicant has accurately described the site characteristics and site parameters together with site-related design parameters and design characteristics in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, certifications, and approvals for nuclear power plants." The review is focused on the site characteristics and site-related design characteristics needed to enable the NRC staff to reach a conclusion on all safety matters related to siting of Vogtle Electric Generating Plant (VEGP) Units 3 and 4. Because this combined license (COL) application references a design certification (DC), this section focuses on the applicant's demonstration that the characteristics of the site fall within the site parameters specified in the DC rule or, if outside the site parameters, that the design satisfies the requirements imposed by the specific site characteristics and conforms to the design commitments and acceptance criteria described in the AP1000 Design Control Document (DCD).

2.0.2 Summary of Application

Section 2.0 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2 of the AP1000 DCD, Revision 17 and Section 1.3 of the VEGP Early Site Permit (ESP) application Site Safety Analysis Report (SSAR), Revision 5.

In addition, in VEGP COL FSAR Section 2.0, the applicant provided the following:

Supplemental Information

- VEGP Supplemental (SUP) 2.0-1

The applicant provided supplemental information in VEGP COL FSAR Section 2.0, "Site Characteristics," which describes the characteristics and site-related design parameters of VEGP Units 3 and 4. In a letter dated July 1, 2010, the applicant provided a proposed revision to VEGP COL FSAR Table 2.0-201 to reflect the proposed changes to the AP1000 Tier 1 Table 5.0-1 and Tier 2 Table 2-1.

- VEGP ESP Permit Condition (PC) 9

The applicant added, in VEGP COL FSAR Table 2.0-201 (sheet 6) and FSAR Table 2.0-202 (sheets 1 and 2), supplemental information to address the VEGP ESP PC 9 related to the accident analysis χ/Q values.

2.0.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793, "Final Safety Evaluation Report [FSER] Related to Certification of the AP1000 Standard Design," and its supplements and in NUREG-1923, "Safety Evaluation Report [SER] for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant (VEGP) ESP Site."

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the site characteristics are given in Section 2.0 of NUREG-0800, "Standard Review Plan [SRP] for the Review of Safety Analysis Reports for Nuclear Power Plants."

The applicable regulatory requirements for site characteristics are as follows:

- 10 CFR 52.79(a)(1)(i) - (vi) provides the site-related contents of the application.
- 10 CFR 52.79(d)(1), as it relates to information sufficient to demonstrate that the characteristics of the site fall within the site parameters specified in the DC.
- 10 CFR Part 100, "Reactor site criteria," as it relates to the siting factors and criteria for determining an acceptable site.

The related acceptance criteria from Section 2.0 of NUREG-0800 are as follows:

- The acceptance criteria associated with specific site characteristics/parameters and site-related design characteristics/parameters are addressed in the related Chapter 2 or other referenced sections of NUREG-0800.
- Acceptance is based on the applicant's demonstration that the site characteristics and site-related design parameters specified in the ESP fall within the site parameters and design characteristics specified in the DC. If the actual site characteristics do not fall within the certified standard design site parameters, the COL applicant provides sufficient justification (e.g., by request for exemption or amendment from the DC, or request for a variance from the ESP) that the proposed facility is acceptable at the proposed site.

2.0.4 Technical Evaluation

The NRC staff reviewed Section 2.0 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to site characteristics. The results of the NRC staff's technical evaluation of the information incorporated by reference related to site characteristics are documented in NUREG-1793 and its supplements and in NUREG-1923.

[1] See Section 1.2.2 for a discussion of the staff's review related to verification of the scope of information to be included in a COL application that references a DC and ESP.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 2.0-1
- VEGP ESP PC 9

The NRC staff reviewed supplemental information VEGP SUP 2.0-1, and VEGP ESP PC 9 in VEGP COL FSAR Section 2.0, "Site Characteristics," describing the characteristics and site-related design parameters of VEGP Units 3 and 4. The DCD site parameters in DCD Table 2-1 are compared to the site-specific characteristics in VEGP COL FSAR Table 2.0-201. In addition, control room (CR) atmospheric dispersion factors for accident dose analysis are presented in VEGP COL FSAR Table 2.0-202.

The NRC staff reviewed and compared the site-specific characteristics included in VEGP COL FSAR Tables 2.0-201 and 2.0-202 against DCD Table 2-1. The staff's evaluation of the population distribution is addressed in Section 2.1 of this SER. The staff's evaluation of the site characteristics associated with air temperature, precipitation, wind speed, atmospheric dispersion values, and CR atmospheric dispersion values is addressed in Section 2.3 of this SER. The staff's evaluation of site characteristics associated with flood level, ground water level, and plant grade elevation is addressed in Section 2.4 of this SER. The staff's evaluation of seismic and soil site characteristics is addressed in Section 2.5 of this SER. The staff's evaluation of site characteristics associated with missiles is addressed in Section 3.5 of this SER.

The NRC staff reviewed and compared the site-specific characteristics included in FSAR Table 2.0-201 against the AP1000 DCD site parameters included in DCD Table 2-1. The staff's review confirmed that in every case, as shown in Table 2.0-201, the DCD value envelops the site-specific value. Detailed discussions of the staff's review are in the individual SER sections identified above. The updating of the VEGP COL FSAR to include the changes to FSAR Table 2-201 discussed in the applicant's letter dated July 1, 2010, is **Confirmatory** Item **2.0-1**.

The applicant took a variance (VEGP ESP VAR 2.3-1) from the site characteristics (the maximum normal temperature and minimum normal temperature) specified in the VEGP ESP SSAR Table 1-1, "Site Characteristics, Design Parameters, and Site Parameters." This variance is addressed in SER Section 2.3.

2.0.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.0.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to the site characteristics and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

As set forth above, the NRC staff reviewed the application to ensure that sufficient information was presented in VEGP SUP 2.0-1, and VEGP ESP PC 9 to demonstrate that the characteristics of the site fall within the site parameters specified in the DC. The updating of the VEGP COL FSAR to include the changes to FSAR Table 2-201 discussed in the applicant's letter dated July 2, 2010, wil remain as **Confirmatory Item 2.0-1**. The applicant has demonstrated that the site characteristics fall within the DC site parameters and thus meet the requirements of 10 CFR 52.79(d)(1).

However, as a result of **Confirmatory Item 2.0-1**, the staff is unable to finalize its conclusions on VEGP SUP 2.0-1.

2.1 Geography and Demography

Section 2.1, "Geography and Demography" of the VEGP COL FSAR addresses site-specific information related to site location and description, exclusion area authority and control, and population distribution.

Section 2.1 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.1 of the AP1000 DCD, Revision 17 and Section 2.1 of the VEGP ESP SSAR, Revision 5, and adds VEGP COL 2.1-1 to address COL Information Item 2.1-1 (COL Action Items 2.1.1-1, 2.1.2-1 and 2.1.3-1). The applicant stated that VEGP COL 2.1-1 is addressed in Sections 1.1.1 and 1.2.2 of the VEGP COL FSAR and in Section 2.1 of the VEGP ESP SSAR. The information in VEGP COL FSAR Sections 1.1.1 and 1.2.2, related to VEGP COL 2.1-1, provides descriptive information regarding the site that does not need NRC review and approval. The staff found that the applicant appropriately supplied site-specific geography and demography by incorporating by reference VEGP ESP SSAR Section 2.1. The staff has already reviewed Section 2.1 of the VEGP ESP SSAR and found the information relating to site-specific geography and demography to be acceptable as documented in NUREG-1923. Therefore, the staff concludes that the information in VEGP ESP SSAR Section 2.1 and incorporated by reference in VEGP COL FSAR Section 2.1 is sufficient to satisfy the requirements of COL Information Item 2.1-1. Hence, the NRC staff considers COL Information Item 2.1-1 resolved.

The NRC staff reviewed Section 2.1 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to site-specific geography and demography. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.2 Nearby Industrial, Transportation, and Military Facilities

2.2.1 Locations and Routes

Section 2.2, "Nearby Industrial, Transportation, and Military Facilities" of the VEGP COL FSAR addresses site-specific information related to "Locations and Routes" of nearby industrial, transportation, and military facilities.

Section 2.2 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.2 of the AP1000 DCD, Revision 17, and VEGP ESP SSAR Section 2.2, Revision 5. Section 2.2 of the DCD is incorporated by reference with no supplements related to "Locations and Routes," and one departure related to DCD Section 2.2.1. The departure, VEGP DEP 1.1-1, applies to VEGP COL FSAR section numbering and is addressed by the NRC staff in Chapter 1 of this SER. Section 2.2 of the VEGP ESP SSAR includes Section 2.2.1, which is incorporated by reference with no variances or supplements. The staff found that the applicant appropriately supplied site-specific information related to locations and routes of nearby industrial, transportation, and military facilities by incorporating by reference VEGP ESP SSAR Section 2.2. The NRC staff documented its review of Section 2.2 of the VEGP ESP SSAR in NUREG-1923; it found the information relating to site-specific locations and routes of nearby industrial, transportation, and military facilities to be acceptable as documented in NUREG-1923. Therefore, the staff concludes that the information in VEGP ESP SSAR Section 2.2 and incorporated by reference in VEGP COL FSAR Section 2.2 is sufficient to satisfy the requirements of COL Information Item 2.2-1. Hence, the NRC staff considers the locations and routes of nearby industrial, transportation, and military facilities aspect of COL Information Item 2.2-1 resolved.

The NRC staff reviewed Section 2.2 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to site-specific locations and routes of nearby industrial, transportation, and military facilities. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.2.2 Descriptions

Section 2.2, "Nearby Industrial, Transportation, and Military Facilities" of the VEGP COL FSAR addresses site-specific information related to "Descriptions" of nearby industrial, transportation, and military facilities.

Section 2.2 of the VEGP COL FSAR, Revision 2, incorporates by reference Subsection 2.2 of the DCD, Revision 17, and VEGP ESP SSAR Section 2.2, Revision 5. Section 2.2 of the DCD is incorporated by reference with no departures or supplements related to "Descriptions." Section 2.2 of the VEGP ESP SSAR includes Section 2.2.2, which is incorporated by reference with no variances or supplements. The staff found that the applicant appropriately supplied site-specific information related to the descriptions of nearby industrial, transportation, and military facilities by incorporating by reference VEGP ESP SSAR Section 2.2. The NRC staff documented its review of Section 2.2 of the VEGP ESP SSAR in NUREG-1923 where it found the information relating to site-specific descriptions of nearby industrial, transportation, and

military facilities to be acceptable. Therefore, the staff concludes that the information in VEGP ESP SSAR Section 2.2 and incorporated by reference in VEGP COL FSAR Section 2.2 is sufficient to satisfy the requirements of COL Information Item 2.2-1. Hence, the NRC staff considers the descriptions of nearby industrial, transportation, and military facilities of COL Information Item 2.2-1 resolved.

The NRC staff reviewed Section 2.2 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to site-specific descriptions of nearby industrial, transportation, and military facilities. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.2.3 Evaluation of Potential Accidents

2.2.3.1 Introduction

Section 2.2.3, "Evaluation of Potential Accidents" addresses the evaluation of potential accidents involving hazardous materials or activities onsite and in the vicinity of the proposed site to confirm that appropriate data and analytical models have been used.

2.2.3.2 Summary of Application

Section 2.2 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.2 of the AP1000 DCD, Revision 17, and Section 2.2 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.2, the applicant provided the following:

AP1000 COL Information Items

- VEGP COL 2.2-1

The applicant provided additional information in VEGP COL 2.2-1 to address COL Information Item 2.2-1 (COL Action Item 2.2-1) related to the evaluation of potential accidents involving hazardous materials. The applicant stated that VEGP COL 2.2-1 is addressed in VEGP COL FSAR Sections 2.2.3.2.3.1, 2.2.3.2.3.2, 2.2.3.3, 2.2.3.4, and Section 2.2 of the VEGP ESP SSAR.

This COL item states that the COL applicant referencing the AP1000 certified design will address the identification of site-specific potential hazards. Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants (LWR [Light-Water Reactor] Edition)," states that onsite hazardous material inventories and related information not reviewed as a part of the ESP will be included in the COL application as appropriate.

The applicant also addressed impacts due to potential fires and radiological hazards as a part of COL Information Item 2.2-1.

- VEGP COL 6.4-1

The applicant provided additional information in VEGP COL 6.4-1 to address COL Information Item 6.4-1 (COL Action Item 6.4-1) related to the evaluation of potential accidents involving hazardous materials that may impact the control room habitability. The applicant stated that VEGP COL 6.4-1 is addressed in VEGP COL FSAR Sections 2.2.3.2.3.1, 2.2.3.2.3.2, 2.2.3.3, 6.4.4, and 6.4.4.2.

This COL item states that COL applicants referencing the AP1000 certified design are responsible for addressing the amount and location of possible sources of hazardous chemicals in or near the plant.

- STD COL 6.4-1

The applicant provided additional information in Standard (STD) COL 6.4-1 to address COL Information Item 6.4-1 (COL Action Item 6.4-1) related to the evaluation of potential accidents involving hazardous materials that may impact the control room habitability. The applicant stated that STD COL 6.4-1 is addressed in VEGP COL FSAR Sections 2.2.3.2.3.1, 2.2.3.2.3.2, 2.2.3.3, 6.4.4, and 6.4.4.2.

In a letter dated June 17, 2010, the applicant provided additional information as STD COL 6.4-1 related to the onsite chemical hazards. Specifically, the applicant provided a proposed revision to VEGP FSAR Table 6.4-201 that provides a description of the onsite chemicals including an identification of which chemicals are expected to be standard to all AP1000 COLs. The FSAR table also provides a description using the VEGP COL 6.4-1 annotation for which chemicals are expected to be plant-specific. The staff's review of the standard AP1000 onsite chemicals found in VEGP's June 17, 2010, letter is found under STD COL 6.4-1 in section 2.2.3.4 below.

ESP COL Information Items

- VEGP ESP COL 2.2-1

The applicant provided additional information in VEGP ESP COL 2.2-1 to address VEGP ESP COL Action Item 2.2-1 related to the hydrazine hazard from onsite storage tanks. The applicant stated that VEGP ESP COL 2.2-1 is addressed in VEGP COL FSAR Section 2.2.3.2.3.1.

NUREG-1923, Section 2.3.3.2.2 states that due to the impact on control room habitability, these calculations will be evaluated at the time of the COL application.

- VEGP ESP COL 2.2-2

The applicant provided additional information in VEGP ESP COL 2.2-2 to address VEGP ESP COL Action Item 2.2-2 related to the other site-specific chemicals from onsite storage tanks providing quantities and locations and evaluation of potential hazards. The applicant stated that VEGP ESP COL 2.2-2 is addressed in VEGP COL FSAR Section 2.2.3.2.3.2.

NUREG-1923, Section 2.3.3.2.2 states that potential toxic concentrations of these chemicals based on their volatility, toxicity, and quantity, including their impact on control room habitability, will be evaluated at the time of the COL application.

Supplemental Information

- VEGP SUP 2.2-1

The applicant provided supplemental information in VEGP SUP 2.2-1 by adding the following references:

> Murphy, K.G., and K.M. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Criterion 19," U.S. Atomic Energy Commission, 13th Air Cleaning Conference, 1974.
>
> U.S. Environmental Protection Agency, "ALOHA (Areal Location of Hazardous Atmospheres)," Version 5.4.1, February 2007.

Variances

- VEGP ESP VAR 2.2-1

This ESP variance item proposed changes to the VEGP ESP SSAR associated with the other chemical hazards from onsite storage tanks.

In VEGP COL FSAR Section 2.2.3.2.3.2, the applicant states that in some instances, alternative chemicals to those proposed by Westinghouse have been suggested.

2.2.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793, the FSER related to the DCD and its supplements, and in NUREG-1923.

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

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the evaluation of potential accidents are provided in Section 2.2.3 of NUREG-0800.

The related SRP acceptance criteria are:

- Event Probability: The identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants of specified type is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological dose in excess of the 10 CFR 50.34(a)(1) limits, as it relates to the requirements of 10 CFR Part 100, is estimated to exceed the NRC staff's objective of an order of magnitude of 10^{-7} per year.

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

2.2.3.4 Technical Evaluation

The NRC staff reviewed Section 2.2 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information related to hazardous materials or activities. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

Hydrazine Hazard from Onsite Storage Tanks

The staff reviewed the information in the VEGP COL FSAR, with respect to the hydrazine hazard from onsite storage tanks.

AP1000 COL Information Items

- VEGP COL 2.2-1
- VEGP COL 6.4-1

ESP COL Information Item

- VEGP ESP COL 2.2-1

The NRC staff reviewed VEGP COL 2.2-1 (related to COL Information Item 2.2-1) and VEGP ESP COL 2.2-1 (related to ESP COL Action Item 2.2-1), which address the hydrazine hazard from onsite storage tanks.

VEGP COL 6.4-1 (related to COL Information Item 6.4-1) is addressed in Section 6.4 of this SER.

In resolution of VEGP ESP COL Action Item 2.2-1, the applicant added new information to VEGP ESP SSAR Section 2.2.3.2.3 with an evaluation of potential hazards for the impact on the new Units 3 and 4 due to an accidental hydrazine release from onsite storage tanks located at VEGP Unit 1. Impact on control room habitability for Units 3 and 4 due to an accidental release of hydrazine, not previously evaluated in the VEGP ESP SSAR, is evaluated and addressed in VEGP COL FSAR Section 2.2.3.2.3.1. The analyses include the following four evaluations as a part of the response to request for additional information (RAI) 6.4-3.

Toxicity of a Hydrazine Vapor Cloud

Toxicity of a vapor cloud from hydrazine release is determined for control room habitability. The concentration of hydrazine based on a release of 6644 gallons is calculated at the outside and inside the Unit 3 control room at a distance of 2200 feet (ft) from the hydrazine tank located at VEGP Unit 1 turbine building. In RAI 6.4-3, the staff requested that the applicant justify analysis methodology and the control room air exchange rate. In its response, dated March 5, 2010, the applicant provided changes to the control room air exchange rate and the associated chemical hazard analysis. The concentration inside the control room with air exchange rate of 0.95 per hour is calculated using the ALOHA model to be 7.76 parts per million (ppm), which is within the limiting immediate danger to life and health (IDLH) value of 50 ppm.

Flammability of a Hydrazine Vapor Cloud

Based on the lower flammability limit (LFL) of 4.7 percent and the upper flammability limit (UFL) of 99.9 percent for hydrazine, the distance calculated from the leak source to the LFL is 54 ft. Therefore, there is no potential flammable hydrazine vapor reaching the Unit 3 control room.

Explosive Hydrazine Vapor Cloud

Since the hydrazine vapor cloud does not reach the control room with any flammability, the NRC staff agrees that no explosion will occur at the control room due to a hydrazine vapor cloud.

Hydrazine Tank Explosion

The potential explosion due to confined vapor in the tank is evaluated by the Trinitrotoluene (TNT) equivalent of hydrazine vapor confined in the tank. The distance not exceeding peak incident pressure of 1 pounds per square inch (psi) due to explosion is determined using RG 1.91, “Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants,” Revision 1 methodology to be 311 ft, which is less than the distance from the hydrazine tank to the Unit 3 control room of 2200 ft.

