3.0 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

3.1 Conformance with NRC General Design Criteria

Section 3.1 of the Vogtle Electric Generating Plant (VEGP) combined license (COL) Final Safety Analysis Report (FSAR), Revision 2, incorporates by reference, with no departures or supplements, Section 3.1, "Conformance with NRC General Design Criteria," of Revision 17 of the AP1000 Design Control Document (DCD). The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD 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, "Final Safety Evaluation Report [FSER] Related to Certification of the AP1000 Standard Design," and its supplements.

3.2 Classification of Structures, Components, and Systems

3.2.1 Seismic Classification

3.2.1.1 Introduction

Nuclear power plant structures, systems, and components (SSCs) important to safety are to be designed to withstand the effects of earthquakes without loss of capability to perform their safety functions. Important to safety SSCs are defined in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities, "Appendix A, "General Design Criteria for Nuclear Power Plants," as those SSCs that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. Important to safety SSCs include safety-related SSCs that perform safety-related functions to ensure: (1) the integrity of the reactor coolant pressure boundary (RCPB); (2) the capability to shut down the reactor and maintain it in a safe-shutdown condition; and (3) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures. The earthquake for which these safety-related plant features are designed is defined as the safe shutdown earthquake (SSE). The SSE is based on an evaluation of the maximum earthquake potential for the site and is an earthquake that produces the maximum vibratory ground motion for which SSCs are designed to remain functional. The regulatory treatment of nonsafety systems (RTNSS) process is applied to define seismic requirements for SSCs that are nonsafety-related but perform risk-significant functions.

The methodology in the referenced AP1000 DCD classifies SSCs into three categories: seismic Category I, seismic Category II and nonseismic (NS). Those plant features that are designed to remain functional, if an SSE occurs, are designated seismic Category I. Seismic Category I applies to both functionality and integrity, and seismic Category II applies only to integrity. NS items located in the proximity of safety-related items, the failure of which during an SSE could result in the loss of function of safety-related items, are designated as seismic Category II. This methodology is similar to Regulatory Guide (RG) 1.29, "Seismic Design Classification," Revision 4, except that RG 1.29 does not use the terms seismic Category II and NS.

[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 design certification (DC).

3.2.1.2 Summary of Application

Section 3.2 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.2 of the AP1000 DCD, Revision 17. Section 3.2 of the DCD includes Section 3.2.1.

In addition, in VEGP COL FSAR Section 3.2, the applicant provided the following:

Supplemental Information

- VEGP Supplement (SUP) 3.2-1

The applicant provided supplemental information by adding text to the end of DCD Section 3.2.1, "Seismic Classification," stating that there are no safety-related SSCs at VEGP Units 3 and 4 outside the scope of the DCD, except for engineered fill, which is classified as a seismic Category I, safety-related structure. The applicant also states that the nonsafety-related SSCs outside the scope of the DCD are classified as NS.

3.2.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the seismic classification are given in Section 3.2.1 of NUREG-0800, "Standard Review Plan [SRP] for the Review of Safety Analysis Reports for Nuclear Power Plants."

The regulatory basis for acceptance of the supplemental information of defining the scope of safety-related SSCs is established in General Design Criteria (GDC) 2, "Design Bases for Protection Against Natural Phenomena," which requires that all SSCs important to safety be designed to withstand the effects of natural phenomena, including earthquakes and guidance on how to meet this requirement is in RG 1.29.

3.2.1.4 Technical Evaluation

The NRC staff reviewed Section 3.2 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 seismic classification. 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.

Section 1.2.3 of this safety evaluation report (SER) provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the Bellefonte Nuclear Plant (BLN) Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs) and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application, with one exception discussed below. This standard content material is identified in this SER by use of italicized, double-indented formatting. The resolution of one of the RAIs not endorsed by the VEGP applicant is discussed by the staff following the standard content material.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 3.2-1

The NRC staff reviewed VEGP SUP 3.2-1, related to the seismic classification of safety-related SSCs included under Section 3.2.1 of the VEGP COL FSAR, which states that there are no safety-related SSCs outside the scope of the DCD at VEGP Units 3 and 4, except for engineered fill, which is classified as a seismic Category I, safety-related structure. The seismic Category I classification of engineered backfill that supports seismic Category I structures is consistent with RG 1.29 that designates such safety-related SSCs including their foundations as seismic Category I. Therefore, the seismic classification is acceptable.

The following portion of this technical evaluation section is reproduced from Section 3.2.1.4 of the BLN SER:

> *Important to Safety SSCs*
>
> *GDC 2 states, in part, that SSCs important to safety shall be designed to withstand the effects of earthquakes. BLN COL FSAR Section 3.2.1 states there are no safety-related SSCs outside the scope of the DCD. In request for additional information (RAI) 3.2.1-1, the applicant was requested to clarify if there is any site-specific non-safety-related SSCs outside the scope of the DCD that are important to safety and, if so, identify the appropriate seismic classification of such SSCs. The applicant's response identified that there are no site-specific*

non-safety-related SSCs outside the scope of the DCD that are important to safety and that non-safety-related SSCs outside the scope of the DCD are classified as non-seismic. In Revision 1 of the BLN COL FSAR, the applicant added the statement that the non-safety-related SSCs outside the scope of the DCD are classified as non-seismic. The revised BLN COL FSAR is acceptable, and the staff's concern is closed. The staff based its conclusion on the applicant's response that there are no site-specific non-safety-related SSCs outside the DCD that are important to safety.

Seismic Classification of Other Site-Specific SSCs

Section 1.8 of the AP1000 DCD, Revision 16 identified certain site-specific SSCs that are outside the scope of the AP1000 standard plant, such as the circulating water system (CWS) and its heat sink, for which the COL applicant must provide site-specific information. The seismic classification of the CWS is not identified in DCD Table 3.2-3. Section 1.8 of BLN COL FSAR identifies certain COL items that represent interfaces for the standard design, but the seismic classification is not identified for the CWS.

In RAI 3.2.1-2, the applicant was requested to clarify if there are any site-specific SSCs outside the scope of the DCD that are not included in DCD Tables 3.2-2 and 3.2-3 that are to be seismically classified in the COL. For example, site-specific structures, the CWS and miscellaneous items such as reactor vessel insulation are not included in the tables. If so, the applicant was requested to identify the appropriate seismic classification of such SSCs. This concern was also identified in an RAI for the review of AP1000 Revision 16 and the DC applicant clarified that the seismic categorization of CWS and reactor vessel insulation are not plant-specific and are to be classified in the DCD. Therefore, this concern is closed and seismic classification of these components is to be addressed in the DCD rather than the BLN COL FSAR.

Quality Assurance for Seismic Category II SSCs

It is not clear in the BLN COL FSAR how Title 10 of the Code of Federal Regulations (CFR) 50, Appendix B is applied to seismic Category II SSCs, including those that may be site-specific. DCD Appendix 1A identifies that AP1000 conforms to RG 1.29, Regulatory Position C.4 and Section 1.8 identifies COL Information Item 17.5-1 for quality assurance (QA) in the design phase. DCD Section 17.5.2 identifies that the COL applicant will address its QA program and that the QA program will include provisions for seismic Category II SSCs. In RAI 3.2.1-4, the applicant was requested to clarify the extent that pertinent QA requirements of Appendix B to 10 CFR Part 50 in Regulatory Position C.4 of RG 1.29 apply to those activities affecting the safety-related functions of those portions of SSCs covered under Regulatory Positions 2 and 3 of RG 1.29, including any site-specific SSCs. If this issue will be resolved in the DCD rather than the COL for all plant SSCs, including those that are site-specific, the applicant was requested to advise the NRC staff that this was the case. The RAI response identified that there are no site-specific seismic Category II SSCs and that the application of 10 CFR Part 50, Appendix B is addressed by the DCD. Since there are no site-specific seismic Category II SSCs, this COL concern is closed for the BLN COL FSAR.

Consistency with RG 1.29, Revision 4

Section 3.2.1 of the BLN COL FSAR does not identify any departures relative to seismic classification identified in the DCD and BLN COL FSAR, Appendix 1AA identifies conformance with RG 1.29, Revision 3 as stated in the DCD rather than Revision 4 of RG 1.29, dated March 2007. In RAI 3.2.1-3, the applicant was requested to clarify if seismic classifications of site-specific SSCs are consistent with RG 1.29, Revision 4. The RAI response identified that seismic classification of site-specific SSCs not addressed in the DCD is consistent with RG 1.29, Revision 4. This position is acceptable to the staff, since it represents the current RG revision. The applicant revised Appendix 1AA in Revision 1 of the BLN COL FSAR to indicate conformance to RG 1.29, Revision 4.

Correction to Standard Content Evaluation

The third paragraph of the BLN SER does not apply. The VEGP applicant identified in a letter dated October 1, 2008, that it did not endorse the standard response to RAI 3.2.1-2. Classification of safety-related fill (VEGP SUP 3.2-1) is evaluated above. Also, for conformance with RG 1.29, the applicant stated that compliance is covered in the VEGP Early Site Permit (ESP) Site Safety Analysis Report (SSAR), Revision 5. The staff has reviewed and accepted this compliance with RG 1.29 in NUREG-1923, "Safety Evaluation Report for an Early Site Permit (ESP) at Vogtle Electric Generating Plant (VEGP) ESP Site."

3.2.1.5 Post Combined License Activities

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

3.2.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to seismic classification, 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.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of 10 CFR Part 50, Appendix A, and GDC 2. The staff based its conclusion on the following:

- VEGP SUP 3.2-1 is acceptable because the VEGP COL FSAR states that there are no safety-related SSCs outside the scope of the AP1000 DCD, except for the engineered fill. The VEGP COL FSAR also states that the nonsafety-related SSCs outside the scope of the DCD are classified as NS. The engineered fill is classified as a seismic Category I, safety-related structure. Therefore, the requirements of 10 CFR Part 50, Appendix A, GDC 2, the acceptance criteria in NUREG-0800, Section 3.2.1, and the guidelines in RG 1.29 are satisfied.

3.2.2 AP1000 Classification Systems (Related to RG 1.206, Section C.III.1, Chapter 3, C.I.3.2.2, "System Quality Group Classification")

3.2.2.1 Introduction

The system and component quality group classification addresses, in part, the general design criterion that nuclear power plant SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. Important to safety SSCs are defined in 10 CFR Part 50, Appendix A as those SSCs that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. Important to safety SSCs include safety-related SSCs that perform one of the following safety-related functions to ensure: (1) the integrity of the RCPB; (2) the capability to shut down the reactor and maintain it in a safe-shutdown condition; and (3) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures. The RTNSS process is applied to define supplemental quality requirements for SSCs that are nonsafety-related but perform risk significant function.

The system and component quality group classification in combination with the RTNSS process define appropriate classifications, codes and standards and special treatment important to safety pressure-retaining components and their supports, depending on their safety function. RG 1.26, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 4, provides the regulatory guidance for classifying SSCs important to safety systems and the appropriate quality standards.

3.2.2.2 Summary of Application

Section 3.2 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.2 of the AP1000 DCD, Revision 17. Section 3.2 of the DCD includes Section 3.2.2.

In addition, in VEGP COL FSAR Section 3.2, the applicant provided the following:

Supplemental Information

- VEGP SUP 3.2-1

The applicant provided supplemental information by adding text to the end of DCD Section 3.2.2, "AP1000 Classification System," stating that there are no safety-related SSCs at VEGP Units 3 and 4 outside the scope of the DCD, except for engineered fill, which is classified as a seismic Category I, safety-related structure.

3.2.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the system quality group classification are given in Section 3.2.2 of NUREG-0800.

The basis for acceptance of the supplemental information of defining the scope of safety-related SSCs is established in RG 1.26 and applicable American Society of Mechanical Engineers (ASME) Codes and industry standards, which provide assurance that component quality will be commensurate with the importance of the safety functions of these systems. Thus, this constitutes the basis for satisfying GDC 1, "Quality Standards and Records," for pressure-retaining components and their supports.

3.2.2.4 Technical Evaluation

The NRC staff reviewed Section 3.2 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 system quality group classification. 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.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the BLN Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 3.2-1

The NRC staff reviewed VEGP SUP 3.2-1 related to the seismic classification of safety-related SSCs included under Section 3.2.2 of the VEGP COL FSAR, which states that there are no safety-related SSCs outside the scope of the DCD at VEGP Units 3 and 4, except for engineered fill, which is classified as a seismic Category I, safety-related structure.

The NRC staff reviewed VEGP SUP 3.2-1 related to quality group classification of systems included under Section 3.2.2 of the VEGP COL FSAR. VEGP SUP 3.2-1 is identical to STD SUP 3.2-1 in the BLN COL FSAR with respect to quality group classification of systems included under Section 3.2.2 of the FSAR. Additional information was needed to evaluate STD SUP 3.2-1 and RAIs were submitted to the BLN applicant. The VEGP applicant endorsed the BLN RAI response in a letter dated October 1, 2008. As such, review of VEGP SUP 3.2-1 is addressed through the comparison with the BLN SER. As discussed below, there are no site-specific nonsafety-related SSCs outside the scope of the AP1000 DCD that are important to safety, so there are no changes to the quality group classifications listed in VEGP COL FSAR Section 3.2.

The following portion of this technical evaluation section is reproduced from Section 3.2.2.4 of the BLN SER:

> *Special Treatment for Risk-Significant SSCs*
>
> *GDC 1 identifies, in part, that SSCs important to safety shall be designed, fabricated, erected and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. Supplemental quality standards and QA programs applicable to passive SSCs used in non-safety-related regulatory treatment of non-safety systems that may be important to safety are not clearly defined in the BLN COL FSAR for site-specific SSCs.*
>
> *In RAI 3.2.2-2, the applicant was requested to clarify what supplemental quality standards are applied to non-safety-related site-specific SSCs that are important to safety to ensure that all SSCs important to safety are designed, fabricated, erected, and tested to quality standards commensurate with the safety function to be performed. Any site-specific SSCs that are considered important to safety may also require special treatment, but the response to RAI 3.2.1-1 identified that there are no site-specific non-safety-related SSCs outside the scope of the DCD that are important to safety. Therefore, this concern is closed.*
>
> *Codes and Standards*
>
> *The Staff Requirements Memorandum (SRM), dated July 21, 1993, concerning SECY-93-087 identified that the staff will review passive plant design applications using the newest codes and standards endorsed by the NRC and unapproved revisions to the codes will be reviewed on a case by case basis. Editions of various codes and standards referenced in DCD Section 3.2.6 are not current and newer codes and standards are not referenced in BLN COL FSAR Sections 3.2 or 1.8. In RAI 3.2.2-3, the applicant was requested to clarify if any different or current codes and standards are applied to the design and procurement of site-specific SSCs, other than those identified in the DCD. The RAI response identified that the applicant intends to implement the DCD identified codes and standards and that the codes and standards applied to the design and procurement of non-safety-related site-specific SSCs are those identified in various sections of the BLN COL FSAR. Although codes and standards for site-specific SSCs would be expected to be identified and reviewed*

in the COL application rather than the DCD, the response to RAI 3.2.1-1 identified that there are no site-specific non-safety-related SSCs outside the scope of the DCD that are important to safety. Therefore, this concern is closed.

Consistency with RG 1.26, Revision 4

Section 3.2.2 of the BLN COL FSAR does not identify any departures relative to quality group classification identified in the DCD and BLN COL FSAR, Appendix 1AA identifies conformance with RG 1.26, Revision 3 in the DCD rather than Revision 4, dated March 2007. In RAI 3.2.2-1, the applicant was requested to clarify if quality group classifications of site-specific SSCs are consistent with RG 1.26, Revision 4. The applicant's response clarified that the quality group classification of site-specific SSCs is consistent with RG 1.26, Revision 4. This position is acceptable to the staff, since it represents the current RG revision. This staff concern is closed and the BLN COL FSAR Appendix 1AA has been revised accordingly to reflect this RAI response.

3.2.2.5 Post Combined License Activities

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

3.2.2.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the system quality group classification, 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.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of 10 CFR Part 50, Appendix A, GDC 1. The staff based its conclusion on the following:

VEGP SUP 3.2-1 is acceptable with regard to quality group classifications because no change was made to the quality group classifications in Section 3.2 and there are no site-specific nonsafety-related SSCs outside the scope of the AP1000 DCD that are important to safety. Therefore, the requirements of 10 CFR Part 50, Appendix A, GDC 1, the acceptance criteria in NUREG-0800, Section 3.2.1, and the guidelines in RG 1.29 are satisfied.

3.3 Wind and Tornado Loadings

Seismic Category I and II buildings and structures are designed to withstand extreme wind and tornado loading conditions in compliance with the requirements dictated in GDC 2 in Appendix A to 10 CFR Part 50, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures shall reflect the appropriate consideration of the most severe of the natural phenomena that have been historically reported in the area of the plant, with sufficient margin to account for limited accuracy, quantity, and period of time for collection of data.

In Section 3.3 of this SER, the staff reviewed the seismic Category I and II structures subjected to wind and tornado loadings; other natural phenomena effects, such as earthquakes, floods, tsunami, and seiches, are evaluated in Sections 3.4, 3.7 and 3.8 of this SER.