The NRC staff performed independent confirmatory calculations for the evaluations discussed above and confirmed the applicant’s results and conclusions. Therefore, the staff considers the applicant’s analysis of hydrazine from onsite storage tanks pertaining to COL Action Item 2.2-1 reasonable and acceptable.

The applicant’s proposed changes to VEGP COL FSAR Section 2.2.3.2.3.1 will be tracked as **Confirmatory Item 2.2-1.**

Other Chemical Hazards from Onsite Storage Tanks

The staff reviewed the information in the VEGP COL FSAR, with respect to the other chemical hazards from onsite storage tanks.

AP1000 COL Information Items

- VEGP COL 2.2-1
- VEGP COL 6.4-1
- STD COL 6.4-1

ESP COL Information Item

- VEGP ESP COL 2.2-2

Variances

- VEGP ESP VAR 2.2-1

The NRC staff reviewed VEGP COL 2.2-1 (related to COL Information Item 2.2-1), VEGP ESP COL 2.2-2 (related to ESP COL Action Item 2.2-2), and VEGP ESP VAR 2.2-1 (related to VEGP ESP VAR Item 2.2-1), which addresses the other chemical hazards from onsite storage tanks.

VEGP COL 6.4-1 (related to AP1000 COL Information Item 6.4-1) is addressed in Section 6.4 of this SER.

The applicant supplemented VEGP ESP SSAR Section 2.2.3.2.3 with new information pertaining to the evaluation of potential hazards for the impact on the new Units 3 and 4 due to other chemical hazards from onsite storage tanks in resolving VEGP ESP COL Action Item 2.2-2. VEGP COL FSAR Table 2.2-201 provides specific information about the chemicals described in VEGP ESP SSAR Table 2.2-6. The applicant stated that "Except as noted, these chemicals have been suggested by Westinghouse for use in the AP1000 and have been evaluated in conjunction with AP1000 standard design and found not to present a hazard to the control room operators or to safety-related systems, structures, or components."

The applicant replaced Table 2.2-201 with Table 6.4-201 in the VEGP COL FSAR giving the list of all chemicals, including standard chemicals suggested by the Westinghouse AP1000 DCD, as well as VEGP site-specific chemicals. In a letter dated June 17, 2010, the applicant provided a proposed revision to VEGP FSAR Table 6.4-201, which provides a description of the onsite chemicals including an identification of which chemicals are expected to be standard to all AP1000 COLs. The staff's review of the standard chemicals for all AP1000 plants is found under STD COL 6.4-1 below. The staff's site-specific evaluation of these chemicals appears under VEGP COL 6.4-1 below.

STD COL 6.4-1

On the basis of the staff's confirmatory analysis of the standard chemicals, the concentration of two chemicals, hydrazine and carbon dioxide, exceeded respective chemical IDLH concentration outside the control room. Therefore, these chemicals are being further evaluated

as part of control room habitability systems in SER Section 6.4, along with the review of other chemicals listed in FSAR Table 6.4-201 in the applicant's June 17, 2010, letter.

The staff reviewed the applicant's Table 6.4-201 standard AP1000 chemicals stored onsite, and the applicant's screening out of chemicals that do not pose a threat to control room habitability. Based on evaluation of the information presented in the VEGP COL FSAR, confirmatory analyses, and review of the response to the request for additional information (RAI 2.2.3-1), the staff evaluated whether any additional chemicals needed to be evaluated further in Section 6.4 along with the applicant's identified list of toxic chemicals for control room habitability. The staff concluded that the two standard AP1000 chemicals hydrazine and carbon dioxide exceeded IDLH concentration outside the control room; these are further evaluated in SER Section 6.4 for control room habitability.

The inclusion of the VEGP FSAR Table 6.4-201 standard chemicals in the applicant's letter dated June 17, 2010, in the next revision of the VEGP COL FSAR is **Confirmatory Item 2.2-2**.

VEGP COL 6.4-1

The applicant has not addressed the site-specific impact of the chemicals on VEGP Units 3 and 4 control room habitability. As a result, RAI 2.2.3-1 was issued asking the applicant to provide the details for the other chemical hazards from onsite storage tanks in addressing the control room habitability impacts. On the basis of the review of the chemical inventory information and response provided by the applicant, and the staff's confirmatory analysis, the staff determined that the concentration of the site-specific chemicals Methoxypropylamine (MPA) and ammonium bisulfite exceeded the respective IDLH concentration outside the control room. Therefore, these two additional chemicals are being further evaluated as part of control room habitability systems in SER Section 6.4.

The staff reviewed the applicant provided (Table 6.4-201 found in the applicant's June 17, 2010 letter) site-specific chemicals stored onsite, and the applicant's screening out of chemicals that do not pose a threat to control room habitability. Based on evaluation of the information presented in the VEGP COL FSAR, confirmatory analyses, and review of the response to RAI 2.2.3-1, the staff considered whether any additional chemicals needed to be evaluated further in Section 6.4 along with the applicant's identified list of toxic chemicals for control room habitability. The staff concludes that two site-specific chemicals, MPA and Ammonium bisulfite, exceeded IDLH concentration limits outside the control room, and these are further evaluated in SER Section 6.4 for control room habitability.

The inclusion of the applicant's Table 6.4-201 standard chemicals in its letter dated June 17, 2010, in the next revision of the VEGP COL FSAR is **Confirmatory Item 2.2-2**.

Fires

The staff reviewed the information in the VEGP COL FSAR, with respect to forest fires and fires due to an accident at an offsite industrial storage facility.

AP1000 COL Information Items

- VEGP COL 2.2-1

- VEGP COL 6.4-1

The NRC staff reviewed VEGP COL 2.2-1 (related to COL Information Item 2.2-1), which addressed fires.

VEGP COL 6.4-1 (related to COL Information Item 6.4-1) is addressed in SER Section 6.4.

The applicant presented additional information to VEGP ESP SSAR Section 2.2.3.3 pertaining to fires as part of VEGP COL 2.2-1.

The NRC staff reviewed the information provided by the applicant with respect to forest fires and industrial fires at offsite industrial storage facilities and finds the applicant's information acceptable, as it meets the guidance provided in NUREG/CR-1748, "Hazards to Nuclear Power Plants from Nearby Accidents Involving Hazardous Materials-A Preliminary Assessment."

Radiological Hazards

The staff reviewed the information in the VEGP COL FSAR, with respect to radiological hazards.

AP1000 COL Information Item

- VEGP COL 2.2-1

The NRC staff reviewed VEGP COL 2.2-1 (related to COL Information Item 2.2-1), which addresses radiological hazards.

The applicant presented additional information to VEGP ESP SSAR Section 2.2.3.4 pertaining to radiological hazards due to loss-of-coolant accident (LOCA) design-basis accident (DBA) in Unit 1 or 2 for uprated conditions using alternate source term methodology as part of VEGP COL 2.2-1.

The NRC staff reviewed the information provided by the applicant, and finds the applicant's information acceptable, as the radiological doses are comparable to the dose reported in AP1000 DCD Tier 2 Table 15.6.5-3 for a postulated LOCA. Radiological doses are further addressed in Section 6.4 and Section 15 of this SER.

Supplemental Information

- VEGP SUP 2.2-1

The applicant provided the following additional references in VEGP SUP 2.2-1.

> Murphy, K.G., and K.M. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Criterion 19," U.S. Atomic Energy Commission, 13th Air Cleaning Conference, 1974.
>
> U.S. Environmental Protection Agency, "ALOHA (Areal Location of Hazardous Atmospheres)," Version 5.4.1, February 2007.

The staff finds the addition of these references to be acceptable, as the methodology provided in these references is consistent with the NRC guidance in NUREG-0570 "Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release."

2.2.3.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.2.3.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to evaluation of potential accidents, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

On the basis of confirmatory analysis, the staff determined that the concentration of two standard chemicals, hydrazine and carbon dioxide; and the concentration of the site-specific chemicals, MPA and ammonium bisulfite, exceeded the respective IDLH concentration outside the control room. Therefore, the two standard AP1000 chemicals, hydrazine and carbon dioxide, and two site-specific chemicals, MPA and ammonium bisulfite, are identified for further evaluation by the staff in SER Section 6.4 for control room habitability, along with the review and evaluation of other chemicals listed in Table 6.4-201.

As set forth above, the applicant has identified potential accidents related to the presence of hazardous materials or activities in the site vicinity that could affect a nuclear power plant or plants of the specified type that might be constructed on the proposed site, has appropriately determined those that should be considered as design-basis events, and has demonstrated that the plant is adequately protected and can be operated with an acceptable degree of safety with regard to the DBAs. The staff has reviewed the information provided in the VEGP ESP SSAR and the VEGP COL FSAR and, for the reasons given above, concludes that the applicant has established that the construction and operation of VEGP Units 3 and 4 on the proposed site location are acceptable to meet the requirements of 10 CFR 52.79(a)(1)(iv) and 10 CFR 52.79(a)(1)(vi) for compliance with respect to determining the acceptability of the site. This addresses VEGP COL 2.2-1. The applicant's proposed revision to VEGP COL FSAR Section 2.2.3.2.3.1 and Table 6.4-201 will remain as **Confirmatory Items 2.2-1 and 2.2-2** respectively until they are incorporated in a future revision. The applicant has provided sufficient information to satisfy the applicable requirements of 10 CFR Part 50, 10 CFR Part 52, and 10 CFR Part 100 for the acceptability of the site for proposed nuclear units.

However, as a result of **Confirmatory Items 2.2-1 and 2.2-2**, the staff is unable to finalize its conclusions on VEGP COL 2.2-1.

2.3 Meteorology

To ensure that a nuclear power plant or plants can be designed, constructed, and operated on an applicant's proposed site in compliance with the Commission's regulations, the NRC staff

evaluates regional and local climatological information, including climate extremes and severe weather occurrences that may affect the design and siting of a nuclear plant. The staff reviews information on the atmospheric dispersion characteristics of a nuclear power plant site to determine whether the radioactive effluents from postulated accidental releases, as well as routine operational releases, are within Commission guidelines.

2.3.1 Regional Climatology

2.3.1.1 Introduction

Section 2.3, "Meteorology," of the VEGP COL FSAR addresses regional climatology, including averages and extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant, including information describing the general climate of the region, seasonal and annual frequencies of severe weather phenomena, and other meteorological conditions to be used for design- and operating-basis considerations.

2.3.1.2 Summary of Application

Section 2.3 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.3.1 of the AP1000 DCD, Revision 17, and Section 2.3.1 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.3, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.3-1

The applicant provided additional information in VEGP COL 2.3-1 to address COL Information Item 2.3-1 (COL Action Item 2.3.1-1) related to regional climatology. The applicant stated that VEGP COL 2.3-1 is addressed in Section 2.3.1 of the VEGP ESP SSAR.

This COL item states that the applicant should address site-specific information related to regional climatology; that is, the COL applicant should describe averages and extremes of climatic conditions and regional meteorological phenomena that could affect the safe design and siting of the plant in accordance with Section 2.3.1 of NUREG-0800.

ESP COL Information Item

- VEGP ESP COL 2.3-1

The applicant provided additional information in VEGP ESP COL 2.3-1 to address VEGP ESP COL Action Item 2.3-1 related to the ultimate heat sink (UHS).

This COL item states that if the applicant chooses an alternative plant design other than the AP1000 that requires the use of a UHS cooling tower, the applicant will need to identify the appropriate meteorological characteristics (i.e., maximum evaporation and drift loss and minimum water cooling conditions) used to evaluate the design of the chosen UHS cooling tower. The applicant has chosen the AP1000 reactor design, which does not use a cooling tower to release heat to the atmosphere following a loss-of-coolant accident (LOCA).

Therefore, the applicant need not identify meteorological characteristics for evaluating the design of a UHS cooling tower.

Supplemental Information

- VEGP SUP 2.3-1

The applicant provided supplemental information in VEGP SUP 2.3-1 related to winter precipitation roof loading.

Variances

- VEGP ESP VAR 2.3-1

This ESP variance (VAR) item proposed changes to the VEGP ESP SSAR associated with the maximum and minimum normal air temperature site characteristic values.

2.3.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for regional climatology are given in Section 2.3.1 of NUREG-0800.

The acceptance criteria for the additional regional climatic information presented in the FSAR beyond that presented in the SSAR (i.e., VEGP SUP 2.3-1 and VEGP ESP VAR 2.3-1) are based on meeting the following relevant requirements of 10 CFR Part 52 and 10 CFR Part 100:

- 10 CFR 52.79(a)(iii), as it relates to identifying 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 time in which the historical data have been accumulated.

- 10 CFR 100.20(c)(2) and 10 CFR 100.21(d), with respect to the consideration given to the regional meteorological characteristics of the site.

The related acceptance criteria summarized from NUREG-0800 Section 2.3.1 specify, in part, that an application meets the above requirements, if the application satisfies the following criteria:

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

- Consistent with the staff's branch position on winter precipitation loads, the winter precipitation loads to be included in the combination of normal live loads to be considered in the design of a nuclear power plant that might be constructed on the proposed site should be based on the weight of the 100-year snowpack or snowfall,

whichever is greater, recorded at ground level. Likewise, the winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant that might be constructed on the proposed site should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour probable maximum winter precipitation (PMWP) at ground level for the month corresponding to the selected snowpack.

Subsequent to publication of NUREG-0800 Section 2.3.1, the staff issued Interim Staff Guidance (ISG) document DC/COL-ISG-7, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," 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

The NRC staff reviewed Section 2.3 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information related to regional climatology. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.3-1

The NRC staff reviewed VEGP COL 2.3-1 (related to AP1000 COL Information Item 2.3-1), which addresses regional climatology. The staff found that the applicant appropriately supplied site-specific regional climatological information by incorporating by reference VEGP ESP SSAR Section 2.3.1. The staff has already reviewed Section 2.3.1 of the VEGP ESP SSAR and found the information included therein to be acceptable as documented in NUREG-1923. Therefore, the staff concludes that the information in VEGP ESP SSAR Section 2.3.1 and incorporated by reference in VEGP COL FSAR Section 2.3 is sufficient to satisfy the requirements of COL Information Item 2.3.1. Hence, the NRC staff considers this COL item resolved.

ESP COL Information Item

- VEGP ESP COL 2.3-1

The NRC staff reviewed VEGP ESP COL 2.3-1 (related to VEGP ESP COL Action Item 2.3-1), which addresses the UHS. The applicant has chosen the AP1000 reactor design, which does not use a cooling tower to release heat to the atmosphere following a LOCA. The AP1000 design uses a passive containment cooling system (PCS) to provide the safety-related UHS. The PCS is designed to withstand the maximum safety dry bulb and coincident wet bulb air

temperature site parameters specified in the AP1000 DCD. Therefore, the applicant need not identify meteorological characteristics for evaluating the design of a UHS cooling tower. Hence, the NRC staff considers this COL item resolved.

Supplemental Information

- VEGP SUP 2.3-1

The staff reviewed the applicant's supplemental information related to winter precipitation roof loading provided in VEGP COL FSAR Section 2.3.1.3.4. The applicant stated that the AP1000 safety-related roofs are sloped and designed to handle winter snowpack with margin to handle rainfall on top of the 100-year snowpack. According to the applicant, the safety-related roofs will not deflect enough to hold water under the snow load; therefore, ponding of rain water with preexisting snow pack conditions will not occur. The applicant stated that the physical arrangement of the AP1000 sloped roof is designed such that the 100-year snow pack will not prevent the PMWP from draining off the sloped roof system. In addition, the applicant stated that the AP1000 roof includes insulation that assures uniform temperatures on the roof surface. According to the applicant, this minimizes the potential for ice dams that are typically formed across roofs with a temperature differential. The VEGP site-specific 100-year ground snow load of 10 pounds-force per square foot (lbf/ft^2) is well within the AP1000 design basis ground snow load site parameter value of 75 lbf/ft^2.

The NRC staff issued proposed DC/COL-ISG-07 for public comment on August 22, 2008 (73 *Federal Register* [FR] 49712). (The staff notes that ISG-07 was finalized and issued on June 23, 2009.) The proposed ISG clarifies the NRC staff's position on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of Seismic Category I structures. The proposed ISG revises the previously issued NRC staff guidance as discussed in NUREG-0800 Section 2.3.1. The proposed ISG states that normal and extreme winter precipitation events should be identified in NUREG-0800 Section 2.3.1 as COL site characteristics for use in NUREG-0800 Section 3.8.4 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 the 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) the extreme frozen winter precipitation event; or (2) the extreme liquid winter precipitation event. The extreme frozen winter precipitation event is assumed to accumulate on the roof on top of the antecedent normal winter precipitation event, whereas 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. The proposed ISG further states:

- The normal winter precipitation event should be the highest ground-level weight (in lbf/ft^2) among: (1) the 100-year return period snowpack; (2) the historical maximum snowpack; (3) the 100-year return period two-day snowfall event; or (4) the historical maximum two-day snowfall event in the site region.

- The extreme frozen winter precipitation event should be the higher ground-level weight (in lbf/ft^2) between: (1) the 100-year return period two-day snowfall event; and (2) the historical maximum two-day snowfall event in the site region.

- The extreme liquid winter precipitation event is defined as the theoretically greatest depth of precipitation (in inches (in.) of water) for a 48-hour period that is physically possible over a 25.9-square-kilometer (km) (10-square-mile (mi)) area at a particular geographical location during those months with the historically highest snowpacks.

The NRC staff asked the applicant in RAI 2.3.1-4 to identify the extreme frozen winter precipitation event and the extreme liquid winter precipitation event as site characteristics in accordance with DC/COL-ISG-07.

In response to RAI 2.3.1-4, dated November 18, 2008, the applicant identified its extreme frozen winter precipitation event as 17.2 lbf/ft^2, based on the historic maximum monthly snowfall recorded in the site vicinity (22 in. of snow recorded at Bamberg, South Carolina, in February 1973). The staff finds this acceptable because this historic maximum monthly snowfall total bounds: (1) any historical maximum two-day snowfall event in the site region; and (2) the 100-year return period 48-hour two-day snowfall event for any climatological stations in the region as reported by the National Climatic Data Center's Snow Climatology web site (http://www.ncdc.noaa.gov/ussc/index.jsp, accessed February 9, 2009). The staff notes that the extreme winter precipitation ground load resulting from the combination of the antecedent 100-year return period snowpack (10 lbs/ft^2) and the extreme frozen winter precipitation event (17.2 lbf/ft^2) is significantly less than AP1000 design basis ground snow load site parameter value of 75 lbf/ft^2.

In response to RAI 2.3.1-4, the applicant also identified its extreme liquid winter precipitation event as 28.3 in. of water, which was identified in the VEGP ESP SSAR as the 48-hour PMWP. Therefore, for the reasons cited above, RAI 2.3.1-4 is closed and the staff finds VEGP SUP 2.3-1 to be an acceptable addition to VEGP ESP SSAR Section 2.3.1.3.4.