3.3.1 Wind Loadings

3.3.1.1 Introduction

Seismic Category I structures must withstand the effects of the specified design wind speed for the plant to ensure conformance with 10 CFR Part 50, Appendix A, GDC 2. The specific areas of review are the design wind speed, its recurrence interval, speed variation with height, and applicable dust factors from the standpoint of use in defining the input parameters for the appropriate structural design criteria for wind loading.

3.3.1.2 Summary of Application

Section 3.3 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.3 of the AP1000 DCD, Revision 17. Section 3.3 of the DCD includes Section 3.3.1.

In addition, in VEGP COL FSAR Section 3.3.1, the applicant provided the following:

AP1000 COL Information Items

- VEGP COL 3.3-1

The applicant provided additional information in VEGP COL 3.3-1 to address COL Information Item 3.3-1 (COL Action Item 3.3.2.2-1) by stating that the wind velocity characteristics for the VEGP site are given in Section 2.3.1.3.1 of the VEGP Early Site Permit (ESP) Application Site Safety Analysis Report (SSAR), Revision 5. The applicant states that these values are bounded by the design wind velocities specified in AP1000 DCD Section 3.3.1.1 for the standard AP1000 plant design. In addition, the applicant states that the effects of wind on the safety-related SSCs due to failures in an adjacent AP1000 plant and VEGP Units 1 and 2 are bounded by the evaluation of the buildings and structures in a single unit. The portion of VEGP COL 3.3-1 relating to design tornado site characteristics and the effects of wind on the safety-related SSCs due to failures in an adjacent AP1000 plant and VEGP Units 1 and 2, is reviewed in SER Section 3.3.2.

- VEGP COL 3.5-1

The portion of VEGP COL 3.5-1 included in VEGP COL FSAR Section 3.3.1 is identical to the information added by VEGP COL 3.3-1, and is addressed by the staff in its evaluation of VEGP COL 3.3-1 in this SER section. The additional information in VEGP COL 3.5-1 included in VEGP COL FSAR Section 3.5 is addressed in Section 3.5 of this SER.

3.3.1.3 Regulatory Basis

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for wind loadings are given in Section 3.3.1 of NUREG-0800.

The regulatory basis for VEGP COL 3.3-1 is 10 CFR Part 50, Appendix A, GDC 2, and the regulatory guidance is in RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

3.3.1.4 Technical Evaluation

The NRC staff reviewed Section 3.3 of VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 wind loadings. 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.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 3.3-1

The NRC staff reviewed VEGP COL 3.3-1 related to design wind loads applied on safety-related SSCs included under Section 3.3.1.1 of the VEGP COL FSAR.

The commitment was also captured as COL Action Item 3.3.2.2-1 in NUREG-1793, Appendix F, "Combined License Action Items," which states:

> COL applicants referencing the AP1000 certified design will address site interface criteria for wind and tornadoes.

The applicant proposed a clarification to VEGP COL FSAR in Section 3.3.1.1 in a letter dated September 20, 2010. The staff agrees with the change that will state, "The wind velocity characteristics for the Vogtle Electric Generating Plant, Units 3 and 4 (VEGP), are given in ESPA SSAR Subsection 2.3.1.3.1. These values are bounded by the design wind velocity values given in DCD Subsection 3.3.1.1 for the AP1000 plant." The incorporation of the planned changes to the VEGP COL FSAR will be tracked as **Confirmatory Item 3.3-1.**

In Section 2.3.1.3.3.1 of NUREG-1923, the staff concluded that a site characteristic 3-second gust basic wind speed value of 104 miles per hour (mph) is an acceptable design wind speed for this site. Since this value is bounded by the AP1000 design wind speed of 145 mph, the staff concludes that the design wind velocities for the VEGP site are in compliance with GDC 2; therefore, VEGP COL 3.3-1 is resolved.

3.3.1.5 Post Combined License Activities

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

3.3.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to wind loadings, 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.

In addition, the staff concludes, pending closure of **Confirmatory Item 3.3-1**, that the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of GDC 2. The staff based its conclusion on the following:

- VEGP COL 3.3-1, as it relates to design wind loads, is acceptable based on the site-specific wind velocities, reviewed and approved in NUREG-1923, being bounded by the AP1000 DCD design wind velocities, and therefore, complying with GDC 2.

3.3.2 Tornado Loading

3.3.2.1 Introduction

Tornado loadings are considered for design in accordance with Section 3.3.2, "Tornado Loadings," of the AP1000 DCD. Section 3.3.2 of the AP1000 DCD addresses tornado loadings for seismic Category I structures using applicable tornado design parameters to determine forces on structures as explained in Section 3.3.1.2 of the AP1000 DCD. Also in Section 3.3.2.1 of the DCD, it is stated that the estimated probability of tornado wind speeds to be greater than the design basis tornado is between 10^{-6} and 10^{-7} per year for an AP1000 at a "worst location" anywhere within the contiguous United States.

The specific areas of review in accordance with Section 3.3.2 of NUREG-0800 include:

- the tornado wind translational and rotational speeds
- the tornado-generated atmospheric pressure change
- the spectrum of tornado-generated missiles

3.3.2.2 Summary of Application

Section 3.3 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.3 of the AP1000 DCD, Revision 17. Section 3.3 of the DCD includes Section 3.3.2.

In addition, in VEGP COL FSAR Section 3.3.2, the applicant provided the following:

AP1000 COL Information Items

- VEGP COL 3.3-1

The applicant provided additional information in VEGP COL 3.3-1 to resolve COL Information Item 3.3-1 (COL Action Item 3.3.2.2-1). In VEGP COL 3.3-1, the applicant states that tornado characteristics for VEGP Units 3 and 4, given in Section 2.3.1.3.2 of the VEGP ESP SSAR are bounded by the tornado design parameters given in DCD Section 3.3.2.1 for the standard

AP1000 plant. In addition, the applicant states that the effects of wind and tornado on the safety-related SSCs due to failures in an adjacent AP1000 plant and VEGP Units 1 and 2 are bounded by the evaluation of the buildings and structures in a single unit. The portion of VEGP COL 3.3-1 relating to design wind velocity characteristics is reviewed in SER Section 3.3.1.

- VEGP COL 3.5-1

The portion of VEGP COL 3.5-1 included in VEGP COL FSAR Section 3.3.2 is identical to the information added by VEGP COL 3.3-1, and is addressed by the staff in its evaluation of VEGP COL 3.3-1 in this SER section. The additional information in VEGP COL 3.5-1 included in VEGP COL FSAR Section 3.5 is addressed in Section 3.5 of this SER.

3.3.2.3 Regulatory Basis

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for tornado loading are given in Section 3.3.2 of NUREG-0800.

Acceptance of the information addressing VEGP COL 3.3-1 is established based on site-specific parameters and verification of bounding conditions for relevant parameters related to the DCD interface criteria for tornado, site arrangement, and building construction. The design of AP1000 safety-related SSCs for tornado loads using acceptable procedures must meet the requirements of 10 CFR Part 50, Appendix A, GDC 2, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

3.3.2.4 Technical Evaluation

The NRC staff reviewed Section 3.3.2 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 tornado loading. 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.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 3.3-1

The NRC staff reviewed VEGP COL 3.3-1 included under Sections 3.3.2 and 3.5.1 of the VEGP COL FSAR. Specific information provided by the applicant to address COL Action Item 3.3.2.2-1 includes development of site-specific parameters and verification of bounding

conditions, site arrangement and building construction. This information is provided to satisfy the commitment documented in Appendix F of NUREG-1793, which states:

> COL applicants referencing the AP1000 certified design will address site interface criteria for winds and tornadoes.

In VEGP COL 3.3-1, the applicant states that the tornado characteristics for VEGP Units 3 and 4, given in Section 2.3.1.3.2 of the VEGP ESP SSAR, are bounded by the tornado design parameters given in DCD Section 3.3.2.1 for the standard AP1000 plant design. In addition, the applicant states that the effects of wind and tornado on the safety-related SSCs due to failures in an adjacent AP1000 plant are bounded by the evaluation of the buildings and structures in a single unit.

In Section 2.3.1.3.3.2 of NUREG-1923, the staff concluded that tornado site characteristics chosen by the applicant were acceptable. Since these values match the design tornado site characteristics included in the AP1000 DCD, the staff concludes that the design tornado site characteristics for the VEGP site are in compliance with GDC 2.

The scope of VEGP COL 3.3-1 also includes the effects of wind and tornado on the safety-related SSCs due to failure of nonsafety-related buildings in an adjacent AP1000 plant and VEGP Units 1 and 2. The applicant states that these effects are bounded by the evaluation of the buildings and structures in a single unit.

In order to assure the failure of structures or components not designed for wind or tornado loadings does not affect the capability of safety-related SSCs to perform their intended safety functions, the COL applicants were offered three options in Section 3.3.2.3 of the DCD:

(1) Design the adjacent nonsafety-related structure to the design basis tornado loading.

(2) Analyze the effect of failure of adjacent nonsafety-related structures on nuclear island (NI) structures to assure that no impairment of safety function will result.

(3) Design a structural barrier to protect seismic Category I SSCs from adjacent structural collapse.

In VEGP COL 3.3-1, the applicant used Option (2), indicating that the effects of wind and tornado on the safety-related SSCs due to failure of an adjacent nonsafety-related building are bounded by the evaluation of the structures in a single unit at VEGP. The analysis of the impact of building collapse on the NI structures is in Section 3.7.2.8 of the AP1000 DCD. The staff's review of this analysis is provided in NUREG-1793 and its supplements.

Based on the above discussion, the NRC staff finds VEGP COL 3.3-1 to be resolved.

3.3.2.5 Post Combined License Activities

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

3.3.2.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to tornado

loading, 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.

In addition, the staff concludes that the relevant information presented within the VEGP COL FSAR, section 3.3.2 is acceptable and meets the requirements of 10 CFR Part 50, Appendix A, GDC 2. The staff based its conclusion on the following:

- VEGP COL 3.3-1, as it relates to design tornado loads, is acceptable based on the design tornado site characteristics, reviewed and approved in NUREG-1923, matching the AP1000 DCD design tornado site characteristics, and therefore, complying with GDC 2. VEGP COL 3.3-1, as it relates to the effects of wind and tornado on the safety-related SSCs due to failure of nonsafety-related buildings in an adjacent AP1000 plant and VEGP Units 1 and 2, is acceptable because the applicant incorporated by reference acceptable methodology from DCD Section 3.7.2.8.

3.4 Water Level (Flood) Design

3.4.1 Flood Protection

3.4.1.1 Introduction

Seismic Category I SSCs have flood protection measures for both external flooding and postulated internal flooding from plant component failures.

3.4.1.2 Summary of Application

Section 3.4 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.4 of the AP1000 DCD, Revision 17. Section 3.4 of the DCD includes Section 3.4.1.

In addition, in VEGP COL FSAR Section 3.4, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 3.4-1

The applicant provided additional information in VEGP COL 3.4-1 to resolve COL Information Item 3.4-1 (COL Action Item 3.4.1.1-1), which addresses plant-specific information on site-specific flooding hazards protective measures. VEGP COL 3.4-1, in VEGP COL FSAR Section 3.4.1.3, "Permanent Dewatering System," states that no permanent dewatering system is required because site groundwater levels are two feet or more below site grade level as described in VEGP ESP SSAR Section 2.4.12.

VEGP COL 3.4-1, in VEGP COL FSAR Section 3.4.3, "Combined License Information," states that the site-specific design basis flood levels given in VEGP COL FSAR Section 3.4.1.3 and VEGP ESP SSAR Section 2.4 satisfy the interface requirements identified in AP1000 DCD Section 2.4.

3.4.1.3 Regulatory Basis

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for flood protection measures are given in Section 3.4.1 of NUREG-0800.

Further, 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 of NUREG-0800.

3.4.1.4 Technical Evaluation

The NRC staff reviewed Section 3.4 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 flood protection measures. 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.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Item

- VEGP COL 3.4-1

The NRC staff reviewed VEGP COL 3.4-1, which addresses permanent dewatering system and site-specific water levels in Sections 3.4.1.3 and 3.4.3 of the VEGP COL FSAR, respectively.

The applicant provided additional information in VEGP COL 3.4-1 to address COL Information Item 3.4-1. COL Information Item 3.4-1 states:

> The Combined License [COL] applicant will demonstrate that the site satisfies the interface requirements as described in Section 2.4. If these criteria cannot be satisfied because of site-specific flooding hazards, the Combined License [COL] applicant may propose protective measures as discussed in Section 2.4.

The commitment was also captured as COL Action Item 3.4.1.1-1 in Appendix F of NUREG-1793, which states:

> The COL applicant will evaluate events leading to potential flooding and demonstrate that the design will fall within the values of these site parameters.

In VEGP COL FSAR Section 3.4, the applicant provided the following plant-specific information to resolve COL Information Item 3.4-1 (COL Action Item 3.4.1.1-1) on site-specific flooding hazards protective measures:

- VEGP COL 3.4-1, in VEGP COL FSAR Section 3.4.1.3, "Permanent Dewatering System," states that no permanent dewatering system is required because site groundwater levels are two feet or more below site grade level as described in VEGP ESP SSAR Section 2.4.12.

- VEGP COL 3.4-1, in VEGP COL FSAR Section 3.4.3, "Combined License Information," states that the site-specific design basis flood levels given in VEGP COL FSAR Section 3.4.1.3 and VEGP ESP SSAR Section 2.4 satisfy the interface requirements identified in DCD Section 2.4.

In Section 2.4.12 of NUREG-1923, the staff accepted the VEGP applicant's position that no permanent dewatering system is required and in Section 2.4.12 of this SER, the staff concluded that the site-specific groundwater level characteristics for the VEGP site are acceptable. Also, in Section 2.4 of this SER, the staff concluded that the site-specific design based flood levels and the consideration of flood protection measures are acceptable. Therefore, the staff concludes that the site-specific information in VEGP COL 3.4-1 is acceptable.

3.4.1.5 Post Combined License Activities

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

3.4.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to flood protection measures, 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.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the regulatory guidance in Sections 2.4.12 and 3.4.1 of NUREG-0800. The staff based its conclusion on the following:

- VEGP COL 3.4-1, is acceptable based on: 1) the staff's conclusions in NUREG-1923 regarding the need for a permanent dewatering system and on the staff's conclusions in Section 2.4.12 of this SER regarding the adequacy of the site-specific groundwater levels; and 2) the staff's conclusions in NUREG-1923 regarding the determination of the site-specific design based flood levels and on the staff's conclusions in Section 2.4 of this SER regarding the consideration of flood protection measures.

3.4.2 Analytical and Test Procedures (Related to RG 1.206, Section C.III.1, Chapter 3, C.I.3.4.2, "Analysis Procedures")

Analysis methods and procedures are described for the design of AP1000 standard plants to assess the maximum water levels due to internal flooding caused by equipment failure or

external flooding caused by natural phenomena and make sure that they do not jeopardize the safety of the plant or the ability to achieve and maintain safe shutdown conditions.

Section 3.4 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.4.2, "Analytical and Test Procedures," of Revision 17 of the AP1000 DCD. Section 3.4.2 of the AP1000 DCD states that the analytical approach for external and internal flooding events is described in DCD Section 3.4.1.2, "Evaluation of Flooding Events." The NRC staff reviewed the application and checked the referenced DCD 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.

3.5 Missile Protection

Seismic Category I structures are analyzed and designed to be protected from a wide spectrum of missiles (e.g., missiles from rotating and pressurized equipment, gravitational missiles, and missiles generated from tornado winds). Once a potential missile is identified, its statistical significance is determined (a significant missile is one which could cause unacceptable consequences or violate the guidelines of 10 CFR Part 100, "Reactor site criteria").

3.5.1 Missile Selection and Description

3.5.1.1 Introduction

SSCs important to safety are protected against internally generated missiles (outside containment), in accordance with Section 3.5.1.1 of NUREG-0800. The missiles generated outside containment by rotating or pressurized (high-energy fluid system) equipment are included.

The design credits only safety-related systems to establish and maintain safe shutdown conditions. The safety-related systems and components needed to bring the plant to safe shutdown, including the main control room and the recirculating service water system, are located inside the containment shield building and the auxiliary building. Both buildings are seismic Category I NI structures having thick structural concrete walls that provide internal and external missile protection. No nonsafety-related systems or components that require protection from missiles are housed in these buildings.

All SSCs that are necessary to perform safety functions are to be protected against damage from the following:

- Internally generated missiles (outside containment)
- Internally generated missiles (inside containment)
- Turbine missiles
- Missiles generated by tornadoes and extreme winds
- Site proximity missiles (except aircraft)
- Aircraft hazards

3.5.1.2 Summary of Application

Section 3.5 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.5 of the AP1000 DCD, Revision 17, and Section 3.5.1.6 of the VEGP ESP SSAR, Revision 5. Section 3.5 of the DCD includes Section 3.5.1. VEGP SER Section 2.2.3 provides an evaluation of potential accidents.