Variances

- VEGP ESP VAR 2.3-1

The Westinghouse response to AP1000 DCD RAI-SRP2.3.1-RSAC-01 stated that the AP1000 maximum and minimum normal temperature site parameters are based on one-percent and 99-percent seasonal exceedance frequencies, which are approximately equivalent to the 0.4-percent and 99.6-percent annual exceedance values, respectively. The applicant provided one-percent and 99-percent annual exceedance site characteristic temperature values for comparison with the AP1000 maximum and minimum normal temperature site parameter values in Revision 0 to VEGP COL FSAR Table 2.0-201. In RAI 2.3.1-3, the NRC staff asked the applicant to revise the normal temperature site characteristic values presented in VEGP COL FSAR Table 2.0-201 accordingly. In response to RAI 2.3.1-3, the applicant revised VEGP COL FSAR Table 2.0-201 by replacing the one-percent and 99-percent annual exceedance site temperature values with 0.4-percent and 99.6-percent annual exceedance site temperature values for comparison with the AP1000 maximum and minimum normal temperature site parameter values. The 0.4-percent and 99.6-percent annual exceedance site temperature values were provided in VEGP ESP SSAR Section 2.3.1.5 and Table 1-1. Since these site temperature values were already evaluated as part of the ESP, the staff accepts the applicant's 0.4-percent and 99.6-percent annual exceedance site temperature values as being correct. For these reasons, the staff accepts VEGP ESP VAR 2.3-1 and RAI 2.3.1-3 is closed.

2.3.1.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.3.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to regional climatology, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

In addition, the staff has compared the additional COL information in the application to the relevant NRC regulations and associated acceptance criteria in NUREG-0800 Section 2.3.1. The staff concludes that the applicant is in compliance with the relevant requirements of 10 CFR Parts 52 and 100. COL items VEGP COL 2.3-1, VEGP SUP 2.3-1, VEGP ESP COL 2.3-1, and VEGP ESP VAR 2.3-1 have been adequately addressed by the applicant and are resolved.

The NRC staff acknowledges that long-term climatic change resulting from human or natural causes may introduce changes to the most severe natural phenomena reported for the site. However, no conclusive evidence or consensus of opinion is available on the rapidity or nature of such changes. There is a level of uncertainty in projecting future conditions because the assumptions regarding the future level of emissions of heat-trapping gases depends on projections of population, economic activity, and choice of energy technologies. If it becomes evident that long-term climatic change is influencing the most severe natural phenomena

reported at the site, the staff notes that the licensee has a continuing obligation to ensure that its plants stay within the licensing basis.

2.3.2 Local Meteorology

Section 2.3, "Meteorology," of the VEGP COL FSAR addresses local meteorology, including the local (site) meteorological characteristics, an assessment of the potential influence of the proposed plant and its facilities on local meteorological conditions, and a topographical description of the site and its environs.

Section 2.3 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.3.2 of the DCD, Revision 17, and adds VEGP COL 2.3-2 to address COL Information Item 2.3-2 (COL Action Item 2.3.2-1). The applicant stated that VEGP COL 2.3-2 is addressed in Section 2.3.2 of the VEGP ESP SSAR. The staff found that the applicant appropriately supplied site-specific local meteorological information by incorporating by reference VEGP ESP SSAR Section 2.3.2. The staff had already reviewed Section 2.3.2 of the VEGP ESP SSAR and found the information relating to local meteorology to be acceptable as documented in NUREG-1923. Therefore, the staff concludes that the information in VEGP ESP SSAR Section 2.3.2 and incorporated by reference in VEGP COL FSAR Section 2.3 is sufficient to satisfy the requirements of COL Information Item 2.3-2. Hence, the NRC staff considers COL Item 2.3-2 resolved.

The NRC staff reviewed Section 2.3 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to local meteorology. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.3.3 Onsite Meteorological Measurement Programs

2.3.3.1 Introduction

Section 2.3, "Meteorology," of the VEGP COL FSAR addresses the need for the onsite meteorological monitoring and the resulting data.

2.3.3.2 Summary of Application

Section 2.3 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.3.3 of the AP1000 DCD, Revision 17, and Section 2.3.3 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.3, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.3-3

The applicant provided additional information in VEGP COL 2.3-3 to address COL Information Item 2.3-3 (COL Action Item 2.3.3-1) related to the onsite meteorological measurements

program. The applicant stated that VEGP COL 2.3-3 is addressed in VEGP COL FSAR Section 2.3.3.4 and Section 2.3.3 of the VEGP ESP SSAR.

This COL item states that the COL applicant referencing the AP1000 certified design will address the site-specific onsite meteorological measurements program; that is, the COL applicant should describe its onsite meteorological measurements program and provide a copy of the resulting meteorological data in accordance with NUREG-0800 Section 2.3.3. The applicant responded to this COL item by referencing the onsite meteorological program description provided in Section 2.3.3 of the VEGP ESP SSAR, including the 1998–2002 onsite hourly database submitted in support of the VEGP ESP application. The applicant also presented VEGP COL FSAR Section 2.3.3.4 as a new section following VEGP ESP SSAR Section 2.3.3.3. This new section states the monitoring program operated in support of VEGP Units 1 and 2 was found by the staff to be adequate for the purposes of the SSAR and will be used to support the operation of VEGP Units 3 and 4.

2.3.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for onsite meteorological measurements programs are given in Section 2.3.3 of NUREG-0800.

2.3.3.4 Technical Evaluation

The NRC staff reviewed Section 2.3 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to onsite meteorological measurement programs. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.3-3

The NRC staff reviewed VEGP COL 2.3-3 related to the onsite meteorological measurements program included under Section 2.3 of the VEGP COL FSAR. The staff found that the applicant appropriately supplied site-specific onsite meteorological measurements program information by incorporating by reference VEGP ESP SSAR Section 2.3.3. The staff had already reviewed Section 2.3.3 of the VEGP ESP SSAR and found the information included therein to be acceptable as documented in NUREG-1923.

The applicant presented VEGP COL FSAR Section 2.3.3.4 as a new section following VEGP ESP SSAR Section 2.3.3.3. This new section states the monitoring program operated in support of VEGP Units 1 and 2 will also support the operation of VEGP Units 3 and 4. The applicant summarized that the NRC evaluated the onsite meteorological measurement program and found it acceptable as documented in Section 2.3.3 of NUREG-1923. It also stated that the current monitoring program and its implementation were determined to meet the guidance in proposed Revision 1 to RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," and found to provide an acceptable basis for estimating atmospheric dispersion conditions for accidental and routine releases of radioactive material to the atmosphere. The staff agrees with the supplemental meteorological monitoring program compliance summary provided and, thus, finds it an acceptable addition to VEGP ESP SSAR Section 2.3.3.3. Hence, the NRC staff considers this COL item resolved.

2.3.3.5 Post Combined License Activities

Appendix B (Inspections, Tests, Analyses, and Acceptance Criteria [ITAAC]) of Part 10 (Proposed License Conditions, Including ITAAC) of the VEGP Units 3 and 4 COL application states that the emergency planning (EP) ITAAC included in ESP-004, Appendix E, are incorporated by reference. Appendix E identifies two EP-ITAAC that are involved in demonstrating that the operational onsite meteorological monitoring program appropriately supports the VEGP Units 3 and 4 EP:

- EP Program Element 6.3: The means exist to continuously assess the impact of the release of radioactive materials to the environment, accounting for the relationship between effluent monitor readings, and onsite and offsite exposures and contamination for various meteorological conditions. The acceptance criterion is that the emergency implementing procedures and the Offsite Dose Calculation Manual calculate the relationship between effluent monitor readings and offsite exposure and contamination.

- EP Program Element 6.4: The means exist to acquire and evaluate meteorological information. The acceptance criterion is wind speed (at 10 m and 60 m), wind direction (at 10 meters [m] and 60 m), standard deviation of horizontal wind direction (at 10 m), vertical temperature difference (between 10 m and 60 m), ambient temperature (at 10 m), dew point temperature (at 10 m) and precipitation (at the tower base) are displayed in the technical support center and control room.

Emergency planning, including EP ITAAC, is addressed in SER Section 13.3, "Emergency Planning."

2.3.3.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information related to onsite meteorological measurement programs, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff concludes that the applicant is in compliance with the relevant requirements of 10 CFR Part 50, "Domestic licensing of production and utilization facilities"; 10 CFR Part 52; and 10 CFR Part 100. COL Item VEGP COL 2.3-3 has been adequately addressed by the applicant.

2.3.4 Short-Term Diffusion Estimates (Related to RG 1.206, Section C.III.2, Chapter 2, C.I.2.3.4, "Short-Term Atmospheric Dispersion Estimates for Accident Releases")

2.3.4.1 Introduction

Section 2.3.4, "Short-Term Diffusion Estimates," of the VEGP COL FSAR addresses short-term atmospheric dispersion estimates, including site-specific information on atmospheric dispersion factor (χ/Q) values at the exclusion area boundary (EAB), the outer boundary of the low population zone (LPZ), and the CR for postulated design-basis accidental radioactive airborne releases.

2.3.4.2 Summary of Application

Section 2.3 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.3.4 of the AP1000 DCD, Revision 17, and Section 2.3.4 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.3.4, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.3-4

The applicant provided additional information in VEGP COL 2.3-4 to address COL Information Item 2.3-4 (COL Action Items 2.3.4-1, 2.3.4-2, and 2.3.4-3) related to short term diffusion estimates. The applicant stated that VEGP COL 2.3-4 is addressed in Sections 2.3.4 and 15.6.5.3.7.3, and in Appendix 15A.3.3 of the VEGP COL FSAR and Section 2.3.4 of the VEGP ESP SSAR.

This COL item states that COL applicants referencing the AP1000 certified design will address the site-specific χ/Q values specified in AP1000 DCD Tier 2, Section 2.3.4; that is, provide site-specific EAB, LPZ, and CR intake χ/Q values. For a site that exceeds the bounding χ/Q values, the COL applicant will address how the radiological consequences associated with the controlling design basis accident continue to meet the dose reference values given in 10 CFR 50.34 and CR operator dose limits given in General Design Criterion (GDC) 19, "Control Room," using site-specific χ/Q values. The COL applicant should consider topographical characteristics in the vicinity of the site for restrictions of horizontal and/or vertical plume spread, channeling or other changes in airflow trajectories, and other unusual conditions affecting atmospheric transport and diffusion between the source and receptors. No further action is required for sites within the bounds of the site parameters for atmospheric dispersion.

The applicant responded to this COL item by incorporating by reference VEGP ESP SSAR Section 2.3.4, with a supplement addressing: (1) the potential changes in the EAB and LPZ χ/Q values presented in VEGP ESP SSAR Section 2.3.4 due to a change in AP1000 building dimensions (i.e., cross sectional area and building height of the containment building) from

Revision 15 to Revision 17 of the DCD; (2) radiological accident dispersion estimates for the CR; and (3) dispersion estimates associated with accidental onsite and offsite hazardous material releases. The applicant also demonstrated in VEGP COL FSAR Table 2.0-201 that the VEGP 3 and 4 EAB, LPZ and CR χ/Q site characteristic values fall within the corresponding AP1000 DCD meteorological dispersion site parameter values, thus ensuring the applicant's site meteorological dispersion values result in doses lower than the dose limits given in 10 CFR 50.34 and GDC 19.

This COL item also states that, with regard to assessment of the postulated impact of an accident on the environment, the COL applicant will provide χ/Q values for each cumulative frequency distribution that exceeds the median value (50 percent of the time). This information on the median value χ/Q values is presented in Section 2.3 of VEGP ESP Environmental Report (ER) and used in the VEGP COL ER. Because median value χ/Q values are used exclusively in the VEGP COL ER and the corresponding Environmental Impact Statement (EIS), these values are not reviewed in this SER.

Supplemental Information

- VEGP SUP 2.3-2

The applicant provided supplemental information in VEGP SUP 2.3-2 by adding the following reference, NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes," PNNL-10521, Revision 1, May 1997.

2.3.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for short-term diffusion estimates are given in Section 2.3.4 of NUREG-0800.

The acceptance criteria for the additional short-term diffusion estimates for accident releases presented in the VEGP COL FSAR beyond those presented in the VEGP ESP SSAR (i.e., VEGP COL 2.3-4) are based on meeting the relevant requirements of 10 CFR Part 50. The staff considered the following regulatory requirements in reviewing the applicant's discussion of CR atmospheric dispersion analyses:

- 10 CFR Part 50, Appendix A, GDC 19, with respect to the meteorological considerations used to evaluate the personnel exposures inside the CR during radiological and airborne hazardous material accident conditions.

The related acceptance criteria summarized from NUREG-0800 Section 2.3.4 specifies, in part, that an application meets the GDC 19 requirements if the application provides the following information:

- A description of the atmospheric dispersion models used to calculate χ/Q values for accidental releases of radioactive and hazardous materials to the atmosphere.

- Meteorological data used for the evaluation (as input to the dispersion models), which represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release.

- A discussion of atmospheric diffusion parameters, such as lateral and vertical plume spread (σ_y and σ_z) as a function of distance, topography, and atmospheric conditions, should be related to measured meteorological data.

- Hourly cumulative frequency distributions of χ/Q values from the effluent release point(s) to the EAB and LPZ should be constructed to describe the probabilities of these χ/Q values being exceeded.

- Atmospheric dispersion factors used for the assessment of consequences related to atmospheric radioactive releases to the CR for design-basis accidents, other accidents, and for onsite and offsite releases of hazardous airborne materials should be provided.

- For CR habitability analysis, a site plan drawn to scale should be included showing true North and potential atmospheric accident release pathways, CR intake, and unfiltered inleakage pathways.

In addition, the short-term atmospheric dispersion estimates for accident releases to the CR should be consistent with the appropriate sections from the following regulatory guides:

- RG 1.23, which provides criteria for an acceptable onsite meteorological measurements program, data from which are used as input to atmospheric dispersion models.

- RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Revision 1, which presents criteria for characterizing atmospheric dispersion conditions for evaluating the consequences of airborne hazardous material releases to the CR.

- RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," which presents criteria for characterizing atmospheric dispersion conditions for evaluating the consequences of radiological releases to the CR.

2.3.4.4 Technical Evaluation

The NRC staff reviewed Section 2.3 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to short-term diffusion estimates. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.3-4

The NRC staff reviewed the applicant's resolution to VEGP COL 2.3-4 related to referencing the EAB and LPZ χ/Q values presented in the VEGP ESP SSAR and new χ/Q values presented in the VEGP COL FSAR that were calculated for the CR.

a. EAB and LPZ χ/Q Values

The NRC staff found the continued use of the VEGP ESP SSAR accident EAB and LPZ χ/Q values acceptable for the following reasons:

- NUREG-0800 Section 2.3.4 states that a COL application referencing an ESP need not include a re-investigation of the site characteristics that have been previously accepted in the referenced ESP.

- The VEGP Units 3 and 4 site layout shown in VEGP COL FSAR Figure 1.1-202 is the same layout shown in VEGP ESP Figure 1-4 and the definitions of the VEGP COL FSAR EAB and LPZ are the same as the VEGP ESP definitions. Consequently, the downwind distances used in the VEGP ESP SSAR to calculate the EAB and LPZ χ/Q site characteristic values are applicable to the VEGP COL application. The VEGP ESP SSAR defined the "dose calculation" EAB and LPZ as circles that extend 0.5 mi and 2 mi beyond the power block area in order to encompass all potential release locations.

- Other input assumptions used to derive the VEGP ESP SSAR EAB and LPZ accident χ/Q site characteristic values remain bounding for VEGP Units 3 and 4. For example, all release points were treated as ground level releases and the applicant did not take credit for building wake effects. Ignoring building wake effects for a ground-level release decreases the amount of atmospheric turbulence assumed to be in the vicinity of the release point, resulting in higher (more conservative) χ/Q values.

The NRC staff concluded that the input assumptions used to model the VEGP ESP SSAR accident EAB and LPZ χ/Q values bound the actual VEGP Units 3 and 4 plant and site characteristics and the use of one set of accident χ/Q values to model all potential accident release points is appropriate. Therefore, the NRC staff finds that the applicant's use of the VEGP ESP SSAR EAB and LPZ χ/Q values for VEGP Units 3 and 4 is appropriate.

b. CR χ/Q Values

AP1000 DCD Tier 2, Figure 15A-1 shows the VEGP Units 3 and 4 onsite release points (i.e., plant vent, PCS air diffuser, fuel building blowout panel, fuel building rail bay door, steam vent/line break, power operated relief valves and safety valves, condenser air removal stack, and containment shell) and the CR inlet locations (i.e., CR heating, ventilation, and air conditioning (HVAC) intake and the annex building access door). The applicant provided χ/Q values in VEGP COL FSAR Tables 2.3-201 and 2.3-202 for use in evaluating potential doses from these VEGP Units 3 and 4 postulated release locations to the VEGP Units 3 and 4 CR inlets utilizing the same onsite 1998-2002 meteorological database used in the VEGP ESP SSAR for the EAB and LPZ atmospheric dispersion calculations. The applicant stated that it

used the ARCON96 atmospheric dispersion computer code (Revision 1 of NUREG/CR-6331) in accordance with guidance provided in RG 1.194.

RG 1.194 states that the ARCON96 computer code is an acceptable methodology for assessing CR χ/Q values for use in design-basis accident radiological analyses, subject to the provisions of RG 1.194. The ARCON96 code estimates χ/Q values for various time-average periods ranging from 2 hours to 30 days. The meteorological input to ARCON96 consists of hourly values of wind speed, wind direction, and atmospheric stability class. The χ/Q values calculated through ARCON96 are based on the theoretical assumption that material released to the atmosphere will be normally distributed (Gaussian) about the plume centerline. A straight-line trajectory is assumed between the release points and receptors. The diffusion coefficients account for enhanced dispersion under low wind speed conditions and in building wakes.

Hourly meteorological data are used to calculate hourly relative concentrations (χ/Q values). The hourly relative concentrations are then combined to estimate concentrations ranging in duration from 2 hours to 30 days. Cumulative frequency distributions are prepared from the average relative concentrations and the relative concentrations that are exceeded no more than five percent of the time for each averaging period are determined.

The diffusion coefficients used in ARCON96 have three components. The first component is the diffusion coefficient used in other NRC models, such as PAVAN (NUREG/CR-2858), which was used in the VEGP ESP SSAR to generate EAB and LPZ accident χ/Q values. The other two components are corrections to account for enhanced dispersion under low wind speed conditions and in building wakes. These components are based on analysis of diffusion data collected in various building wake diffusion experiments under a wide range of meteorological conditions. Because the diffusion occurs at short distances within the plant's building complex, the ARCON96 diffusion parameters are not affected by nearby topographic features such as hills and bodies of water. Therefore, the NRC staff finds that the applicant's use of the ARCON96 diffusion parameter assumptions is acceptable.