In addition, in VEGP COL FSAR Section 3.5, the applicant provided the following:

AP1000 COL Information Item

- VEGP COL 3.3-1 and VEGP COL 3.5-1

The applicant provided additional information in VEGP COL 3.3-1 to resolve COL Information Item 3.3-1 (COL Action Item 3.3.2.2-1) and in VEGP COL 3.5-1 to resolve COL Information Item 3.5-1 (COL Action Item 3.5.1.5-1). VEGP COL 3.3-1 and VEGP COL 3.5-1, in VEGP COL FSAR Section 3.5.1.5, "Missiles Generated by Events Near the Site," states that the buildings and structures at the VEGP site are common structures that are located at a nuclear power plant. They are of similar design and construction to those that are typical at nuclear power plants. Therefore, any missiles resulting from a tornado-initiated failure are not more energetic than tornado missiles postulated for design of the AP1000.

In addition, VEGP COL 3.3-1 and VEGP COL 3.5-1 in VEGP COL FSAR Section 3.5.1.6, "Aircraft Hazards," states that Section 3.5.1.6 of the referenced VEGP ESP SSAR is incorporated by reference with no variances or supplements.

Supplemental Information

- STD SUP 3.5-1

The applicant provided supplemental information by adding text to the end of DCD Section 3.5.1.3. This supplemental information states that the potential for a turbine missile from another AP1000 plant in close proximity has been considered for VEGP Units 3 and 4 in accordance with RG 1.115, "Protection Against Low-Trajectory Turbine Missiles," Revision 1.

- STD SUP 3.5-2

The applicant provided supplemental information by stating that the turbine system maintenance and inspection program is discussed in DCD Section 10.2.3.6.

- VEGP SUP 3.5-1

The applicant provided supplemental information by stating that the orientation of the VEGP Units 1 and 2 turbines has been evaluated and VEGP Units 3 and 4 are located outside of the low trajectory strike zones as described in RG 1.115. Therefore, the applicant stated that there is no potential for a turbine missile from Units 1 and 2 to impact Units 3 and 4.

3.5.1.3 Regulatory Basis

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for missile selection and description are given in Sections 3.5.1.1 through 3.5.1.6 of NUREG-0800.

The regulatory basis for acceptance of VEGP COL 3.5-1 is based on the development of site-specific parameters and verification of bounding conditions compared to the DCD interface criteria for missile generation, site arrangement, and building construction. The design of AP1000 safety-related structures for protection against missiles using acceptable procedures must meet the requirements of GDC 4, "Environmental and dynamic effects design bases." Regulatory requirements for potential hazards associated with nearby transportation routes, industrial and military facilities are provided in 10 CFR 100.21(e), "Non-seismic site criteria."

Additional regulatory guidance related to the review of the issues in this SER section are given in RG 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," Revision 1; RG 1.115 and RG 1.117, "Design Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1.

3.5.1.4 Technical Evaluation

The NRC staff reviewed Section 3.5 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 missile protection of safety-related SSCs. 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.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the BLN Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. There was one open item (Open Item 1-1) to resolve. The resolution of the item is addressed in this SER.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Items

- VEGP COL 3.3-1 and VEGP COL 3.5-1

In Section 3.5.1.5 of the VEGP COL FSAR, the applicant provided the site-specific information to resolve COL Information Items 3.3-1 and 3.5-1. VEGP COL FSAR Section 3.5.1.5 states that in accordance with VEGP ESP SSAR Section 2.2.3, the effects of explosions have been evaluated and it has been determined that the over pressure criteria of RG 1.91 is not exceeded. Consistent with RG 1.91, the effect of blast-generated missiles will be less than those associated with the blast over-pressure levels considered, and, therefore, no further evaluation of blast-generated missiles is required.

VEGP COL FSAR Section 3.5.1.6, "Aircraft Hazards," states that Section 3.5.1.6 of the referenced VEGP ESP SSAR is incorporated by reference with no variances or supplements.

The NRC staff reviewed and found acceptable, in Sections 2.2.3 and 3.5.1.6 of NUREG-1923, the information provided by the applicant in VEGP ESP SSAR Sections 2.2.3 and 3.5.1.6, respectively, related to the issues covered by VEGP COL 3.3-1 and VEGP COL 3.5-1. Therefore, VEGP COL 3.3-1 and VEGP COL 3.5-1 are acceptable.

The following portion of this technical evaluation section is reproduced from Section 3.5.1.4 of the BLN SER:

> *Supplemental Information*
>
> - *STD SUP 3.5-1*
>
> *The NRC staff reviewed the standard supplementary information (STD SUP 3.5-1) on the probability of turbine missiles from another AP1000 plant in close proximity affecting SSCs. The applicant proposes to add to the AP1000 DCD, Section 3.5.1.3, a statement that the potential for a turbine missile from another AP1000 plant in close proximity is less than $1x10^{-5}$ per year, and that the reinforced concrete shield building and auxiliary building walls, roofs, and floors satisfies the guidance of RG 1.115 for two AP1000 plants side-by-side.*
>
> *It should be noted that AP1000 DCD, Section 1.2.2 refers to Figure 1.2 2 of the AP1000 DCD for the building structure orientation with respect to the turbine building and the nuclear island. Figure 1.2 2 illustrates the AP1000 plant as a single unit. Section 1.2.1.3.1 of the AP1000 DCD also states that the turbine orientation minimizes potential interaction between turbine missiles and safety-related structures and components. In addition, Section 3.5.1.3 of the AP1000 DCD states that the turbine generator is located north of the nuclear island with its shaft oriented north-south so that safety-related systems are*

located outside the high-velocity, low trajectory missile strike zone. With this information, the AP1000 design is considered to favorably orient the turbine building with respect to safety-related SSCs as defined in RG 1.115. However, since BLN Units 3 and 4 will be side-by-side, the staff notes that each turbine generator may not be oriented favorably with respect to the other plant's safety-related SSCs (i.e., BLN Unit 3 turbine generator not favorably orientated to BLN Unit 4 safety-related SSCs, and vice versa).

In Revision 1 of the BLN COL FSAR, the applicant revised STD SUP 3.5-1 to state that when two or more AP1000 units are situated side-by-side, the turbine generators are orientated unfavorably with respect to the other nuclear island which contains safety-related SSCs. The BLN site has two AP1000 units situated side-by-side. Therefore, the staff notes that to meet the guidance of RG 1.115 and Section 3.5.1.3 of NUREG-0800, for an unfavorable turbine generator orientation, the probability of generating a turbine missile must be equal to or less than $1x10^{-5}$ per year. As stated in the BLN COL FSAR, Section 3.5.1.3, the probability of generating a missile for the AP1000 turbine generator is less than $1x10^{-5}$ per year as calculated in the applicable bounding turbine missile analysis topical report referenced in the AP1000 DCD, Sections 3.5.1.3 and 10.2.8. The staff has not completed its review of the DCD with respect to this issue. Therefore, the staff is unable to make final determination. This is ***Open Item 1-1****.*

- *STD SUP 3.5-2*

STD SUP 3.5-2 to BLN COL, Section 3.5.1.3 states, "The turbine system maintenance and inspection program is discussed in Section 10.2.3.6." This statement refers to Section 10.2.3.6 of the BLN COL, for information concerning the turbine maintenance and inspection program. The staff's review of the turbine maintenance and inspection program is included in Section 10.2.3 [sic 10.2] *of this SER.*

Resolution of the Standard Content Evaluation Concerning Open Item 1-1 for Turbine Missiles

The NRC staff identified a statement in the text reproduced above from Section 3.5.1.4 of the BLN SER that requires clarification for the VEGP COL application. The BLN SER states that the review of the AP1000 DCD with respect to the probability of generating a turbine missile was not completed and, therefore, identified it as Open Item 1-1. The results of the NRC staff's technical evaluation of the AP1000 DC amendment application are documented in NUREG-1793 and its supplements, and include the final staff conclusions on the issue of probability of a missile striking a safety-related component.

Therefore, the staff finds that the probability of generating a turbine missile meets the guidance in Section 3.5.1.3 of NUREG-0800 and the requirements of GDC 4, since the probability of a missile striking a safety-related component is acceptably low. As an additional conservative measure, the reinforced concrete shield building and auxiliary building walls, roofs, and floors provide some inherent protection of the safety-related components, but are not credited in preventing turbine missile strikes of safety-related components. As a result, Open Item 1-1, as it relates to the probability of a missile striking a safety-related component, is closed for the VEGP application review.

- VEGP SUP 3.5-1

The applicant provided supplemental information by stating that the orientation of the VEGP Units 1 and 2 turbines has been evaluated and VEGP Units 3 and 4 are located outside of the low trajectory strike zones as described in RG 1.115. Therefore, the applicant stated that there is no potential for a turbine missile from Units 1 and 2 to impact Units 3 and 4. The NRC staff reviewed this information and found that the potential turbine orientation and placement, provides a high degree of confidence that low-trajectory missiles resulting from turbine failures will not damage essential systems. Therefore, the staff considers the applicant's conclusions acceptable.

3.5.1.5 Post Combined License Activities

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

3.5.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to missile protection, 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 concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the regulatory guidance in Sections 3.5.1.1 through 3.5.1.6 of NUREG-0800. The staff based its conclusion on the following:

- VEGP COL 3.3-1 and VEGP COL 3.5-1 are acceptable because they meet the acceptance criteria provided in Sections 3.5.1.5 and 3.5.1.6 of NUREG-0800.

- STD SUP 3.5-1 is acceptable because the turbine missile evaluation for co-located AP1000 units meets the guidance of NUREG-0800 Section 3.5.1.3; therefore, ensures that the requirements of GDC 4 to 10 CFR Part 50 are met for protecting safety-related SSCs against the effects of turbine missiles.

- STD SUP 3.5-2 provides information on the turbine maintenance and inspection program. The staff's review of the turbine maintenance and inspection program is included in Section 10.2 of this SER.

- VEGP SUP 3.5-1 is acceptable because the protection of safety-related SSCs from turbine missiles meets the acceptance criteria defined in NUREG-0800, Section 3.5.1.

3.5.2 Protection from Externally Generated Missiles

Systems required for safe shutdown are protected from the effects of missiles. Protection from external missiles, including those generated by natural phenomena, is provided by the external walls and roof of the seismic Category I NI structures. The external walls and roofs are reinforced concrete. The structural design requirements for the shield building and auxiliary

building are outlined in AP1000 DCD Section 3.8.4. Openings through these walls are evaluated on a case-by-case basis to provide confidence that a missile passing through the opening would not prevent safe shutdown and would not result in an offsite release exceeding the limits defined in 10 CFR Part 100.

Section 3.5 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.5.2, "Protection from Externally Generated Missiles," of the AP1000 DCD, Revision 17 without any departures or supplements. The NRC staff reviewed the application and checked the referenced DCD 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.

3.5.3 Barrier Design Procedures

Missile barriers and protective structures are designed to withstand and absorb missile impact loads to prevent damage to safety-related systems or components. Formulae used for missile penetration calculations into steel or concrete barriers are the Modified National Defense Research Committee formula for concrete and either the Ballistic Research Laboratory or Stanford formulae for steel as documented in AP1000 DCD, Section 3.5.3.

Section 3.5 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.5.3, "Barrier Design Procedures," of the AP1000 DCD, Revision 17 without any departures or supplements. The NRC staff reviewed the application and checked the referenced DCD 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.

3.6 Protection against Dynamic Effects Associated with the Postulated Rupture of Piping

3.6.1 Introduction

The design basis and criteria are described to demonstrate that safety-related systems are protected from pipe ruptures. This section also evaluates design bases for locating postulated breaks and cracks in high- and moderate-energy piping systems inside and outside the containment; the procedures used to define the jet thrust reaction at the break location; the procedures used to define the jet impingement loading on adjacent essential SSCs; pipe whip restraint design; and the protective assembly design. Pipe breaks in several high-energy systems, including the reactor coolant loop (RCL) and surge line, are replaced by small leakage cracks when the leak-before-break (LBB) criteria are applied. Jet impingement and pipe whip effects are not evaluated for these small leakage cracks.

Mechanistic pipe break evaluations (also referred to as LBB) demonstrate that for piping lines meeting the criteria, sudden catastrophic failure of the pipe is not credible. The evaluations demonstrate that piping that satisfies the criteria leaks at a detectable rate from postulated flaws prior to growth of the flaw to a size that would fail due to applied loads resulting from normal conditions, anticipated transients, and a postulated SSE.

3.6.2 Summary of Application

Section 3.6 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.6 of the AP1000 DCD, Revision 17. Section 3.6 of the DCD includes Section 3.6.4.

In addition, in VEGP COL FSAR Section 3.6.4, the applicant provided the following:

AP1000 COL Information Items

- STD COL 3.6-1

The applicant provided additional information in STD COL 3.6-1 to address COL Information Item 3.6-1. Specifically, the applicant stated that a pipe rupture hazard analysis is part of the piping design. It is used to identify postulated break locations and layout changes, support design, whip restraint design, and jet shield design. The applicant further stated that the final design of these activities will be completed prior to fabrication and installation of the piping and connected components.

- STD COL 3.6-4

The applicant provided additional information in STD COL 3.6-4 to address COL Information Item 3.6-4, regarding LBB inspections.

License Condition

- Part 10, License Condition 2, Item 3.6-1

The applicant has proposed a license condition addressing the as-designed pipe rupture hazards analysis completion schedule.

Inspections, Tests, Analyses and Acceptance Criteria (ITAAC)

In a letter dated April 23, 2010, the applicant has proposed ITAAC requiring the completion of an as-designed pipe rupture hazards analysis to demonstrate that SSCs required to be functional during and following a postulated pipe failure are protected against or qualified to withstand the dynamic and environmental effects resulting from postulated failures in high- and moderate-energy piping.

3.6.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations (GDC 4 of Appendix A to 10 CFR Part 50) for the piping design against pipe breaks, pipe break locations and characteristics in safety-related piping, and LBB evaluation procedures are given in Sections 3.6.1, 3.6.2, and 3.6.3 of NUREG-0800.

3.6.4 Technical Evaluation

The NRC staff reviewed Section 3.6 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 piping design against pipe break, pipe break locations and characteristics in safety-related piping, and LBB evaluation procedures. 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.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the BLN Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. There was one open item (Open Item 3.6-1) to resolve. The resolution of the item is addressed in this SER.

AP1000 COL Information Items

The following portion of this technical evaluation section is reproduced from Section 3.6.4 of the BLN SER:

- *STD COL 3.6-1*

The staff notes that there are two different actions to be addressed: 1) the COL holder item addresses the as-designed pipe rupture hazard analysis report; and 2) the ITAAC addresses as-built reconciliation of the pipe rupture hazard analysis report. The ITAAC has a stated schedule, prior to fuel load, and a regulatory requirement that the ITAAC schedule be provided one year after the license is granted.

Based on the review of the information included in the BLN COL FSAR, it is unclear to the staff when the as-designed pipe rupture hazard analysis report will be completed by the applicant. As identified in 10 CFR 52.79(d)(3), the applicant

should supply the NRC with a schedule for completion of detailed engineering information, in this case, the as-designed pipe rupture hazard analysis report. The applicant is requested to revise the implementation milestone for the License Condition to address the as-designed pipe rupture hazard analysis report (as opposed to as-built reconciliation) to allow coordination of activities with the NRC construction inspection program following the issuance of the COL such that the analysis would be made available to verify the design was completed in accordance with the regulations and DCD prior to fabrication and installation of the piping and connected components. In RAI 3.6.2-1, the staff requested the applicant provide a description pertaining to the closure milestone of the as-designed pipe rupture hazard analysis activities.

The applicant responded to RAI 3.6.2-1, however, based on its review of the applicant's response, the staff determined that it is not acceptable. Specifically, RAI 3.6.2-1 requested that the applicant address the implementation milestone of the as-designed pipe rupture hazard analysis report. However, the applicant's RAI response addressed the as-built rather than the as-designed aspect. Therefore, RAI 3.6.2-1 remains unresolved and will be tracked as ***Open Item 3.6-1.***

- *STD COL 3.6-4*

The BLN COL FSAR replaced the first paragraph of Section 3.6.4.4 of AP1000 DCD with the following text:

> *Alloy 690 is not used in leak-before-break [LBB] piping. No additional or augmented inspections are required beyond the inservice inspection [ISI] program for leak-before-break [LBB] piping. An as-built verification of the leak-before-break piping is required to verify that no change was introduced that would invalidate the conclusion reached in this subsection.*

Based upon its review of the replaced Section 3.6.4.4, the staff determined that additional information was needed by the COL applicant to address whether Alloy 690 material is being used in the BLN-specific LBB piping systems. Accordingly, the staff issued several RAIs.

In RAI 3.6.3-1, the staff noted that it was unclear why Alloy 690 was not used in LBB piping applications. If Alloy 690 base material and Alloy 52/152 weld material was not being used, the staff asked the applicant to identify what material was being used for the piping.

In RAI 3.6.3-2, the staff asked if another base material was being used other than Alloy 690/52/152, then the applicant should provide its reasons for using this material in LBB piping applications based upon operating experience, and provide justification as to why no augmented inspection plans and evaluation criteria were considered necessary. Additionally, the staff requested that the applicant provide a discussion which supports the use of an alternative material and discuss why concerns for potential PWSCC [primary water stress-corrosion cracking] should not be considered a factor.