Much of the information needed to run ARCON96 for the AP1000 building configuration is presented in AP1000 DCD Tier 2, Table 15A-7 (e.g., source and receptor heights; distances between sources and receptors). In RAI 2.3.4-1, the staff asked the applicant to provide information related to the direction between the receptors and release points for the VEGP Units 3 and 4 building layout so that the staff could review the inputs used by the applicant and conduct its own confirmatory analysis. The applicant provided the requested information in its response to RAI 2.3.4-1 dated September 11, 2008. The staff reviewed the applicant's receptor-to-source direction data against the AP1000 release points and receptors shown in DCD Tier 2, Figure 15A-1, and obtained similar results. Hence, RAI 2.3.4-1 is considered closed.

The NRC staff found the applicant's CR χ/Q values presented in VEGP COL FSAR Tables 2.3-201 and 2.3-202 acceptable for the following reasons:

- The applicant derived its χ/Q values using the ARCON96 atmospheric dispersion computer code in accordance with the guidance provided in RG 1.194 and the source and receptor data presented in AP1000 DCD Tier 2, Table 15A-7. The staff evaluated the applicability of the ARCON96 model and concluded that there is no unusual siting, building arrangements, release characterization, source-receptor configuration,

meteorological regimes, or terrain conditions, which preclude the use of the ARCON96 model for VEGP Units 3 and 4.

- The applicant derived its χ/Q values utilizing the same onsite 1998-2002 meteorological database used to derive the EAB and LPZ χ/Q values presented in the VEGP ESP SSAR. The staff reviewed the 1998-2002 onsite meteorological database in Section 2.3.3 of the VEGP ESP SER and concluded that these data were representative of the dispersion conditions at the VEGP ESP site.

- The NRC staff confirmed the applicant's atmospheric dispersion estimates by running the ARCON96 model and obtaining similar results (i.e., most values were within ± 3 percent).

In light of the foregoing, the staff accepts the CR χ/Q values presented by the applicant.

The applicant also briefly addressed the determination of accident-related concentrations at the CR due to onsite and/or offsite airborne releases of hazardous materials. The NRC staff's technical evaluation of the applicant's dispersion estimates associated with accidental onsite and offsite hazardous material releases is discussed in Section 2.2 of this SER.

The NRC staff considers this COL item resolved for the reasons discussed above.

Supplemental Information

- VEGP SUP 2.3-2

The applicant provided supplemental information in VEGP SUP 2.3-2 to reference NUREG/CR-6331, which is the documentation package for the ARCON96 atmospheric dispersion computer code. Because RG 1.194 states that the ARCON96 computer code is an acceptable methodology for assessing CR χ/Q values and the applicant used the ARCON96 model in its CR χ/Q evaluations, the staff finds the addition of this reference to be acceptable.

2.3.4.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.3.4.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information related to short-term diffusion estimates, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

In addition, the staff has compared the additional COL information in the application to the relevant NRC regulations and acceptance criteria defined in NUREG-0800 Section 2.3.4. The staff concludes that the applicant is in compliance with the relevant requirements of

10 CFR Parts 50, 52, and 100. COL Items VEGP COL 2.3-4 and VEGP SUP 2.3-2 have been adequately addressed by the applicant.

2.3.5 Long-Term Diffusion Estimates (Related to RG 1.206, Section C.III.2, Chapter 2, C.I.2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases")

2.3.5.1 Introduction

Section 2.3.5, "Long-Term Diffusion Estimates" of the VEGP COL FSAR addresses long-term atmospheric dispersion estimates, including site-specific information on atmospheric dispersion factor (χ/Q) and dry deposition factor (D/Q) values to a distance of 80 km (50 mi) from the plant for releases of radiological effluents to the atmosphere during normal plant operation for annual average release limit calculations and offsite dose estimates.

2.3.5.2 Summary of Application

Section 2.3 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.3.5 of the AP1000 DCD, Revision 17, and Section 2.3.5 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.3.5, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.3-5

The applicant provided additional information in VEGP COL 2.3-5 to address COL Information Item 2.3-5 (COL Action Items 2.3.5-1 and 2.3.5-2) related to long-term diffusion estimates. The applicant stated that VEGP COL 2.3-5 is addressed in Section 2.3.5 of the VEGP COL FSAR and Section 2.3.5 of the VEGP ESP SSAR.

This COL item states that the COL applicant will address long-term diffusion estimates and χ/Q values specified in AP1000 DCD Tier 2, Section 2.3.5; that is, the COL applicant should provide χ/Q and D/Q estimates for calculating concentrations in air and the amount of material deposited on the ground as a result of routine releases of radiological effluents to the atmosphere during normal plant operation. This COL item further states that the COL applicant should consider topographical characteristics in the vicinity of the site for restrictions of horizontal and/or vertical plume spread, channeling or other changes in airflow trajectories, and other unusual conditions affecting atmospheric transport and diffusion between the source and receptors. No further action is required for sites within the bounds of the site parameter for atmospheric dispersion. With regard to environmental assessment, this COL item also states that the COL applicant will provide estimates of annual average χ/Q values for 16 radial sectors to a distance of 50 mi from the plant. The applicant responded to this COL item by referencing the long-term χ/Q and D/Q values presented in VEGP ESP SSAR Section 2.3.5. The applicant also provided a supplement addressing the potential changes in the long-term atmospheric dispersion and deposition values, as presented in VEGP ESP SSAR Section 2.3.5, due to a change in the pertinent AP1000 building dimensions (i.e., cross sectional area and building height of the containment building) from Revision 15 to Revision 17 of the AP1000 DCD.

2.3.5.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for long-term diffusion estimates are given in Section 2.3.5 of NUREG-0800.

2.3.5.4 Technical Evaluation

The NRC staff reviewed Section 2.3 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to long-term diffusion estimates. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.3-5

The NRC staff reviewed VEGP COL 2.3-5 related to long-term diffusion estimates included under Section 2.3.5 of the VEGP COL FSAR.

The applicant stated in Revision 0 to the VEGP COL FSAR Section 2.3.5 that it reevaluated the long-term (routine release) dispersion and deposition estimates at the dose calculation EAB and various receptors using the same assumptions and methodology described in the VEGP ESP SSAR (which relied on the AP1000 DCD, Revision 15), with the exception of the reactor building dimensions provided in the AP1000 DCD, Revision 16. The applicant stated that the revised χ/Q values were bounded by those provided in the VEGP ESP SSAR.

Using an updated reactor building cross-sectional area and containment height while maintaining the other model inputs consistent with the VEGP ESP SSAR, the staff calculated slightly less conservative χ/Q and D/Q values for both the EAB and the various receptors. Consequently, the staff asked the applicant, first in RAI 2.3.5-1, and then again in follow-up RAI 2.3.5-2, to provide clarification on how the revised χ/Q values are less than those presented in the VEGP ESP SSAR.

In its response to RAI 2.3.5-2, dated November 18, 2008, the applicant stated it recalculated the χ/Q values using the same area-weighted "effective height" methodology used in the VEGP ESPA SSAR to determine the reactor building height. The applicant found that the recalculated χ/Q values for the EAB and other receptor locations were not bounding but were within approximately 3.3 percent of those provided in the VEGP ESP SSAR. The applicant subsequently revised VEGP COL FSAR Section 2.3.5 to reflect this comparison result. The applicant further stated that the χ/Q values from the revised analysis would not appreciably

change the normal release dose evaluations and the doses would remain within regulatory limits.

The NRC staff found the continued use of the VEGP ESP SSAR long-term χ/Q and D/Q values to model all routine release pathways acceptable for the following reasons:

- The VEGP Units 3 and 4 site layout shown in VEGP COL FSAR Figure 1.1-202 is the same layout shown in VEGP ESP SSAR Figure 1-4. The VEGP ESP SSAR defined the "dose calculation" EAB as a circle that extends 0.5-mi beyond the power block area in order to encompass all potential release locations (VEGP Units 3 and 4 airborne effluents will normally be released through the plant vent and turbine building vent). Similarly, the shortest distance between the VEGP Units 3 and 4 power block and the nearest residence (i.e., 0.67 mi) was conservatively used in all the directional sectors for all receptors of interest (i.e., meat animal, vegetable garden, and residence).

- The VEGP ESP SSAR long-term χ/Q and D/Q site characteristic values were conservatively determined by treating all releases as ground level releases. A ground level release assumption generally produces more conservative χ/Q and D/Q values for relatively flat terrain sites such as VEGP Units 3 and 4.

- The NRC staff confirmed the applicant's EAB and the various receptors atmospheric dispersion estimates by independently calculating results similar to the VEGP ESP SSAR (within ± 3.3 percent) using the AP1000 DCD, Revision 17 reactor building dimensions.

Because the applicant used conservative assumptions in generating the VEGP ESP SSAR long-term χ/Q and D/Q values and the staff's confirmatory analysis generated similar results, RAIs 2.3.5-1 and 2.3.5-2 are closed. Hence, the NRC staff considers this COL item resolved.

2.3.5.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.3.5.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information related to long-term diffusion estimates, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

In addition, the staff has compared the additional COL information in the application to the relevant NRC regulations and acceptance criteria defined in NUREG-0800 Section 2.3.5. The staff concludes that the applicant is in compliance with the relevant requirements of 10 CFR Parts 50, 52, and 100. COL Item VEGP COL 2.3-5 has been adequately addressed by the applicant.

2.4 Hydrologic Engineering

2.4.1 Hydrologic Description

The hydrologic description of the nuclear power plant site includes the interface of the plant with the hydrosphere, hydrological causal mechanisms, surface and groundwater uses, hydrologic data, and alternate conceptual models. The review covers the following specific areas: (1) interface of the plant with the hydrosphere including descriptions of site location, major hydrological features in the site vicinity, surface- and groundwater-related characteristics, and the proposed water supply to the plant; (2) hydrological causal mechanisms that may require special plant design bases or operating limitations with regard to floods and water supply requirements; (3) current and likely future surface and groundwater uses by the plant and water users in the vicinity of the site that may impact safety of the plant; (4) available spatial and temporal data relevant for the site review; (5) alternate conceptual models of the hydrology of the site that reasonably bound hydrological conditions at the site; and (6) potential effects of seismic and non-seismic data on the postulated design bases and how they relate to the hydrology in the vicinity of the site and the site region.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17 and adds VEGP COL 2.4-1. To address VEGP COL 2.4-1, the applicant incorporates by reference VEGP ESP SSAR Section 2.4.1.

The NRC staff reviewed Section 2.4.1 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the hydrologic description. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.2 Floods

2.4.2.1 Introduction

This section of the VEGP COL FSAR discusses flooding at the proposed site or in the region of the site. The information summarizes and identifies the individual types of flood-producing phenomena and combinations of flood-producing phenomena considered in establishing the flood design bases for safety-related plant features. It also covers the potential effects of local intense precipitation. The flood history and the potential for flooding are reviewed. Factors affecting potential runoff, such as urbanization, forest fire, or type of agricultural use, as well as erosion and sediment deposition, are considered in the review. In addition to describing flood history, this section also determines the local intense precipitation on the site to estimate local flooding. Local intense precipitation is reported as a site characteristic used in site grading design.

2.4.2.2 Summary of Application

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17, and Section 2.4.2 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.4.2, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.4-2

The applicant added text in VEGP COL FSAR Section 2.4.2.3 to the end of VEGP ESP SSAR Section 2.4.2.3. The applicant provided detailed information on the site drainage plan to address COL Information Item 2.4-2 by confirming that locally intense precipitation would not violate flooding criteria. The applicant provided site descriptions and analyses for a network of drainage channels that would convey local intense precipitation away from the structures that are important to safety.

2.4.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the identification of floods and flood design considerations are given in Section 2.4.2 of NUREG-0800.

The applicable regulatory requirements for identifying floods are:

- 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).

- 10 CFR 52.79(a)(1)(iii), as it relates to the hydrologic 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.

The related guidance document is RG 1.59, “Design Basis Floods for Nuclear Power Plants,” Revision 2, as supplemented by best current practices.

2.4.2.4 Technical Evaluation

The NRC staff reviewed Section 2.4.2 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents a complete scope of information relating to this review topic.[1] The staff’s review confirmed the information in the application and incorporated by reference addresses the required information relating to floods. The results of the NRC

staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.4-2

Specific to the local flooding at the VEGP site, the applicant provided information in the VEGP COL FSAR and numerical modeling files, which were developed using HEC-RAS (U.S. Army Corps of Engineers [USACE] 2008a) and HEC-HMS (USACE 2008b). Numerical modeling was used in the analysis of the local intense precipitation event and the associated drainage effects. The VEGP COL FSAR describes a network of drainage ditches at the site that are designed to move local surface water runoff away from structures important to safety. The VEGP COL FSAR discusses the applicant's design basis for handling floodwaters due to local intense precipitation in the vicinity of the power block and provides commitments to ensure that the drainage system would function as designed throughout the operating life of the power station.

The staff reviewed the information provided in the VEGP COL FSAR and hydrologic and hydraulic models for the site. In the VEGP COL FSAR, the applicant included the overall site map of the VEGP Units 3 and 4, SER Figure 2.4-1 (corresponding to VEGP COL FSAR Figure 1.1-202). While the figure identifies several drainage channels, the applicant's analysis was limited to drainage channels located within or near the VEGP Units 3 and 4 power block. Drainage channels located elsewhere within the site footprint were omitted from the safety analyses because they do not impact the safety-related structures. SER Figure 2.4-2, (corresponding to FSAR Figure 2.4-201), identifies the relevant drainage basins for VEGP Units 3 and 4 within and around the power block and provides more detail of the drainage system around the power block. The staff compared the relevant drainage ditches presented in SER Figure 2.4-2 with the inventory of channels considered within the safety analysis and identified that two channels were not directly considered in the hydraulic (HEC-RAS) analysis by the applicant. A third channel was included with Feeder Ditch 1 as ineffective flow area. The applicant's analysis of the surface water flow used the HEC-RAS model to determine elevations of the surface water runoff from the site. An important aspect of the HEC-RAS model is that it uses cross sections to define the geometry of the overbank areas and ditch channels. A map with the locations of these cross sections was not originally provided in the VEGP COL FSAR. Therefore, the staff issued RAI 2.4.2-1 requesting the applicant provide a map with HEC-RAS cross-section locations. The applicant provided this in its response to RAI 2.4.2-1, and it can be seen in SER Figure 2.4-6 (corresponding to VEGP COL FSAR Figure 2.4-201a).

As shown in the SER Figure 2.4-1, several culverts were identified within the feeder ditches that drain the power block, and the main ditch was free of culverts. The applicant stated in VEGP COL FSAR Section 2.4.2.3 that the culverts were conservatively assumed to be completely blocked and were simulated as inline weirs. The staff reviewed the VEGP COL FSAR and confirmed that most culverts received this treatment within the HEC-RAS files. To verify this model and its results, the staff conducted sensitivity analyses of the inline weirs to determine the effect of possible blockage with debris during the local intense precipitation event. By reducing the weir coefficient to 2.0 (from the typical value of 2.6), only a small increase in maximum water

surface elevation was found. Because of the relatively small width of blockage, flow was able to move onto the overbank areas.

The staff's review of the HEC-RAS input files determined that a culvert within Feeder Ditch 3 is included in the model, but it is not included in VEGP COL FSAR Figure 2.4-102. RAI 2.4.2-1 requested the map be revised to identify all culverts and additional information on these features. SER Figure 2.4-2 also shows a surface feature that appears to cover Feeder Ditches 2 and 3 at their downstream ends, but no such feature appeared in the HEC-RAS input files. The staff also identified that the access road over Feeder Ditch 4 did not include a culvert, although it did include the Feeder Ditch 4 channel. The staff conducted a sensitivity analysis by blocking the channel and simulating the access road crossing as an inline weir (as with the other blocked culvert simulations completed by the applicant). This analysis produced only a small increase (0.01 ft) in water surface elevation in Feeder Ditches 1 and 2 and in the main ditch. The staff requested that the applicant's HEC-RAS model and results be updated by blocking the culvert in Feeder Ditch 4 and that these results be included with the FSAR. The applicant provided an updated HEC-RAS file under a supplemental response letter to RAI 2.4.2-1 dated August 5, 2009. The staff verified that Revision 2 of the VEGP COL FSAR adequately addressed the above discussion.

The applicant provided responses to the four items identified in RAI 2.4.2-1. Item 1 of the RAI requested clarification regarding channels presented in VEGP COL FSAR Figure 2.4-201 that were not included in the HEC-RAS hydraulic analysis of the localized probable maximum precipitation (PMP). The applicant stated in its response to the RAI that only the channels affecting flood levels in the power block are simulated in the HEC-RAS analyses. Other channels and drainage areas were included as contributors of flow from the local intense PMP (SER Figure 2.4-2). These channels are Feeder Ditch 5 and the ditch to the east of Feeder Ditch 1. The applicant's response included statements describing the process of including flows from these other sub-basins in the hydraulic analysis. SER Figure 2.4-3 (from the applicant-provided HEC-HMS files) shows the drainage area connectivity. Based on the applicant-provided HEC-HMS model, SER Table 2.4-2 shows the drainage areas that contribute to the flow in the ditches. The applicant also illustrated the connectivity of the drainage areas in SER Figure 2.4-2 by the identification of HEC-HMS nodes and sub-basins. The staff reviewed the applicant's response and concluded that the VEGP COL FSAR accurately represents the updated models and agrees with the applicant's response. Consequently, Item 1 of RAI 2.4.2-1 is considered closed.

Item 2 of RAI 2.4.2-1 refers to a culvert included in the HEC-RAS model in Feeder Ditch 3 that is not included in VEGP COL FSAR Figure 2.4-201. Also, the fourth item of the RAI refers to an unknown feature shown in VEGP COL FSAR Figure 2.4-201. The applicant provided an updated figure in the response indicating the location of the culvert, SER Figure 2.4-5 (corresponding to VEGP COL FSAR Figure 2.4-201). The updated figure also identifies the unknown feature as a heavy haul road. The haul road would be used during construction and would have culverts placed in the drainage ditch to handle flows that occur during construction. The local PMP analysis was done for the operational condition in which the heavy haul road would have been removed. The applicant updated this figure in a letter dated March 27, 2009. The RAI response also included a discussion concerning the culvert at the downstream end of Feeder Ditch 4, in which the applicant states inclusion of the effect of a blocked culvert at this location would be minimal. Sensitivity analyses by staff confirmed this assertion as discussed previously. Therefore, Item 2 of RAI 2.4.2-1 is closed.

A supplemental response to RAI 2.4.2-1 was provided in a letter dated August 5, 2009, in which revisions to the HEC-RAS hydraulic model reflect the effect of inclusion of the effect of a blocked culvert at the downstream end of Feeder Ditch 4. The revisions also included correction of channel widths in the main stem channel to make the channel uniform. The modifications produced an increase of 0.02 ft (SER Table 2.4-1). Several revisions to the VEGP COL FSAR were proposed in this supplemental response as follows:

- Updates to the maximum probable maximum flood (PMF) elevation discussion for the local intense precipitation event.
- Assumptions made in the hydraulic analysis concerning surface material type, conservative analysis of culverts with complete blockage, and use of steady-state flows, which is conservative.
- Updates to the discussion concerning flow regime (sub- and super-critical) locations in the main stem ditch.
- Updates to VEGP COL FSAR Table 2.4-207 summarizing the revised HEC-RAS hydraulic model output.
- Updates of proposed VEGP COL FSAR Figure 2.4-201a reflecting the inclusion of the blocked culvert at the downstream end of Feeder Ditch 4 (SER Figure 2.4-7).