In RAI 3.6.3-3, for piping requiring dissimilar metal welds, the applicant was requested to address that if Alloy 52/152 is not being used for the weld material, then they should identify the weld material and provide justification for its use. In addition, the applicant should provide a discussion which supports the use of an alternative weld material and why concerns regarding the potential for PWSCC should not be considered a factor. The staff noted that there are currently ASME Code cases being developed for dissimilar-metal welds due to PWSCC concerns.

In its response to these RAIs, the applicant provided additional information to clarify the material that is used for LBB piping systems. The applicant stated that there is some limited use of Alloy 690 base material as safe ends in components connected to LBB piping, and there is some limited use of Alloy 52/152 weld material associated with these safe ends. However, the applicant noted that the base material for most of the LBB piping is 316LN stainless steel material. The applicant further stated that the material used in the AP1000 LBB piping is the same material currently used for LBB piping in operating nuclear power plants. Alloy 690 and Alloy 600 are not used as base material for LBB piping in the AP1000 design and are not commonly used in the LBB piping in current operating nuclear power plants. The applicant also stated that even though the material used in the LBB piping for the AP1000 design do not presently require an augmented ISI program, if ASME Code cases are developed and approved to address PWSCC concerns for dissimilar metal welds used in the AP1000 DCD, they will be evaluated and implemented.

The staff notes that in a final rule to amend 10 CFR 50.55a (73 FR [Federal Register] 52730) issued on September 10, 2008, a new requirement was added for licensees to augment their ISI program to use ASME Code Case N-722 for ISI of Alloy 600/182/82 materials to address PWSCC concerns. The applicant stated that there will be no Alloy 600/182/82 material used for new reactor construction of AP1000 plants. The staff notes that the final rule did not impose any additional requirements for augmented ISI of Alloy 690/152/52 materials. Based on the applicant's response discussed above and its commitment to evaluate and implement ASME Code cases that are developed and approved for augmented inspections of Alloy 690/152/52 material to address PWSCC concerns, the staff concludes the applicant's changes to COL Information Item 3.6-4 is consistent with current industry practice and NRC regulations as amended in 10 CFR 50.55a and is thus, acceptable.

Resolution of Standard Content Open Item 3.6-1

To address Open Item 3.6-1 in the BLN SER with open items, the VEGP applicant proposed in its letter dated April 23, 2010, an ITAAC for as-designed pipe rupture hazards analysis in ITAAC Table 3.8-# and a revision to the proposed License Condition 2, Item 3.6-1 in Part 10 of the VEGP COL application. In addition, the applicant proposed to revise VEGP COL FSAR Section 3.6.4.1 and to add VEGP COL FSAR Section 14.3.3.# related to pipe rupture hazards analysis.

Specifically, the proposed ITAAC includes a post-COL requirement related to the completion of the as-designed pipe rupture hazards analysis report. The proposed VEGP COL FSAR Section 3.6.4.1 states that the completed as-designed pipe rupture hazards analysis will be in

accordance with the criteria outlined in AP1000 DCD Sections 3.6.1.3.2 and 3.6.2.5. The applicant stated that the completed as-designed pipe rupture hazards analysis report will be completed prior to installation of the piping and connected components and will be made available to the NRC staff. The applicant's proposed license condition that will require completion of the as-designed pipe rupture hazards analysis report prior to installation of the piping and connected components in their final location is proposed License Condition 2, Item 3.6-1. In the proposed VEGP COL FSAR Section 14.3.3.#, the applicant stated that the as-designed pipe rupture hazards analysis completed for the first standard AP1000 plant will be available to subsequent standard AP1000 plants under the "one issue, one review, one position" approach for closure.

The staff reviewed the applicant's April 23, 2010, response to BLN open items for Chapter 3, and has determined that the use of a plant-specific ITAAC to verify that the as-design pipe rupture hazards evaluation has been performed in accordance with the criteria outlined in AP1000 DCD Sections 3.6.1.3.2 and 3.6.2.5 is acceptable. The applicant's proposed license condition requiring completion of the as-designed pipe rupture hazards analysis report prior to installation of the piping and connected components in their final location, through the above discussed ITAAC, will allow the staff sufficient time to review the as-design pipe rupture hazards evaluation in a timely matter in order to identify and address any design issues. Therefore, the staff finds the response acceptable and concludes that Standard Content Open Item 3.6-1 has been satisfactorily resolved. The incorporation of the planned VEGP COL FSAR changes will be tracked as **Confirmatory Item 3.6-1**.

3.6.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the applicant proposes to include the following ITAAC for the pipe rupture hazards analysis:

- The licensee shall perform and satisfy the pipe rupture hazards analysis ITAAC defined in SER Table 3.6-1, "Piping Rupture Hazard Analysis."

For the reasons discussed in the technical evaluation section above, the applicant proposes to include the following license condition:

- License Condition (3-1) - The licensee will complete, prior to installation of the piping and connected components in their final location, the as-designed pipe rupture hazards analysis in accordance with the criteria outlined in AP1000 DCD Sections 3.6.1.3.2 and 3.6.2.5.

3.6.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the pipe design against pipe break, pipe break locations and characteristics in safety-related piping, and LBB evaluation procedures 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.

In addition, the staff concludes that, pending closure of **Confirmatory Item 3.6-1**, the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of GDC 4 of Appendix A to 10 CFR Part 50. The staff based its conclusion on the following:

- STD COL 3.6-1 is acceptable because the applicant's proposed resolution to COL Information Item 3.6-1 in VEGP COL FSAR Section 3.6.4.1 meets the relevant guidelines of NUREG-0800 Sections 3.6.1 and 3.6.2 and 10 CFR 52.79(d)(3) and is, thus, acceptable. Conformance with these guidelines provides an acceptable basis for satisfying, in part, the requirements of GDC 4 of Appendix A to 10 CFR Part 50.

- STD COL 3.6-4 is acceptable because the applicant's proposed resolution to COL Information Item 3.6-4 in Section 3.6.4.4 of the VEGP COL FSAR meets the relevant guidelines of NUREG-0800 Section 3.6.3 and is, thus, acceptable. Conformance with these guidelines provides an acceptable basis for satisfying, in part, the requirements of GDC 4 of Appendix A to 10 CFR Part 50.

3.7 Seismic Design

Seismic design of the AP1000 seismic Categories I and II structures, systems, equipment, and components are based on the SSE. The operating basis earthquake (OBE) has been eliminated as a design requirement for the AP1000. Low-level seismic effects are included in the design of certain equipment potentially sensitive to a number of such events based on a percentage of the responses calculated for the SSE.

Criteria for evaluating the need to shut down the plant following an earthquake are established. For the purposes of the shutdown criteria the OBE for shutdown is considered to be one-third of the SSE.

Seismic Category I SSCs are designed to withstand the effects of the SSE event and to maintain the specified design functions. Seismic Category II and NS structures are designed or physically arranged (or both) so that the SSE could not cause unacceptable structural interaction with or failure of seismic Category I SSCs.

As part of the applicant's Limited Work Authorization (LWA), the staff reviewed, in Section 3.7.1 of NUREG-1923, the technical basis for seismic design provided in Appendix 2.5E of the VEGP ESP SSAR, Revision 5. The scope of the staff's review under NUREG-0800, Section 3.7 was limited to the evaluation of maximum seismic demands for use in sliding and overturning stability evaluations.

3.7.1 Seismic Design Parameters

3.7.1.1 Introduction

The input seismic design ground motion response spectra (GMRS) for the SSE in the free field at plant grade is addressed. The horizontal and vertical design GMRS for the AP1000 were developed based on the response spectra in Revision 1 of RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," with consideration of high-frequency amplification effects.

The bases for the seismic design of safety-related SSCs and equipment include the following:

- Design GMRS
- Design ground motion time histories
- Percentage of critical damping values
- Supporting media for seismic Category I structures
- COL action items

3.7.1.2 Summary of Application

Section 3.7 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.7, of the AP1000 DCD, Revision 17. Section 3.7 of the DCD includes Section 3.7.1.

In addition, in VEGP COL FSAR Section 3.7, the applicant provided the following:

Supplemental Information

- VEGP SUP 3.7-3

The applicant provided supplemental information in VEGP SUP 3.7-3 by adding Section 3.7.1.1.1 to the VEGP COL FSAR, which addresses plant-specific GMRS. The portion of VEGP SUP 3.7-3 evaluated here is the technical basis used for the damping values selected by the applicant. The portion applicable to the evaluation of site-specific analyses for developing in-structure response spectra (ISRS) is reviewed in Section 3.7.2 of this SER.

3.7.1.3 Regulatory Basis

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the seismic design parameters are given in Section 3.7.1 of NUREG-0800.