The staff verified that the above changes were made to the VEGP COL FSAR.

The applicant provided revised HEC-RAS hydraulic model input files. The staff found them acceptable because they conform to the applicant's statements in the supplemental RAI response.

RAI 2.4.2-1, Item 3 asked for a figure that includes the locations of the cross sections used in the HEC-RAS analyses. The applicant provided a figure in the response, SER Figure 2.4-6 (corresponding to VEGP COL FSAR Figure 2.4-201a). The applicant also provided proposed text for the revised FSAR to include the figure under letter dated March 27, 2009. The staff verified the updates to the VEGP COL FSAR, Revision 2 for inclusion of the updated Figure 2.4-201a; therefore, RAI 2.4.2-1, Item 3 is considered closed.

RAI 2.4.2-1, Item 4 requested clarification concerning a surface feature in Feeder Ditches 2 and 3. The applicant provided an updated figure in the response, which indicates the location of the culvert and which is shown in SER Figure 2.4-5 (corresponding to VEGP COL FSAR Figure 2.4-201). The applicant provided this information in a letter dated March 27, 2009. The staff verified the updates to the FSAR for the inclusion of the updated Figure 2.4-201; therefore, RAI 2.4.2-1, Item 4 is considered closed.

The VEGP COL FSAR identifies the elevation of 220 ft mean sea level (MSL) as the plant grade and states that entrances and openings for all safety-related facilities are located at or above this elevation. The primary basis for this conclusion was the result of HEC-RAS modeling. The staff performed a variety of sensitivity analyses to verify the validity of the model. The applicant developed the HEC-RAS model cross sections from topographic data for the overbank areas

and the proposed geometric configurations for the channels. The staff compared the HEC-RAS model cross sections with the topographic data provided in VEGP COL FSAR Figure 2.4-201. The staff confirmed the channel cross section elevations and structural blockages in the HEC-RAS model, which was used to develop the flooding scenario by the applicant. As stated in VEGP COL FSAR Section 2.4.2.3, the applicant adjusted the conveyance to prevent flooding of the site, but the applicant did not provide a detailed description of the nature of such conveyance adjustments in the FSAR, nor were they clear to the staff following a review of the HEC-RAS input files provided by the applicant. Initially, the staff was unable to independently confirm the adequacy of these adjustments. RAI 2.4.2-2 was issued requesting that the applicant provide additional information on modifications to channel conveyance.

The staff initially interpreted VEGP COL FSAR Section 2.4.2.3 to mean that the applicant, after initially setting up the model, modified the channel conveyance to reduce flooding. In its response to RAI 2.4.2-2, dated March 27, 2009, the applicant clarified that the change in conveyance was from the current (existing) condition to the conditions for the proposed units. The existing channel conveys flow from the western portion of the existing Units 1 and 2. The modification to the channel conveyance was made to address the flood waters from the proposed units. The applicant proposed to remove the statement from the VEGP COL FSAR. The staff agrees with the applicant's response and verified that the misleading statement had been removed from the VEGP COL FSAR. RAI 2.4.2-2 is considered closed.

As stated in VEGP COL FSAR Section 2.4.2.3, the applicant used peak flows from the PMP analysis conducted using the hydrologic model HEC-HMS. These flows were input into the local flooding analysis modeling using HEC-RAS for a steady-state analysis. Flows at the HEC-HMS nodes were linearly interpolated for input into the HEC-RAS model. VEGP COL FSAR Tables 2.4-205 and 2.4-206 present the flows used in the HEC-RAS model and the methodology employed for interpolation to individual cross sections. The flows from the HEC-HMS model as input to HEC-RAS were confirmed by the staff.

The applicant ran the HEC-RAS model under a mixed flow regime, indicating that both sub- and super-critical flows were expected to occur. As shown in SER Figure 2.4-4, extensive backwater conditions were produced in the feeder and main drainage ditches in the applicant's HEC-RAS model setup. At the downstream reach of the main drainage ditch, the water surface has a steep hydraulic gradient, and super-critical flows occur. Because this hydraulic feature occurs away from the safety-related structures, this super-critical flow occurrence is not relevant from a safety perspective, and the situation is not considered further by the applicant. The staff agrees with this approach.

Examination of the applicant's HEC-RAS input files shows that the channel sections of the feeder and main ditches are small relative to the overall cross section width. The staff found that the top width of both the feeder ditch and main ditch cross sections are approximately 1000 ft, while the top width of the channels is approximately 100 ft. In such a scenario, the conveyance of the overbank might dominate the conveyance of the cross sections. In addition, the staff found that the lengths of the feeder channels are approximately 1200 ft, which makes the modeled area nearly square. The staff also noted the topography of the Units 3 and 4 power blocks is relatively flat. The staff's concern was that PMF flows could short circuit the drainage system. This is an important note because a key assumption of the HEC-RAS modeling analysis is that the flows are one-dimensional with flow only occurring along the channel axis. The staff questioned the validity of this assumption, particularly when the cross

sections are completely inundated, and were unable to locate the constraining features of each of the channels in the maps provided in the VEGP COL FSAR. Also, the staff noted that the level of cross-section inundation, as produced by the HEC-RAS model for VEGP and shown in SER Figure 2.4-4, would not necessarily be one-dimensional.

To address this issue, the staff requested in RAI 2.4.2-3 justification for use of a one-dimensional model to identify features that constrain the system to one-dimensional flow. The applicant noted in its response dated March 27, 2009, that while there are no designed constraints to lateral flow between ditches at the cross-sections in question, the effective flow barriers between feeder ditches in the one-dimensional model would produce conservative results. The staff agreed with this assumption and closed RAI 2.4.2-3.

Examination of VEGP COL FSAR Figure 2.4-201 shows that two drainage areas (UN12-N and UN12-S) are located east of Feeder Ditch 1. These areas include the drainage channel west of the existing units, which conveys flow to the north. VEGP COL FSAR Table 2.4-206 shows that flow from UN12-N and drainage at the upstream end of Feeder Ditch 1 (FD1W) are combined to provide flows for the upstream section of Feeder Ditch 1. The flows from UN12-S are added to the downstream section of Feeder Ditch 1. The use of these flows in this analysis is a conservative assumption that considers the blockage of the culvert handling flows from the west side of the existing units.

The applicant states in VEGP COL FSAR Section 2.4.2.3 that the local PMP flood elevation produced by its HEC-RAS model is 219.45 ft MSL, which is 0.55 ft below plant elevation (220 ft MSL). This is the water surface elevation at the upstream end of Feeder Ditch 1. Water surface elevation profiles are shown in SER Figure 2.4-4.

According to VEGP COL FSAR Section 2.4.2.3, the HEC-RAS model was developed using Manning's roughness coefficients for the feeder ditches, which reflect well-maintained concrete lined channels (n = 0.014) and graveled surfaces with concrete curbs in the over bank areas (n = 0.020). For other channels, VEGP COL FSAR Section 2.4.2.3 indicates Manning's roughness coefficients were selected to reflect float-finished concrete (n = 0.015) with short-grass cover chosen for overbanks areas (n = 0.030). Examination of the HEC-RAS input files showed that the model setup included two cross sections, located in the lower reaches of the main drainage ditch, with Manning's roughness coefficients indicative of short-grass. Otherwise, all overbank areas along the main drainage ditch used Manning's roughness coefficients indicative of graveled surfaces.

The staff conducted sensitivity tests for the model inputs, including systematic variations of the channel and overbank roughness (Manning's n); contraction-expansion coefficients at the culverts; and inline weir coefficients. These parameters were selected following a review of the FSAR and the applicant's HEC-RAS model. Summary results showing the impact of these sensitivity tests on water surface elevations are shown in SER Table 2.4-1. The following paragraphs discuss these sensitivity analyses.

Of particular note was the model's sensitivity to Manning's roughness. For both feeder ditches and the main ditch, staff examined a range of bed-roughness values for the overbanks and channel sections. The impact on water surface elevations was assessed for Manning's roughness values of 0.025, 0.030, and 0.050. These represent the range of roughness for the construction materials stated in the VEGP COL FSAR (USACE, 2008). The effect of overbank

roughness was the primary parameter examined, but sensitivity assessments related to varying channel roughness were also conducted. The results of overbank roughness sensitivity assessments indicate that water surface elevations are expected to remain below the plant elevation of 220 ft MSL, with a maximum computed water surface elevation of 219.65 ft at the upstream end of Feeder Ditch 3 (SER Table 2.4-1). However, for a scenario reflecting a very conservative condition of Manning's roughness set to 0.025 for the overbanks and main channels for all cross sections, staff determined a maximum water surface elevation of 220.11 ft at the upstream end of the Feeder Ditch 1. When using this scenario, the maximum water surface elevation in all ditches was determined to exceed the safety grade elevation of 220 ft.

Varying the Manning's roughness also affected the conveyance capacity of the different regions of the cross section. The staff compared the conveyance at cross section 71+00 in Feeder Ditch 3 and determined the flow along the overbanks and channel at this cross section. The results of the analysis are below:

Left Overbank, 1558.35 cfs Channel, 1821.85 cfs Right Overbank, 1763.81 cfs

The staff performed a sensitivity analysis using Manning's roughness = 0.025 for the overbank areas and produced the following flow values:

Left Overbank, 1426.71 cfs Channel, 2101.11 cfs Right Overbank, 1616.18 cfs

The staff observed the modeling results and the changes in conveyance in the channel and overbank areas. The intended effect was to decrease flow in the overbank areas in the sensitivity run; however, in both cases, the HEC-RAS estimated flow in the overbank areas are greater than in the channel. This sensitivity test illustrates that the overbank conveys significant flow. Therefore, it is especially important that the drainage system be maintained during operational times as it was designed and modeled.

To ensure water surface elevations remain below plant grade, the staff issued RAI 2.4.2-4 asking the applicant to include information in the FSAR about the planned maintenance of the drainage channels and overbank areas so that the surface roughness would continue over the operating life of each unit to be the same as used in the design-basis calculations. The applicant's response to the RAI proposed quarterly inspections of the drainage system and provided proposed text revision to the FSAR. Additionally, the applicant committed to procedural requirements to assure that the overbanks would be maintained in the configuration originally modeled. The applicant updated the FSAR to include this commitment. Accordingly, the staff agrees that the commitment would ensure that the very conservative roughness condition would not occur and concludes that this is an acceptable response. The staff verified that Revision 2 of the VEGP COL FSAR adequately addressed the staff's concern. RAI 2.4.2-4 is closed.

The staff examined the effects of greater contraction and expansion coefficients to evaluate the effect of blockage and associated hydraulic energy losses. Contraction and expansion coefficients account for energy losses between cross sections. Typical coefficient values range from 0.1 to 0.3 for gradual transitions, 0.3 to 0.5 for typical bridge sections, and 0.6 to 1.0 (maximum) for abrupt transitions (USACE, 2008a). The staff performed a sensitivity test to examine the effect on maximum water surface elevations produced by abrupt transitions at the culvert cross sections. The staff's analyses using contraction and expansion coefficients of

0.6 and 0.8 produced minimal variation in the maximum water surface elevations (SER Table 2.4-1). Consequently, the effects of the increased contraction and expansion coefficients of the channels are offset by the large extent of the overbank areas.

The applicant's HEC-RAS model conservatively assumed the culverts completely blocked and represented as inline (broad-crested) weirs. The user-specified weir coefficient for inline weirs accounts for the energy losses and affects the upstream water surface elevation. A smaller weir coefficient will result in reduced flow over the weir and higher upstream water surface elevation. Typical broad-crested weir coefficients range from 2.6 to 3.1 (USACE, 2008a). To simulate the effect of blockage on maximum water surface elevations, the staff examined a smaller weir coefficient (2.0) than used by the applicant (2.6). This produced no change in the maximum water surface elevations of the ditches. As previously indicated, examination of the channel conveyance of the cross section showed the overbank areas convey approximately two-thirds of the total flow, as computed by HEC-RAS. Consequently, the effects of the reduced weir coefficients are offset by the large extent of the overbank areas.

Based on the staff's review and verification of the methods used to determine the local flooding at the VEGP site, the staff determined that the application and the development of the flood elevation are acceptable. The applicant has provided reasonable assurances in an updated FSAR and responses to RAIs for staff to conclude that the variability of the flood elevation based on the overbank flood would not allow the site to become flooded.

2.4.2.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.4.2.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to floods, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

As set forth above, the applicant has presented and substantiated information relative to the PMF from local intense precipitation important to the design and siting of this plant. The staff reviewed the available information provided including VEGP COL 2.4-2 related to PMF from local intense precipitation. For the reasons given above, the staff concludes that the identification and consideration of the PMF from local intense precipitation at the site area are acceptable and meet the relevant requirements of 10 CFR 52.79 and 10 CFR 100.20(c), with respect to determining the acceptability of the site for the AP1000 design.

2.4.3 Probable Maximum Flood on Streams and Rivers

The PMF on streams and rivers is used to determine the extent of any flood protection required for those safety-related structures, systems, and components (SSCs) necessary to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition. The specific

areas of review are as follows: (1) design basis for flooding in streams and rivers; (2) design basis for site drainage; and (3) consideration of other site-related evaluation criteria.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.4-2. To address that portion of VEGP COL 2.4-2 related to PMF on streams and rivers, the applicant incorporates by reference VEGP ESP SSAR Section 2.4.3.

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to PMF on streams and rivers. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.4 Potential Dam Failures

The potential dam failures are addressed to ensure that any potential hazard to the safety-related facilities due to the failure of onsite, upstream, and downstream water control structures is considered in the plant design. The specific areas of review are as follows: (1) flood waves resulting from a dam breach or failure, including those due to hydrologic failure as a result of overtopping for any reason, routed to the site and the resulting highest water surface elevation that may result in the flooding of SSCs important to safety; (2) successive failures of several dams in the path to the plant site caused by the failure of an upstream dam due to plausible reasons, such as a PMF, landslide-induced severe flood, earthquakes, or volcanic activity and the effect of the highest water surface elevation at the site under the cascading failure conditions; (3) dynamic effects of dam failure-induced flood waves on SSCs important to safety; (4) failure of a dam downstream of the plant site that may affect the availability of a safety-related water supply to the plant; (5) effects of sediment deposition or erosion during dam failure-induced flood waves that may result in blockage or loss of function of SSCs important to safety; (6) failure of onsite water control or storage structures such as levees, dikes, and any engineered water storage facilities that are located above site grade and may induce flooding at the site; (7) the potential effects of seismic and non-seismic data on the postulated design bases and how they relate to dam failures in the vicinity of the site and the site region.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.4-2. To address that portion of VEGP COL 2.4-2 related to potential dam failures, the applicant incorporates by reference VEGP ESP SSAR Section 2.4.4 with no variances or supplements.

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to potential dam failures. The results of the NRC staff's evaluation of the information incorporated by reference in the

VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.5 Probable Maximum Surge and Seiche Flooding

The probable maximum surge and seiche flooding are addressed to ensure that any potential hazard to the safety-related facilities due to the effects of probable maximum surge and seiche is considered in plant design. The specific areas of review are as follows: (1) probable maximum hurricane (PMH) that causes the probable maximum surge as it approaches the site along a critical path at an optimum rate of movement; (2) probable maximum wind storm (PMWS) from a hypothetical extratropical cyclone or a moving squall line that approaches the site along a critical path at an optimum rate of movement; (3) a seiche near the site, and the potential for seiche wave oscillations at the natural periodicity of a water body that may affect flood water surface elevations near the site or cause a low water surface elevation affecting safety-related water supplies; (4) wind-induced wave run-up under a PMH or PMWS winds; (5) effects of sediment erosion and deposition during a storm surge and seiche-induced waves that may result in blockage or loss of function of SSCs important to safety; and (6) the potential effects of seismic and non-seismic information on the postulated design bases and how they relate to a surge and seiche in the vicinity of the site and the site region.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.4-2. To address that portion of VEGP COL 2.4-2 related to probable maximum surge and seiche flooding, the applicant incorporates by reference VEGP ESP SSAR Section 2.4.5 with no variances or supplements.

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to probable maximum surge and seiche flooding. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.6 Probable Maximum Tsunami Hazards

The probable maximum tsunami (PMT) hazards are addressed to ensure that any potential tsunami hazards to the SSCs important to safety are considered in plant design. The specific areas of review are as follows: (1) historical tsunami data, including paleotsunami mappings and interpretations, regional records and eyewitness reports, and more recently available tide gauge and real-time bottom pressure gauge data; (2) PMT that may pose hazards to the site; (3) tsunami wave propagation models and model parameters used to simulate the tsunami wave propagation from the source toward the site; (4) extent and duration of wave run-up during the inundation phase of the PMT event; (5) static and dynamic force metrics including the inundation and drawdown depths, current speed, acceleration, inertial component, and momentum flux that quantify the forces on any safety-related SSCs that may be exposed to the tsunami waves; (6) debris and water-borne projectiles that accompany tsunami currents and may impact safety-related SSCs; (7) effects of sediment erosion and deposition caused by tsunami waves that may result in blockage or loss of function of safety-related SSCs; and

(8) potential effects of seismic and non-seismic information on the postulated design bases and how they relate to tsunami in the vicinity of the site and the site region.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.4-2. To address that portion of VEGP COL 2.4-2 related to PMT hazards, the applicant incorporates by reference VEGP ESP SSAR Section 2.4.6 with no variances or supplements.

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to PMT hazards. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.7 Ice Effects

The ice effects are addressed to ensure that safety-related facilities and water supplies are not affected by ice-induced hazards. The specific areas of review are as follows: (1) regional history and types of historical ice accumulations (i.e., ice jams, wind-driven ice ridges, floes, frazil ice formation, etc.); (2) potential effects of ice-induced, high- or low-flow levels on safety-related facilities and water supplies; (3) potential effects of a surface ice-sheet to reduce the volume of available liquid water in safety-related water reservoirs; (4) potential effects of ice to produce forces on, or cause blockage of, safety-related facilities; and (5) potential effects of seismic and non-seismic data on the postulated worst-case icing scenario for the proposed plant site.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements related to ice effects, Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.7, "Ice Effects" of VEGP ESP SSAR, Revision 5. The NRC staff reviewed the application and checked the referenced VEGP ESP SSAR to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.8 Cooling Water Canals and Reservoirs

The cooling water canals and reservoirs used to transport and impound water supplied to the SSCs important to safety are reviewed to verify their hydraulic design basis. The specific areas of review are as follows: (1) design bases postulated and used by the applicant to protect structures such as riprap, inasmuch as they apply to safety-related water supply; (2) design bases of canals pertaining to capacity, protection against wind waves, erosion, sedimentation, and freeboard and the ability to withstand a PMF (surges, etc.), inasmuch as they apply to a safety-related water supply; (3) design bases of reservoirs pertaining to capacity, PMF design basis, wind wave and run-up protection, discharge facilities (e.g., low-level outlet, spillways, etc.), outlet protection, freeboard, and erosion and sedimentation processes, inasmuch as they apply to a safety-related water supply; and (4) potential effects of seismic and non-seismic

information on the postulated hydraulic design bases of canals and reservoirs for the proposed plant site.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements related to cooling water canals and reservoirs, Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.8, "Cooling Water Canals and Reservoirs" of VEGP ESP SSAR, Revision 5. The NRC staff reviewed the application and checked the referenced VEGP ESP SSAR to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.9 Channel Diversions

Plant and essential water supplies used to transport and impound water supplies were evaluated to ensure that they will not be adversely affected by stream or channel diversions. The review includes stream channel diversions away from the site (which may lead to a loss of safety-related water) and stream channel diversions toward the site (which may lead to flooding). In addition, in such an event, the applicant needs to show that alternate water supplies are available to safety-related equipment. The specific areas of review are as follows: (1) historical channel migration phenomena including cutoffs, subsidence, and uplift; (2) regional topographic evidence that suggests a future channel diversion may or may not occur (used in conjunction with evidence of historical diversions); (3) thermal causes of channel diversion, such as ice jams, which may result from downstream ice blockages that may lead to flooding from backwater or upstream ice blockages that can divert the flow of water away from the intake; (4) potential for forces on safety-related facilities or the blockage of water supplies resulting from channel migration-induced flooding (flooding not addressed by hydrometeorological-induced flooding scenarios in other sections); (5) potential of channel diversion from human-induced causes (i.e., land-use changes, diking, channelization, armoring, or failure of structures); (6) alternate water sources and operating procedures; and (7) potential effects of seismic and non-seismic information on the postulated worst-case channel diversion scenario for the proposed plant site.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements related to channel diversions, Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.9, "Channel Diversions" of VEGP ESP SSAR, Revision 5. The NRC staff reviewed the application and checked the referenced VEGP ESP SSAR to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.10 Flooding Protection Requirements

2.4.10.1 Introduction

The flooding protection requirements address the locations and elevations of safety-related facilities and those of structures and components required for protection of safety-related facilities. These requirements are then compared with design-basis flood conditions to

determine whether flood effects need to be considered in the plant's design or in emergency procedures. The specific areas of review are as follows: (1) safety-related facilities exposed to flooding; (2) type of flood protection (e.g., "hardened facilities," sandbags, flood doors, bulkheads, etc.) provided to the SSCs exposed to floods; (3) emergency procedures needed to implement flood protection activities and warning times available for their implementation reviewed by the organization responsible for reviewing issues related to plant emergency procedures; and (4) potential effects of seismic and non-seismic information on the postulated flooding protection for the proposed plant site.

2.4.10.2 Summary of Application

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.10 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.4, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.4-2 Flooding

The supplemental information discussed flood protection requirements due to onsite drainage to address COL Information Item 2.4-2 and verified that local intense precipitation would not violate flooding criteria. VEGP COL FSAR Section 2.4.10 references VEGP COL FSAR Section 2.4.2 and states that based on the site-specific analysis of local intense precipitation, no additional flood protection requirements are needed.

2.4.10.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the identification of floods and flood design considerations are given in Section 2.4.10 of NUREG-0800.

2.4.10.4 Technical Evaluation

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to flooding protection requirements. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.4-2

The staff's technical evaluation was limited to the supplemental information provided in VEGP COL FSAR Section 2.4.10. The staff reviewed the supplemental information addressing flood protection requirements and the information incorporated by reference in the VEGP ESP SSAR. The staff reviewed the local intense precipitation in Section 2.4.2 of this SER and determined that the flooding elevation due to local intense precipitation will not require additional flood protection onsite because the maximum flood elevation is below the elevation of safety-related structures.

2.4.10.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.4.10.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to flooding protection requirements, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

As set forth above, the applicant has presented and substantiated information relative to the effects of the flooding protection requirements important to the design and siting of this plant. The staff reviewed the available information provided including VEGP COL 2.4-2 related to flood protection. For the reasons given above, the staff concluded that the identification and consideration of the effects of the flooding protection requirements at the site and in the surrounding area are acceptable and meet the relevant requirements of 10 CFR 52.79, 10 CFR 100.23(d), and 10 CFR 100.20(c).

2.4.11 Low Water Considerations

The low water considerations address natural events that may reduce or limit the available safety-related cooling water supply. The applicant ensures that an adequate water supply will exist to shut the plant down under conditions requiring safety-related cooling. The specific areas of review are as follows: (1) worst drought considered reasonably possible in the region; (2) effects of low water surface elevations caused by various hydrometeorological events and a potential blockage of intakes by sediment, debris, littoral drift, and ice because they can affect the safety-related water supply; (3) effects on the intake structure and pump design bases in relation to the events described in safety analysis report (SAR) Sections 2.4.7, 2.4.8, 2.4.9, and 2.4.11, which consider the range of water supply required by the plant (including minimum operating and shutdown flows during anticipated operational occurrences and emergency conditions) compared with availability (considering the capability of the UHS to provide adequate cooling water under conditions requiring safety-related cooling); (4) use limitations

imposed or under discussion by Federal, State, or local agencies authorizing the use of the water; and (5) potential effects of seismic and non-seismic information on the postulated worst-case low water scenario for the proposed plant site.

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements related to low water considerations, Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.7, "Low Water Considerations" of VEGP ESP SSAR, Revision 5. The NRC staff reviewed the application and checked the referenced ESP SSAR to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.4.12 Groundwater

2.4.12.1 Introduction

The groundwater section describes the hydrogeological characteristics of the site. The specific areas of review are as follows: (1) identification of the aquifers, types of onsite groundwater use, sources of recharge, present withdrawals and known and likely future withdrawals, flow rates, travel time, gradients (and other properties that affect the movement of accidental contaminants in groundwater), groundwater levels beneath the site, seasonal and climatic fluctuations, monitoring and protection requirements, and fabricated changes that have the potential to cause long-term changes in local groundwater regime; (2) effects of groundwater levels and other hydrodynamic effects of groundwater on design bases of plant foundations and other SSCs important to safety; (3) reliability of groundwater resources and related systems used to supply safety-related water to the plant; (4) reliability of dewatering systems to maintain groundwater conditions within the plant's design bases; and (5) potential effects of seismic and non-seismic information on the postulated worst-case groundwater conditions for the proposed plant site.

2.4.12.2 Summary of Application

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.12 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.4, the applicant provided the following:

AP1000 COL Information Items

- VEGP COL 2.4-3

In VEGP COL FSAR Section 2.4, the applicant incorporated by reference VEGP ESP SSAR Section 2.4.12 to address COL Information Item 2.4-3 related to the cooling water supply.

- VEGP COL 2.4-4

In VEGP COL FSAR Section 2.4, the applicant incorporated by reference VEGP ESP SSAR Section 2.4.12 to address COL Information Item 2.4-4 related to the groundwater.

Supplemental Information

- VEGP SUP 2.4-1

The applicant supplemented VEGP COL FSAR Section 2.4.12 to address a commitment in VEGP ESP SSAR Section 2.4.12.3 to evaluate the existing groundwater monitoring program to determine whether changes to the program will be required to adequately monitor impacts on groundwater from construction and operation of VEGP Units 3 and 4 related to long term groundwater level monitoring.

2.4.12.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the identification of floods and flood design considerations are given in Section 2.4.12 of NUREG-0800.

2.4.12.4 Technical Evaluation

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to groundwater. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Items

- VEGP COL 2.4-3

In VEGP COL FSAR Section 2.4, the applicant incorporated by reference, with no variances or supplements, VEGP ESP SSAR Section 2.4.12 to address COL Information Item 2.4-3 related to the cooling water supply.

- VEGP COL 2.4-4

In VEGP COL FSAR Section 2.4, the applicant incorporated by reference, with no variances or supplements, VEGP ESP SSAR Section 2.4.12 to address COL Information Item 2.4-4 related to the groundwater.

Supplemental Information

- VEGP SUP 2.4-1

In VEGP COL FSAR Section 2.4.12.3.1, the applicant provided additional information about post-construction monitoring of groundwater levels. The applicant stated that many of the existing monitoring wells would be impacted by construction activities. The number and location of replacement monitoring wells would be determined during construction, with some of the replacement wells installed in the power block areas of Units 3 and 4. Monitoring would commence prior to commercial operation of VEGP Unit 3.

The NRC staff's technical evaluation was based on the staff's SER for the VEGP ESP and the supplemental information provided in VEGP COL FSAR Section 2.4.12. The staff reviewed the supplemental information provided in the FSAR regarding groundwater monitoring programs. The staff recognizes that groundwater monitoring is an ongoing activity and monitoring wells may need to be closed and new wells installed because of changing site access conditions during construction. The staff agrees that further evaluation of the existing groundwater monitoring program and the installation of new monitoring wells would be valuable to confirm that groundwater levels would be adequately monitored as site conditions change. The purpose of the groundwater monitoring program described in VEGP COL FSAR Section 2.4.12.4 is to protect present and projected groundwater users (RG 1.206, "Combined License Applications for Nuclear Power Plants," Section C.I.2.4.12.4) and to ensure the reliability of groundwater resources and systems used for safety-related purposes (NUREG-0800 Section 2.4.12). During the VEGP ESP review, the staff evaluated the effects of groundwater uses and proposed plant facilities on the groundwater system and concluded that the projected maximum groundwater level (165 ft MSL) would be far enough below the site grade (220 ft MSL) so as not to violate any safety concerns or regulatory requirements. The staff finds VEGP SUP 2.4-1 acceptable.

2.4.12.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.4.12.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to groundwater, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

As set forth above, the applicant has presented and substantiated information relative to groundwater and the long term groundwater level monitoring important to the design and siting

of this plant. The staff reviewed the available information provided including VEGP COL 2.4-3, VEGP COL 2.4-4 and VEGP SUP 2.4-1. For the reasons given above, the staff concluded that the groundwater characteristics and the identification and consideration of the long term groundwater level monitoring at the site and in the surrounding area are acceptable and meet the relevant requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 52.79, 10 CFR 100.23(d), and 10 CFR 100.20(c).

2.4.13 Accidental Release of Radioactive Liquid Effluent in Ground and Surface Waters

2.4.13.1 Introduction

This section considers the potential effects of postulated accidental releases from the radwaste systems and their components that handle liquid effluents generated during normal plant operations. Such releases would have relatively low levels of radioactivity, but could be large in volume. Normal releases are considered in the applicant's ER, as are releases from design-basis and severe accidents.

The accidental release of radioactive liquid effluents in ground and surface waters is evaluated based on the hydrogeological characteristics of the site that govern existing uses of groundwater and surface water and their known and likely future uses. The source term from a postulated accidental release is reviewed under NUREG-0800 Section 11.2 following the guidance in Branch Technical Position (BTP) 11-6, "Postulated Radioactive Releases Due to Liquid-containing Tank Failures." The source term is determined from a postulated release from a single tank outside of the containment.

The specific areas of review are: (1) alternate conceptual models of the hydrology at the site that reasonably bound hydrogeological conditions at the site, inasmuch as these conditions affect the transport of radioactive liquid effluents in the ground and surface water environment; (2) a bounding set of plausible surface and subsurface pathways from potential points of an accidental release to determine the critical pathways that may result in the most severe impact on existing uses and known and likely future uses of ground and surface water resources in any unrestricted area; (3) ability of the groundwater and surface water environments to delay, disperse, dilute, or concentrate accidentally released radioactive liquid effluents during transport; and (4) assessment of scenarios, wherein an accidental release of radioactive effluents is combined with potential effects of seismic and non-seismic events.

2.4.13.2 Summary of Application

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.13 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.4, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.4-5

In VEGP COL FSAR Section 2.4, the applicant incorporated by reference VEGP ESP SSAR Section 2.4.13 to address COL Information Items 2.4-5 and 15.7-1 related to accidental release of liquid effluents into groundwater and surface water.

VEGP ESP COL Action Item

- VEGP ESP COL Action Item 2.4-1

In VEGP COL FSAR Section 11.2.2.1.6, the applicant provided information related to chelating agents to address the VEGP ESP COL Action Item 2.4-1 related to the chelating agents.

2.4.13.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the accidental release of radioactive liquid effluents in ground and surface waters considerations are given in Sections 2.4.13 and 11.2 of NUREG-0800.

2.4.13.4 Technical Evaluation

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to accidental release of radioactive liquid effluent in ground and surface waters. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.4-5

The staff's evaluation of VEGP COL 2.4-5 is addressed in Section 11.2 of this SER.

VEGP ESP COL Action Item

- VEGP ESP COL Action Item 2.4-1

The staff's technical review of this application was limited to the supplemental information pertaining to Vogtle ESP COL Action Item 2.4-1 related to the chelating agents.

The staff concluded in VEGP ESP SER Section 2.4.13.3.2 that a release of a radioactive liquid effluent to the groundwater environment will meet the requirements of 10 CFR Part 20, "Standards for protection against radiation," Appendix B, and Table 2. However, the staff stated that the use of the minimum distribution coefficients in their analysis assumes that no chelating agents can be comingled with the radioactive liquid effluents. Therefore, COL Action Item 2.4-1 requires the following:

> A COL or CP [construction permit] applicant will need to confirm that no chelating agents will be comingled with radioactive waste liquids and that such agents will not be used to mitigate an accidental release. Alternatively, the applicant should repeat the distribution coefficient experiments with chelating agents included and incorporate these newly determined distribution coefficients into the analysis to demonstrate that 10 CFR Part 20, Appendix B, Table 2 is satisfied.

In VEGP COL FSAR Section 11.2.2.1.6, the applicant stated that chelating agents will not be routinely used in liquid radioactive processing, and, in the event chelating agents are required for a specific purpose, controls will be implemented to prevent comingling of chelating agents with the plant's normal liquid radioactive waste system. In a letter dated March 27, 2009, the applicant stated that the AP1000 standard design does not require the use of chelating agents in liquid radioactive waste processing and such agents will not be used. The staff determined that VEGP COL FSAR content resolves VEGP ESP COL Action Item 2.4-1.

2.4.13.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.4.13.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to the use of chelating agents, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The applicant provided supplemental information on the use of chelating agents in the liquid radioactive waste system and in mitigating an accidental release. This information addresses and resolves VEGP ESP COL Action Item 2.4-1. Therefore, the staff concludes that the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d) have been met with respect to determining the acceptability of the site for the AP1000 design.

2.4.14 Technical Specification and Emergency Operation Requirements

2.4.14.1 Introduction

The technical specifications and emergency operation requirements described here implement protection against floods for safety-related facilities to ensure that an adequate supply of water for shutdown and cool-down purposes is available. The specific areas of review are (1) controlling hydrological events to identify bases for emergency actions required during these events; (2) the amount of time available to initiate and complete emergency procedures before the onset of conditions while controlling hydrological events that may prevent such action; (3) reviewing technical specifications related to all emergency procedures required to ensure adequate plant safety from controlling hydrological events by the organization responsible for the review of issues related to technical specifications; and (4) potential effects of seismic and non-seismic information on the postulated technical specifications and emergency operations for the proposed plant site.

2.4.14.2 Summary of Application

Section 2.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.4 of the AP1000 DCD, Revision 17 and Section 2.4.14 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Section 2.4, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 2.4-6

The applicant provided Section 2.4.14 in the VEGP COL FSAR to address COL Information Item 2.4-6 and referenced Section 2.4.2 of the VEGP COL FSAR and Section 2.4.3 of the VEGP ESP SSAR regarding design basis floods and their impacts on safety-related SSCs. The applicant concluded that the combination of the DCD design and the plant grade elevation do not necessitate emergency procedures or technical specifications.

2.4.14.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and the VEGP ESP.

The guidance relevant to the Commission's regulations for the technical specifications and emergency operation requirements, and the associated acceptance criteria, are given in Section 2.4.14 of NUREG-0800. The applicable regulatory requirements for reviewing the applicant's discussion of technical specifications and emergency operation are described in 10 CFR Part 100, 10 CFR 100.23 (d), 10 CFR 52.79(a)(1)(iii), and 10 CFR 50.36.

2.4.14.4 Technical Evaluation

The NRC staff reviewed Section 2.4 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review

topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to technical specifications and emergency operation requirements. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 2.4-6

The NRC staff reviewed the resolution to COL Information Item 2.4-6, related to the technical specifications and emergency operation requirements that implement protection against floods for safety-related facilities to ensure that an adequate supply of water for shutdown and cool-down purposes is available. Based on the applicant's selection of a design basis plant grade of 220 ft MSL, which is above the expected surface water and groundwater elevations, no emergency procedures or technical specifications are necessary.

2.4.14.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.4.14.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to technical specifications and emergency operation requirements, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The review confirmed that no emergency procedures or technical specifications are necessary to prevent hydrological phenomena from degrading the UHS and VEGP COL 2.4-6 is acceptable. No outstanding information is expected to be addressed in the FSAR related to this section. Therefore, the staff concludes that the relevant requirements of 10 CFR 50.36 and 10 CFR 100.20(c) have been met with respect to determining the acceptability of the site for the AP1000 design.

2.5 Geology, Seismology, and Geotechnical Engineering

2.5.1 Basic Geologic and Seismic Information

Section 2.5 of the VEGP COL FSAR, Revision 2 describes the basic geologic and seismic information that was collected by the applicant. This technical information resulted primarily from surface and subsurface geologic, seismic, geophysical, and geotechnical investigations, performed in progressively greater detail closer to the site, within each of four areas defined by circles drawn around the site using radii of 320 km (200 mi), 40 km (25 mi), 8 km (5 mi), and

1 km (0.6 mi). These four circumscribed areas correspond, respectively, to site region, site vicinity, site area, and site location. The primary purposes for conducting these investigations are to determine geologic and seismic suitability of the site, to provide the bases for plant design, and to determine whether there is significant new tectonic or ground motion information that could impact seismic design bases as determined by probabilistic seismic hazard analysis (PSHA). The geologic, seismic, geophysical, and geotechnical information provided by the applicant addresses the following three specific topics necessary for review of regional and site geology: tectonic and seismic information, non-tectonic deformation information, and conditions caused by human activities.

Section 2.5 of the VEGP COL FSAR, incorporates by reference Section 2.5.1 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.5-1 to address COL Information Item 2.5-1 (COL Action Item 2.5.1-1). In VEGP COL 2.5-1, the applicant incorporates by reference Sections 2.5.1, 2.5.2, and 2.5.4 of the VEGP ESP SSAR, Revision 5, with no variances or supplements. The staff has already reviewed Sections 2.5.1, 2.5.2, and 2.5.4 of the VEGP ESP SSAR and found the basic geologic and seismic information to be acceptable. Therefore, the NRC staff considers VEGP COL 2.5-1 resolved.

The NRC staff reviewed Section 2.5 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to basic geologic and seismic information. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.5.2 Vibratory Ground Motion

2.5.2.1 Introduction

The vibratory ground motion is evaluated based on seismological, geological, geophysical, and geotechnical investigations carried out to determine the site-specific ground motion response spectra (GMRS), which is the safe shutdown earthquake (SSE) ground motion for the site. The GMRS is defined as the free-field horizontal and vertical GMRS at the plant site. The development of the GMRS is based upon a detailed evaluation of earthquake potential, taking into account the regional and local geology, Quaternary (1.8 million years ago to present) tectonics, seismicity, and site-specific geotechnical engineering characteristics of the site subsurface material. The specific investigations necessary to determine the GMRS include the seismicity of the site region and the correlation of earthquake activity with seismic sources. Seismic sources are identified and characterized, including the rates of occurrence of earthquakes associated with each seismic source. Seismic sources that have any part within 320 km (200 mi) of the site must be identified. More distant sources that have a potential for earthquakes large enough to affect the site must also be identified. Seismic sources can be capable tectonic sources or seismogenic sources. The review covers the following specific areas: (1) seismicity; (2) geologic and tectonic characteristics of the site and region; (3) correlation of earthquake activity with seismic sources; (4) PSHA and controlling earthquakes; (5) seismic wave transmission characteristics of the site; and (6) site-specific GMRS.

2.5.2.2 Summary of Application

Section 2.5 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.5.2 of the AP1000 DCD, Revision 17 and Sections 2.5.2 and 2.5.4 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Sections 2.5.7.2 and 2.5.7.3, the applicant provided the following:

AP1000 COL Information Items

- VEGP COL 2.5-2

The applicant provided additional information in VEGP COL 2.5-2 to resolve COL Information Item 2.5-2 (COL Action Item 2.5.2-1 identified in NUREG-1793). The applicant stated that VEGP COL 2.5-2 is addressed in VEGP ESP SSAR Sections 2.5.2 and 2.5.4.
VEGP COL 2.5-2 addresses the provision of site-specific information related to the vibratory ground motion aspects of the site: seismicity; geologic and tectonic characteristics of site and region; correlation of earthquake activity with seismic sources; PSHA and controlling earthquakes; seismic wave transmission characteristics of the site; and the SSE ground motion.

- VEGP COL 2.5-3

The applicant provided additional information in VEGP COL 2.5-3 to resolve COL Information Item 2.5-3 (COL Action Item 2.6.3 identified in NUREG-1793). The applicant stated that VEGP COL 2.5-3 is addressed in VEGP ESP SSAR Sections 2.5.2 and 2.5.4.
VEGP COL 2.5-3 addresses the site-specific evaluation that is needed if the site-specific spectra at the foundation level exceed the certified seismic design response spectra (CSDRS) at any frequency, or if soil conditions were outside the range evaluated for AP1000 DC. The AP1000 DCD also provides steps for conducting site-specific soil structure interaction (SSI) analysis and developing in-structure response spectra (ISRS) at six specified locations on the nuclear island to determine the suitability of the site for an AP1000 plant.

In the referenced VEGP ESP SSAR Section 2.5.2, the applicant addresses vibratory ground motion. VEGP ESP SSAR Section 2.5.2.1, “Seismicity,” describes the development of a current earthquake catalog for the site region (within a 320 km (200 mi) radius); VEGP ESP SSAR Section 2.5.2.2, “Geologic and Tectonic Characteristics of the Site and Region,” describes the seismic sources and seismicity parameters that the applicant used to calculate the seismic ground motion hazard for the VEGP site; VEGP ESP SSAR Section 2.5.2.3, “Correlation of Earthquake Activity with Seismic Sources,” describes the correlation of updated seismicity with the Electric Power Research Institute (EPRI) seismic source model; VEGP ESP SSAR Section 2.5.2.4, “Probabilistic Seismic Hazard Analysis and Controlling Earthquakes,” presents the results of the applicant’s PSHA for the VEGP site; VEGP ESP SSAR Section 2.5.2.5, “Seismic Wave Transmission Characteristics of the Site,” describes the method used by the applicant to develop the site free-field soil ground motion; and, VEGP ESP SSAR Section 2.5.2.6, “Ground Motion Response Spectra,” describes the method used to develop the horizontal and vertical site-specific GMRS.

2.5.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and its supplements and in NUREG-1923.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for vibratory ground motion are given in Section 2.5.2 of NUREG-0800.

The applicable regulatory requirement for reviewing the applicant's discussion of vibratory ground motion is:

- 10 CFR 100.23, "Geologic and Seismic Siting Criteria," with respect to obtaining geologic and seismic information necessary to determine site suitability and ascertain that any new information derived from site-specific investigations does not impact the GMRS derived by a PSHA. In complying with this regulation, the applicant also meets guidance in RG 1.132, "Site Investigations for Foundations of Nuclear Power Plants," Revision 2; and RG 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion."

The related acceptance criteria summarized from NUREG-0800 Section 2.5.2 are as follows:

- Seismicity: To meet the requirements in 10 CFR 100.23, this section is accepted when the complete historical record of earthquakes in the region is listed and when all available parameters are given for each earthquake in the historical record.

- Geologic and Tectonic Characteristics of Site and Region: Seismic sources identified and characterized by the Lawrence Livermore National Laboratory (LLNL) and the EPRI were used for studies in the Central and Eastern United States (CEUS) in the past.

- Correlation of Earthquake Activity with Seismic Sources: To meet the requirements in 10 CFR 100.23, acceptance of this section is based on the development of the relationship between the history of earthquake activity and seismic sources of a region.

- PSHA and Controlling Earthquakes: For CEUS sites relying on LLNL or EPRI methods and databases, the staff will review the applicant's PSHA, including the underlying assumptions and how the results of the site investigations are used to update the existing sources in the PSHA, how they are used to develop additional sources, or how they are used to develop a new database.

- Seismic Wave Transmission Characteristics of the Site: In the PSHA procedure described in RG 1.208, the controlling earthquakes are determined for generic rock conditions.

- GMRS: In this section, the staff reviews the applicant's procedure to determine the GMRS.

In addition, the geologic characteristics should be consistent with appropriate sections from: RG 1.132; RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Revision 2; RG 1.208; and RG 1.206.

2.5.2.4 Technical Evaluation

The NRC staff reviewed Section 2.5 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to vibratory ground motion. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements, and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Items

- VEGP COL 2.5-2

The NRC staff reviewed VEGP COL 2.5-2 related to COL Information Item 2.5-2, which requires the COL applicant to provide information pertaining to the following vibratory ground motion aspects of the site and region:

- Seismicity
- Geologic and tectonic characteristics of site and region
- Correlation of earthquake activity with seismic sources
- PSHA and controlling earthquakes
- Seismic wave transmission characteristics of the site
- SSE ground motion

The applicant incorporated by reference all the information in Section 2.5.2 of the VEGP ESP SSAR, which includes the above vibratory ground motion aspects of the VEGP Units 3 and 4 site. The staff has already reviewed the VEGP ESP SSAR and found the information included therein to be acceptable. Therefore, the staff concludes that the information in VEGP ESP SSAR Sections 2.5.2 and 2.5.4 and incorporated by reference in VEGP COL FSAR Section 2.5.7.2 is sufficient to satisfy, in part, the requirements of VEGP COL 2.5-2.

With respect to COL Information Item 2.5-2, the COL applicant is also required to demonstrate that the free-field peak ground acceleration at the finished grade level is less than or equal to a 0.30g SSE and that the site-specific GMRS at the finished grade level in the free-field are less than or equal to the AP1000 CSDRS. The applicant is also required to demonstrate that the site conditions are comparable to those used in the AP1000 generic soil site analyses or, alternatively, perform a site-specific evaluation to demonstrate that the AP1000 plant designed for the CSDRS is acceptable for the proposed site.

In VEGP ESP SSAR Appendix 2.5E, the applicant stated that the VEGP geotechnical conditions and ground materials have differences from the design analyses performed for the AP1000 seismic analyses. Furthermore, the applicant compared the VEGP GMRS (defined at the ground surface) and foundation input response spectra (FIRS) (defined at a depth of 40 ft

(12.2 m)) to the AP1000 CSDRS, in Figures 3-4 and 3-5 of Appendix 2.5E and observed that there are exceedances above the CSDRS.

Thus, the applicant performed a site-specific seismic evaluation, which is referenced in Section 2.5.2.9 of the VEGP ESP SSAR and documented in detail in VEGP ESP SSAR Appendix 2.5E. The staff reviewed the results of the applicant's 2D system for analysis of soil structure interaction (SASSI) analyses, which are provided in VEGP ESP SSAR Figures 2.5.2-59 to 2.5.2-64, and noted that the CSDRS enveloped the generated ISRS at the key locations identified by the AP1000 DCD with significant margin except for a narrow band in the 0.5 to 0.6 Hz frequency range. To address this concern, the staff issued RAI 3.7.2-1 to request that the applicant perform 3D SASSI analysis to more accurately predict in-structure response. In response to RAI 3.7.2-1, the applicant provided a justification for the low frequency exceedances of the AP1000 ISRS. The staff's review of the applicant's response is being evaluated in SER Section 3.7.

- VEGP COL 2.5-3

The NRC staff reviewed VEGP COL 2.5-3 related to COL Information Item 2.5-3, which requires the COL applicant to perform a site-specific seismic evaluation if the site-specific spectra at the foundation level exceed the CSDRS at any frequency, or if site conditions are outside the range evaluated for the AP1000 DC. As described above, the applicant performed site-specific SSI analyses using a 2D SASSI model, which is documented in VEGP ESP SSAR Appendix 2.5E. The staff concludes that the applicant conducted a site-specific evaluation to show that the AP1000 CSDRS is adequate for the VEGP Units 3 and 4 site and satisfies the requirements of VEGP COL 2.5-3.

2.5.2.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.5.2.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant addressed the required information relating to vibratory ground motion, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The NRC staff concludes that VEGP COL FSAR Sections 2.5.7.2 and 2.5.7.3 adequately incorporate by reference Sections 2.5.2 and 2.5.4 of the VEGP ESP SSAR and the information pertaining to vibratory ground motion is acceptable. In addition, the staff concludes that VEGP COL 2.5-2 and VEGP COL 2.5-3 have been adequately addressed by the applicant. Therefore, the staff concludes that the site is suitable with respect to the vibratory ground motion criteria for new nuclear power plants and meets the applicable requirements of 10 CFR 100.23.

2.5.3 Surface Faulting

VEGP COL FSAR Section 2.5.7.4 is concerned with the potential for surface deformation due to faulting and references VEGP ESP SSAR Section 2.5.3. The information related to surface deformation due to faulting was collected by the applicant during the ESP site characterization investigations. The information provided by the applicant in the VEGP ESP SSAR addressed the following specific topics related to surface faulting: geologic, seismic, and geophysical investigations; evidence or absence of evidence for tectonic surface deformation; correlation of earthquakes with capable tectonic sources; ages of most recent deformation; relationship of tectonic structures in the site area to regional tectonic structures; characterization of capable tectonic sources; designation of zones of Quaternary deformation in the site region; and potential for surface tectonic deformation at the site.

Section 2.5 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 2.5.3 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.5-4 to address COL Information Item 2.5-4 (COL Action Item 2.5.3-1). In VEGP COL 2.5-4, the applicant incorporates by reference Section 2.5.3 of the VEGP ESP SSAR, Revision 5, with no variances or supplements. The staff has already reviewed Section 2.5.3 of the VEGP ESP SSAR and found the information relating to surface faulting to be acceptable. Therefore, the NRC staff considers VEGP COL 2.5-4 resolved.

The NRC staff reviewed Section 2.5 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to surface faulting. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

2.5.4 Stability of Subsurface Materials and Foundations

2.5.4.1 Introduction

This section addresses the properties and stability of the soil and rock underlying the site that could affect the safe design and siting of the plant. The review covers the following specific areas: (1) geologic features of the site and vicinity; (2) static and dynamic engineering properties of soil and rock strata underlying the site; (3) relationship of the foundations for safety-related facilities and the engineering properties of underlying materials; (4) results of seismic refraction and reflection surveys, including in-hole and cross-hole explorations; (5) safety-related excavation and backfill plans and engineered earthwork analysis and criteria; (6) groundwater conditions and piezometric pressure in all critical strata as they affect the loading and stability of foundation materials; (7) responses of site soils or rocks to dynamic loading; (8) liquefaction potential and consequences of liquefaction of all subsurface soils, including the settlement of foundations; (9) earthquake design bases; (10) results of investigations and analyses conducted to determine foundation material stability, deformation and settlement under static conditions; (11) criteria, references, and design methods used in static and seismic analyses of foundation materials; and (12) techniques and specifications to improve subsurface conditions, which are to be used at the site to provide suitable foundation conditions.

2.5.4.2 Summary of Application

Section 2.5 of the VEGP COL FSAR Revision 2, incorporates by reference Section 2.5.4 of the AP1000 DCD, Revision 17 and Section 2.5.4 of the VEGP ESP SSAR, Revision 5.

In addition, in VEGP COL FSAR Table 1.8-204, Section 2.5.4.10.3, Sections 2.5.7.5 through 2.5.7.13, and Section 2.5.7.16, the applicant provided the following:

AP1000 COL Information Items

- VEGP COL 2.5-5

The applicant provided VEGP COL 2.5-5 to resolve COL Information Item 2.5-5 (COL Action Item 2.5.1-1). The applicant stated that VEGP COL 2.5-5 is addressed in VEGP ESP SSAR Section 2.5.4. It addresses the provision of site-specific information regarding the underlying site conditions and geologic features, including site topographical features and the locations of seismic Category I structures.

- VEGP COL 2.5-6

The applicant provided VEGP COL 2.5-6 to resolve COL Information Item 2.5-6 discussed in Section 2.5.4.6.2 of the AP1000 DCD. The applicant stated that VEGP COL 2.5-6 is addressed in VEGP ESP SSAR Section 2.5.4. It addresses the properties of the foundation soils to be within the range considered for design of the nuclear island basemat.

- VEGP COL 2.5-7

The applicant provided VEGP COL 2.5-7 to resolve COL Information Item 2.5-7 discussed in Section 2.5.4.6.3 of the AP1000 DCD. The applicant stated that VEGP COL 2.5-7 is addressed in VEGP ESP SSAR Section 2.5.4. It addresses the information concerning the extent (horizontal and vertical) of seismic Category I excavations, fills, and slopes.

- VEGP COL 2.5-8

The applicant provided VEGP COL 2.5-8 to resolve COL Information Item 2.5-8 (COL Action Item 2.4.1-1). The applicant stated that VEGP COL 2.5-8 is addressed in VEGP ESP SSAR Section 2.5.4. It addresses the ground water conditions relative to the foundation stability of the safety-related structures at the site.

- VEGP COL 2.5-9

The applicant provided VEGP COL 2.5-9 to resolve COL Information Item 2.5-9 (COL Action Item 2.5.4-3). The applicant stated that VEGP COL 2.5-9 is addressed in VEGP ESP SSAR Section 2.5.4, where the demonstration that the potential for liquefaction is negligible is provided.

- VEGP COL 2.5-10

The applicant provided VEGP COL 2.5-10 to resolve COL Information Item 2.5-10 (COL Action Item 2.6-4). The applicant stated that VEGP COL 2.5-10 is addressed in VEGP ESP SSAR Section 2.5.4, where the verification that the maximum bearing reaction determined from the analyses described in AP1000 DCD, Appendix 3G is less than 35,000 pounds per square foot (psf) under all combined loads, including the SSE for static and dynamic loads, is provided.

- VEGP COL 2.5-11

The applicant provided additional information for VEGP COL 2.5-11 to resolve COL Information Item 2.5-11 discussed in Section 2.5.4.6.7 of the AP1000 DCD. The applicant provided information regarding lateral earth pressure in VEGP COL FSAR Section 2.5.4.10.3 and also stated that VEGP COL 2.5-11 is addressed in VEGP ESP SSAR Section 2.5.4, where the methodology used in determination of static and dynamic lateral earth pressures and hydrostatic groundwater pressures acting on plant safety-related facilities using soil parameters as evaluated in previous sections is discussed.

- VEGP COL 2.5-12

The applicant provided VEGP COL 2.5-12 to resolve COL Information Item 2.5-12 discussed in Section 2.5.4.6.9 of the AP1000 DCD. The applicant stated that VEGP COL 2.5-12 is addressed in VEGP ESP SSAR Section 2.5.4, where soil characteristics affecting the stability of the nuclear island including foundation rebound, settlement, and differential settlement are discussed.

- VEGP COL 2.5-13

The applicant provided VEGP COL 2.5-13 to resolve COL Information Item 2.5-13 (COL Action Item 2.6-5). The applicant stated that VEGP COL 2.5-13 is addressed in VEGP ESP SSAR Section 2.5, Appendix 2.5E, where instrumentation for monitoring the performance of the foundations of the nuclear island, along with the location for benchmarks and markers for monitoring the settlement, is identified.

- VEGP COL 2.5-16

The applicant provided additional information in VEGP COL 2.5-16 to address COL Information Item 2.5-16 discussed in Section 2.5.4.6.11 of the AP1000 DCD. The applicant stated that VEGP COL 2.5-16 is addressed in VEGP ESP SSAR Section 2.5.4, where data on short-term (elastic) and long-term (heave and consolidation) settlement for soil sites for the history of loads imposed on the foundation consistent with the construction sequence are provided.

- VEGP COL 2.5-17

This COL Information Item was provided in a letter dated July 1, 2010, to reflect a response from Westinghouse dated July 21, 2009, regarding NRC RAI AP1000 DCD RAI-TR85-SEB1-36 R2. Westinghouse proposed COL Information Item 2.5-17 to provide a waterproofing system used for the below grade, exterior walls exposed to flood and groundwater under seismic Category I structures. COL Information Item 2.5-17 states that:

> The Combined License applicant will provide a waterproofing system used for the below grade, exterior walls exposed to flood and groundwater under seismic Category I structures. Waterproofing membrane should be placed immediately beneath the upper Mud Mat, and on top of the lower Mud Mat. The performance requirements to be met by the COL applicant for the waterproofing system are described in subsection 3.4.1.1.1.1.

Evaluation of the waterproofing capability of the system presented in VEGP COL 2.5-17 occurs in Section 3.8 of this SER. The evaluation of the system's ability to meet the seismic requirements outlined in DCD Section 3.4.1.1.1.1 is located in Section 3.8 of this SER.

ESP Permit Conditions

- ESP PC 1

The applicant provided additional information in VEGP COL FSAR Table 1.8-204 and VEGP COL Part 10, Appendix B, to address ESP PC 1 relating to eliminating soil liquefaction potential.

2.5.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSERs related to the DCD and its supplements and in NUREG-1923.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for stability of subsurface materials and foundations are given in Section 2.5.4 of NUREG-0800.

The applicable regulatory requirements for reviewing the applicant's discussion of stability of subsurface materials and foundations are as follows:

- 10 CFR 50.55a, "Codes and Standards," requires that SSCs be designed, fabricated, erected, constructed, tested and inspected in accordance with the requirements of applicable codes and standards commensurate with the importance of the safety function to be performed.

- 10 CFR Part 50, Appendix A, GDC 1, "Quality Standards and Records," 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.

- 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena," relates to the consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

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

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

- 10 CFR Part 100 provides the criteria that guide the evaluation of the suitability of proposed sites for nuclear power and testing reactors.

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

The related acceptance criteria summarized from NUREG-0800 Section 2.5.4 are as follows:

- Geologic Features: In meeting the requirements of 10 CFR Parts 50 and 100, the section defining geologic features is acceptable if the discussions, maps, and profiles of the site stratigraphy, lithology, structural geology, geologic history, and engineering geology are complete and are supported by site investigations sufficiently detailed to obtain an unambiguous representation of the geology.

- Properties of Subsurface Materials: In meeting the requirements of 10 CFR Parts 50 and 100, the description of properties of underlying materials is considered acceptable if state-of-the-art methods are used to determine the static and dynamic engineering properties of all foundation soils and rocks in the site area.

- Foundation Interfaces: In meeting the requirements of 10 CFR Parts 50 and 100, the discussion of the relationship of foundations and underlying materials is acceptable if it includes: (1) a plot plan or plans showing the locations of all site explorations, such as borings, trenches, seismic lines, piezometers, geologic profiles, and excavations with the locations of the safety-related facilities superimposed thereon; (2) profiles illustrating the detailed relationship of the foundations of all seismic Category I and other safety-related facilities to the subsurface materials; (3) logs of core borings and test pits; and (4) logs and maps of exploratory trenches in the application for a COL.

- Geophysical Surveys: In meeting the requirements of 10 CFR 100.23, the presentation of the dynamic characteristics of soil or rock is acceptable if geophysical investigations have been performed at the site and the results obtained there from are presented in detail.

- Excavation and Backfill: In meeting the requirements of 10 CFR Part 50, the presentation of the data concerning excavation, backfill, and earthwork analyses is acceptable if: (1) the sources and quantities of backfill and borrow are identified and are shown to have been adequately investigated by borings, pits, and laboratory property

and strength testing (dynamic and static) and these data are included, interpreted, and summarized; (2) the extent (horizontally and vertically) of all Category I excavations, fills, and slopes are clearly shown on plot plans and profiles; (3) compaction specifications and embankment and foundation designs are justified by field and laboratory tests and analyses to ensure stability and reliable performance; (4) the impact of compaction methods are incorporated into the structural design of the plant facilities; (5) quality control methods are discussed and the quality assurance program described and referenced; (6) control of groundwater during excavation to preclude degradation of foundation materials and properties is described and referenced.

- Ground Water Conditions: In meeting the requirements of 10 CFR Parts 50 and 100, the analysis of groundwater conditions is acceptable if the following are included in this section or cross-referenced to the appropriate sections in NUREG-0800 Section 2.4 of the SAR: (1) discussion of critical cases of groundwater conditions relative to the foundation settlement and stability of the safety-related facilities of the nuclear power plant; (2) plans for dewatering during construction and the impact of the dewatering on temporary and permanent structures; (3) analysis and interpretation of seepage and potential piping conditions during construction; (4) records of field and laboratory permeability tests, as well as dewatering induced settlements; (5) history of groundwater fluctuations as determined by periodic monitoring of 16 local wells and piezometers.

- Response of Soil and Rock to Dynamic Loading: In meeting the requirements of 10 CFR Parts 50 and 100, descriptions of the response of soil and rock to dynamic loading are acceptable if: (1) an investigation has been conducted and discussed to determine the effects of prior earthquakes on the soils and rocks in the vicinity of the site; (2) field seismic surveys (surface refraction and reflection and in-hole and cross-hole seismic explorations) have been accomplished and the data presented and interpreted to develop bounding P and S wave velocity profiles; (3) dynamic tests have been performed in the laboratory on undisturbed samples of the foundation soil and rock sufficient to develop strain-dependent modulus reduction and hysteretic damping properties of the soils and the results included.

- Liquefaction Potential: In meeting the requirements of 10 CFR Parts 50 and 100, if the foundation materials at the site adjacent to and under Category I structures and facilities are saturated soils and the water table is above bedrock, then an analysis of the liquefaction potential at the site is required.

- Static Stability: In meeting the requirements of 10 CFR Parts 50 and 100, the discussions of static analyses are acceptable if the stability of all safety-related facilities has been analyzed from a static stability standpoint including bearing capacity, rebound, settlement, and differential settlements under deadloads of fills and plant facilities, and lateral loading conditions.

- Design Criteria: In meeting the requirements of 10 CFR Part 50, the discussion of criteria and design methods is acceptable if the criteria used for the design, the design methods employed, and the factors of safety obtained in the design analyses are described and a list of references presented.

- Techniques to Improve Subsurface Conditions: In meeting the requirements of 10 CFR Part 50, the discussion of techniques to improve subsurface conditions is acceptable if plans, summaries of specifications, and methods of quality control are described for all techniques to be used to improve foundation conditions (such as grouting, vibroflotation, dental work, rock bolting, or anchors).

In addition, the geologic characteristics should be consistent with appropriate sections from: RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," Revision 2; RG 1.28; RG 1.132; RG 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants," Revision 2; RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites"; and RG 1.206.

2.5.4.4 Technical Evaluation

The NRC staff reviewed Section 2.5 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information related to stability of subsurface materials and foundations. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Items

- VEGP COL 2.5-5

The NRC staff reviewed VEGP COL 2.5-5 related to COL Information Item 2.5-5, which requires the applicant to provide site-specific information regarding the underlying site conditions and geologic features, including site topographical features and the locations of seismic Category I structures. VEGP COL FSAR Section 2.5.7.5 refers to Section 2.5.4 of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-5. VEGP ESP SSAR Section 2.5.4.1 refers to SSAR Section 2.5.1 for detailed descriptions of the geologic features in the VEGP Units 3 and 4 site region and site area. Since the staff already reviewed this topic and concluded that it has been resolved, as documented in the SER for the VEGP ESP and limited work authorization (LWA) applications, no further evaluation is needed for VEGP COL 2.5-5.

- VEGP COL 2.5-6

The NRC staff reviewed VEGP COL 2.5-6 related to COL Information Item 2.5-6, which requires the applicant to confirm the properties of the foundation soils to be within the range considered for design of the nuclear island basemat. VEGP COL FSAR Section 2.5.7.6 refers to Section 2.5.4 of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-6. Since the staff has already reviewed this topic and concluded that it has been resolved, as documented in the SER for the VEGP ESP and LWA applications, no further evaluation is needed for VEGP COL 2.5-6.

- VEGP COL 2.5-7

The NRC staff reviewed VEGP COL 2.5-7 related to COL Information Item 2.5-7, which requires the applicant to provide information concerning the extent (horizontal and vertical) of seismic Category I excavations, fills, and slopes. VEGP COL FSAR Section 2.5.7.7 refers to Section 2.5.4 of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-7. Since the staff has already reviewed this topic and concluded that it has been resolved, as documented in the SER for the VEGP ESP and LWA applications, no further evaluation is needed for VEGP COL 2.5-7.

- VEGP COL 2.5-8

The NRC staff reviewed VEGP COL 2.5-8 related to COL Information Item 2.5-8, which requires the applicant to assess the ground water conditions relative to the foundation stability of the safety-related structures at the site. In VEGP COL FSAR Section 2.5.7.8, the applicant referred to Section 2.5.4 of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-8. Since the staff has already reviewed this topic and concluded that it has been resolved, as documented in the SER for the VEGP ESP and LWA applications, no further evaluation is needed for VEGP COL 2.5-8.

- VEGP COL 2.5-9

The NRC staff reviewed VEGP COL 2.5-9 related to COL Information Item 2.5-9, which requires the applicant to demonstrate that the potential for liquefaction is negligible. In VEGP COL FSAR Section 2.5.7.9, the applicant referred to VEGP ESP SSAR Section 2.5.4 for the information that addresses VEGP COL 2.5-9. Since the staff already reviewed this topic and concluded that it has been resolved, as documented in the SER for the VEGP ESP and LWA applications, no further evaluation is needed for VEGP COL 2.5-9.

- VEGP COL 2.5-10

The NRC staff reviewed VEGP COL 2.5-10 related to COL Information Item 2.5-10, which requires the applicant to verify that the maximum bearing reaction determined from the analyses described in AP1000 DCD, Appendix 3G is less than 35,000 psf under all combined loads, including the SSE, for static and dynamic loads, and for the COL applicant to verify that the site-specific allowable soil bearing capacities for the static and dynamic loads at the site exceed this demand. VEGP COL FSAR Section 2.5.7.10 refers to Section 2.5.4 of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-10. Since the staff already reviewed this topic and concluded that it has been resolved, as documented in the SER for the VEGP ESP and LWA applications, no further evaluation is needed for VEGP COL 2.5-10.

- VEGP COL 2.5-11

The NRC staff reviewed VEGP COL 2.5-11 related to COL Information Item 2.5-11, which requires the applicant to describe the methodology used in the determination of static and dynamic lateral earth pressures and hydrostatic groundwater pressures acting on plant safety-related facilities using soil parameters as evaluated in previous sections. In VEGP COL FSAR Section 2.5.7.11, the applicant referred to Section 2.5.4 of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-11. The staff asked the applicant to provide

additional explanations of the methodologies used to determine the lateral earth pressures and the hydrostatic pressures acting on the safety-related structures at the VEGP Units 3 and 4 site in RAI 2.5.4-1.

In response to RAI 2.5.4-1, dated December 11, 2008, the applicant proposed a revision to the VEGP FSAR to include information on the development and mitigation of lateral earth pressures against the below-grade structures. The RAI response provided an analysis utilizing the Mononobe-Okabe (M-O) method. Based on the staff's review of the applicant's response to RAI 2.5.4-1, as well as the concerns surrounding the use of the M-O method, which does not consider the non-yielding and under at-rest conditions for foundation of structures below grade, the staff concluded that the response was not fully consistent with the AP1000 DCD.

Accordingly, in RAI 2.5.4-3, the staff asked the applicant to address the issues identified by the staff regarding the use of the M-O method. In its response, dated April 9, 2009, the applicant presented a revised site-specific total lateral earth pressure calculation that included both the dynamic Wood solution and the peak passive pressure solution evaluation and compared it with the enveloping lateral earth pressures of the design case for the below grade nuclear island walls of the AP1000 DCD. The applicant also proposed changes to VEGP COL FSAR Section 2.5 by adding a new Section 2.5.4.10.3, with associated references and figures, to incorporate the RAI response into the FSAR. Based on the applicant's commitment to revise the FSAR to include an additional discussion of the earth pressures at the site, the staff concluded that the applicant provided a satisfactory response to resolve RAI 2.5.4-3, as well as RAI 2.5.4-1. The staff verified that Revision 2 of the VEGP COL FSAR adequately incorporates the above. As a result, RAIs 2.5.4-1 and 2.5.4-3 are closed, and VEGP COL 2.5-11 is resolved.

- VEGP COL 2.5-12

The NRC staff reviewed VEGP COL 2.5-12 related to COL Information Item 2.5-12, which requires the applicant to address the soil characteristics affecting the stability of the nuclear island, including foundation rebound, settlement, and differential settlement. VEGP COL FSAR Section 2.5.7.12 refers to VEGP ESP SSAR Section 2.5.4 for the information that addresses VEGP COL 2.5-12. The staff already reviewed this topic and concluded that it had been resolved, as documented in the SER for the VEGP ESP and LWA applications. No further evaluation is needed for VEGP COL 2.5-12.

- VEGP COL 2.5-13

The NRC staff reviewed VEGP COL 2.5-13 related to COL Information Item 2.5-13, which requires the applicant to describe the instrumentation to be used to monitor the performance of the foundations of the nuclear island, along with the location for benchmarks and markers for monitoring the settlement. VEGP COL FSAR Section 2.5.7.13 refers to Section 2.5, Appendix 2.5E of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-13. The staff concluded that this topic has been adequately addressed, as documented in the SER for the VEGP ESP and LWA applications.

However, the staff noted that in AP1000 DCD, Revision 17, the differential settlement between the nuclear island and other structures is set as less than 1.27 centimeters (cm) (1/2 in.), not 7.62 cm (3 in.) as previously specified when the VEGP ESP SSAR was approved. Accordingly, in RAI 2.5.4-5, the staff asked the applicant to provide detailed information on whether the

site-specific settlement analysis results meet the revised standard design requirement. In a letter dated March 2, 2010, the applicant indicated that the revision of the AP1000 DCD would correct the differential settlement between nuclear island and other structures from 1.27 cm (1/2 in.) to 7.62 cm (3 in.) and the applicant would incorporate this DCD change into the VEGP COL FSAR. The staff considers this action acceptable pending formal revision to the VEGP COL FSAR. Accordingly this is **Confirmatory Item 2.5-1**.

- VEGP COL 2.5-16

The NRC staff reviewed VEGP COL 2.5-16 related to COL Information Item 2.5-16, which requires the applicant to provide data on short-term (elastic) and long-term (heave and consolidation) settlement for soil sites for the history of loads imposed on the foundation consistent with the construction sequence. VEGP COL FSAR Section 2.5.7.16 refers to Section 2.5.4 of the VEGP ESP SSAR for the information that addresses VEGP COL 2.5-16. The staff concluded that VEGP ESP SSAR Section 2.5.4 related to short-term and long-term settlement had been resolved, as documented in the SER for the VEGP ESP and LWA applications, and that no further evaluation was needed for VEGP COL 2.5-16.

ESP Permit Conditions

- ESP PC 1

To address ESP PC 1 related to eliminating soil liquefaction potential, the applicant proposed, in Part 10 of the COL application, certain ITAAC (safety-related backfill). Specifically, the applicant stated that the ITAAC identified in ESP SSAR Section 2.5.4.5.5 are incorporated by reference. The staff previously reviewed VEGP ESP SSAR Section 2.5.4 and accepted the backfill ITAAC, as documented in the SER for the VEGP ESP and LWA applications. To complete these ITAAC, the applicant will replace soil that has liquefaction potential with non-liquefiable backfill.

As part of its COL-stage review, the NRC staff reviewed the safety-related backfill ITAAC identified in ESP SSAR Section 2.5.4.5.5 and their relationship to the terms of ESP PC 1. The staff concludes that the placement of safety-related backfill that would be verified through these ITAAC would satisfy the PC. However, because at this time the applicant has not yet completed the previously-approved placement of the safety-related backfill and thus has not closed the backfill ITAAC, the applicant has not satisfied the PC. Consequently, this ESP PC will be included as COL License Condition.

2.5.4.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the staff proposes to include the ESP PC as a license condition:

- License Condition (2-1) - The licensee shall either remove and replace, or shall improve, the soils directly above the bluff marl for soils under or adjacent to Seismic Category 1 structures, to eliminate any liquefaction potential.

However, for the reasons described above, the staff concludes that if the safety-related backfill is placed in accordance with the previously-approved LWA, the closure of the associated backfill ITAAC will also constitute compliance with the license condition.

2.5.4.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD and the VEGP ESP SSAR. The NRC staff's review confirmed that the applicant had addressed the required information relating to stability of subsurface materials and foundations, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

The staff further concludes that the applicant has performed sufficient investigations at the site to justify the soil and rock characteristics used in the design, and that the design analyses contain adequate margins of safety for construction and operation of the nuclear power plant and meet the requirements of 10 CFR Part 50, Appendix A (GDC 1, 2, and 44); Appendices B and S of 10 CFR Part 50; and 10 CFR 100.23.

Based on the review and evaluation, the staff also concludes that VEGP COL 2.5-5 through VEGP COL 2.5-12, and VEGP COL 2.5-16, have been resolved. VEGP COL 2.5-13 will be resolved once Confirmatory Item 2.5-1 is adequately addressed by the applicant.

2.5.5 Stability of Slopes

The stability of slopes addresses the stability of all earth and rock slopes both natural and manmade (cuts, fill, embankments, dams, etc.) whose failure, under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the plant. The following subjects are evaluated using the applicant's data in the VEGP COL FSAR and information available from other sources: (1) slope characteristics; (2) design criteria and design analyses; (3) results of the investigations including borings, shafts, pits, trenches, and laboratory tests; and (4) properties of borrow material, compaction and excavation specifications.

Section 2.5 of the VEGP COL FSAR, Revision 2, incorporates by reference Sections 2.5.5 and 2.5.6 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.5-14 to address COL Information Item 2.5-14 (COL Action Item 2.5.5-1). In VEGP COL 2.5-14, the applicant incorporates by reference Section 2.5.5 of the VEGP ESP SSAR, Revision 5, with no variances or supplements. The applicant also adds VEGP COL 2.5-15 to address COL Information Item 2.5-15 (COL Action Item 2.5.6-1). In VEGP COL 2.5-15, the applicant incorporates by reference Section 2.5.6 of the VEGP ESP SSAR, Revision 5, with no variances or supplements. The staff has already reviewed Sections 2.5.5 and 2.5.6 of the VEGP ESP SSAR and found the information relating to the stability of slopes to be acceptable. Therefore, the NRC staff considers VEGP COL 2.5-14 and VEGP COL 2.5-15 resolved.

The NRC staff reviewed Section 2.5 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review

topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the stability of slopes. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

Section 2.5 of the VEGP COL FSAR, Revision 2, incorporates by reference Sections 2.5.5 and 2.5.6 of the AP1000 DCD, Revision 17, and adds VEGP COL 2.5-14 to address COL Information Item 2.5-14 (COL Action Item 2.5.5-1). In VEGP COL 2.5-14, the applicant incorporates by reference Section 2.5.5 of the VEGP ESP SSAR, Revision 5, with no variances or supplements. The applicant also adds VEGP COL 2.5-15 to address COL Information Item 2.5-15 (COL Action Item 2.5.6-1). In VEGP COL 2.5-15, the applicant incorporates by reference Section 2.5.6 of the VEGP ESP SSAR, Revision 5, with no variances or supplements. The staff has already reviewed Sections 2.5.5 and 2.5.6 of the VEGP ESP SSAR and found the information relating to the stability of slopes to be acceptable. Therefore, the NRC staff considers VEGP COL 2.5-14 and VEGP COL 2.5-15 resolved.

The NRC staff reviewed Section 2.5 of the VEGP COL FSAR and checked the referenced DCD and the VEGP ESP SSAR to ensure that the combination of the DCD, the VEGP ESP SSAR and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the stability of slopes. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements and in NUREG-1923.

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Section 2.0

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DATE	3/17/10	3/17/10	4/02/10	7/0610

Section 2.1, 2.2, and 2.3

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Section 2.4

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Section 2.5

OFFICE	DNRL/NWE1/LA	DNRL/NWE1/PM	DSER/RGS1/BC	OGC	DNRL/NWE1/BC
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