3.7.1.4 Technical Evaluation

The NRC staff reviewed Section 3.7 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 seismic design parameters. 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.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 3.7-3

The applicant provided supplemental information in VEGP SUP 3.7-3 by stating that the site-specific GMRS for VEGP, given in VEGP COL FSAR Chapter 2, are not entirely bounded by the certified seismic design response spectrum (CSDRS) ground acceleration level given in the AP1000 DCD and that there are exceedances above the CSDRS. VEGP COL FSAR Section 3.7.1.1.1 states that a site-specific seismic evaluation is performed to demonstrate that the AP1000 plant designed for the CSDRS is acceptable for the VEGP site. It is stated that the results from the VEGP site-specific analysis that demonstrate the acceptability of the VEGP site are given in VEGP ESP SSAR, Appendix 2.5E.

The VEGP COL FSAR cites VEGP ESP SSAR, Section 2.5E, Section 5.1, "2-D SASSI Analyses and Parameter Studies," (Report SVO-1000-S2R-802) in concluding that the 2-D analyses demonstrate that VEGP Units 3 and 4 seismic design is within the SSE design response spectra level of the CSDRS at VEGP's plant grade.

The VEGP site-specific GMRS are applied in the free-field at plant grade and the foundation input response spectra (FIRS) are developed at the foundation depth of 40 feet (ft) below final grade (-40 ft). There are exceedances above the CSDRS; therefore, a plant-specific seismic evaluation is performed to demonstrate that the AP1000 plant designed for the CSDRS is acceptable for the VEGP site.

As part of the LWA-1 review, the critical damping values used in the applicant's 2-D analyses were found by the staff to be acceptable in Section 3.7.1 of NUREG-1923 for sliding and overturning calculations. However, critical damping values can have an effect on the in-structure floor response used for equipment selection. The critical damping values for the NI structural GMRS-based response analysis may not be the same as the damping values utilized for the CSDRS analyses in the AP1000 DCD. In Table 1 of RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1, the damping values are for structural stress states near code limits. As discussed in RG 1.61, Section 1.2, the GMRS response levels, when expected to be significantly less than the AP1000 DCD CSDRS-based response, may necessitate the use of smaller damping values corresponding to Table 2 of RG 1.61. The GMRS seismic response is indeed significantly less than the CSDRS seismic response as demonstrated in Figures 5.1-1 through 5.1-18 of the VEGP ESP SSAR. As stated in RG 1.61 for response spectra generation, it is necessary to utilize damping-compatible structural response.

To address this concern, the staff issued RAI 3.7.2-2 to request that the applicant provide a plant-specific technical basis for the use of damping values that are higher than the OBE values specified in RG 1.61.

In response to RAI 3.7.2-2, the applicant has performed a site-specific system for analysis of soil structure interaction (SASSI) soil-structure interaction (SSI) analysis using a 3-D model that uses OBE damping values of 4 percent. At low frequencies, less than 1 Hertz (Hz), there are exceedances at a limited number of locations in the structure where the VEGP site-specific ISRS exceeds the AP1000 design ISRS. The impacts of these exceedances on the design of the supported SSCs have been evaluated; and the justification provided by the applicant

insured that the AP1000 design has not been compromised. The results of the evaluation are included in the VEGP COL FSAR as Appendix 3GG. This evaluation confirms that the AP1000 design is applicable to the VEGP site.

3.7.1.5 Post Combined License Activities

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

3.7.1.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the seismic design parameters, 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.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the guidance in Section 3.7.1 of NUREG-0800. The staff based its conclusion on the following:

- VEGP SUP 3.7-3 is acceptable because the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDC 2, Appendix S, 10 CFR Part 100 and the guidance in Section 3.7.1 of NUREG-0800.

3.7.2 Seismic System Analysis

3.7.2.1 Introduction

Seismic analysis methods and acceptance criteria for all seismic Category I SSCs are described. It includes a review of basic assumptions, procedures for modeling, seismic analysis methods, development of ISRS envelopes, consideration of torsional effects, evaluation of overturning and sliding of seismic Category I structures, and determination of composite damping. The effects of SSI to the seismic responses of the NI structures are included in the review scope because the VEGP site is considered a soft-soil site (e.g., shear wave velocity of 1,000 feet per second (fps) at foundation elevation). The review also covered design criteria and procedures for evaluating the interaction of NS Category I structures with seismic Category I structures and the effects of parameter variations on floor response spectra (FRS).

Specifically, the criteria and methods for the seismic analysis of safety-related SSCs and equipment include the following:

- Seismic analysis methods
- Natural frequencies and response loads
- Procedures used for analytical modeling
- SSI
- Development of FRS
- Three components of earthquake motion
- Combination of modal responses
- Interaction of NS Category II structures with seismic Category I SSCs

- Effects of parameter variations on FRS
- Use of constant vertical static factors
- Method used to account for torsional effects
- Methods for seismic analysis of dams
- Determination of seismic Category I structures overturning moments
- Analysis procedure for damping

3.7.2.2 Summary of Application

Section 3.7 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.7 of the AP1000 DCD, Revision 17. Section 3.7 of the DCD includes Section 3.7.2.

In addition, in VEGP COL FSAR Section 3.7.2, the applicant provided the following:

Supplemental Information

- VEGP SUP 3.7-3

The applicant provided supplemental information in VEGP SUP 3.7-3 by adding Section 3.7.1.1.1 to the VEGP COL FSAR, which addresses plant-specific GMRS. The portion of VEGP SUP 3.7-3 evaluated here is the site-specific analyses for developing ISRS.

AP1000 COL Information Items

- VEGP COL 3.7-1

The applicant provided additional information in VEGP COL 3.7-1 regarding seismic analysis of dams near the site, to address COL Action Item 3.7.2.13-1 identified in NUREG-1793, Appendix F, and COL Information Item 3.7-1 discussed in Section 3.7.5.1 of the AP1000 DCD.

- STD COL 3.7-3

The applicant provided additional information in STD COL 3.7-3 to address COL Action Item 3.7.5-3 identified in NUREG-1793, Appendix F, and COL Information Item 3.7-3 discussed in Section 3.7.5.3 of the AP1000 DCD. Since the information added by STD COL 3.7-3 is the subject of a proposed license condition (Part 10, License Condition 2, Item 3.7-3, see below), this COL item will not be discussed further in this SER.

- STD COL 3.7-4

The applicant provided additional information in STD COL 3.7-4 to address COL Action Item 3.7.5-1 identified in NUREG-1793, Appendix F, and COL Information Item 3.7-4 discussed in Section 3.7.5.4 of the AP1000 DCD. Since the information added by STD COL 3.7-3 is the subject of a proposed license condition (Part 10, License Condition 2, Item 3.7-4, see below), this COL item will not be discussed further in this SER.

License Conditions

- Part 10, License Condition 2, Item 3.7-3

The applicant has proposed a license condition requiring a seismic interaction review for as-built information. This review is performed in parallel with the seismic margin evaluation **and will follow the methodology in Section 3.7.5.3 of the AP1000 DCD**. The review is based on as-procured data, as well as the as-constructed condition. The as-built seismic interaction review is to be completed prior to fuel load.

- Part 10, License Condition 2, Item 3.7-4

The applicant has proposed a license condition requiring a seismic analysis for detail design changes, such as those due to as-procured or as-built changes in component mass, center of gravity, and support configuration based on as-procured equipment information. The reconciliation of seismic analysis of NI structures will be complete prior to fuel load.

3.7.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the seismic system analysis are given in Section 3.7.2 of NUREG-0800.

3.7.2.4 Technical Evaluation

The NRC staff reviewed Section 3.7 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 seismic system analysis. 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.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 3.7-3

The applicant provided supplemental information in VEGP SUP 3.7-3 by adding Section 3.7.1.1.1 to the VEGP COL FSAR, which addresses plant-specific GMRS. The portion of VEGP SUP 3.7-3 evaluated here is the site-specific analyses for developing ISRS.

The VEGP site-specific GMRS are applied in the free-field at plant grade and the FIRS are developed at the foundation depth (40 ft).

There are exceedances above the CSDRS; therefore, a plant-specific seismic evaluation is performed to demonstrate that the AP1000 plant designed for the CSDRS is acceptable for the

VEGP site. The applicant, in VEGP COL FSAR Section 3.7.1.1.1 states that the 2-D site-specific analysis sufficiently demonstrates that the generic AP1000 DCD CSDRS analysis is adequate based on comparisons of in-structure amplified response spectra (ARS) generated by the 2-D generic AP1000 CSDRS (Appendix 3G, Section 3G.3) and the site-specific 2-D response analyses at critical selected nodes (see Table 5.1-1 of Site-Specific Seismic Evaluation Report SVO-1000-S2R-802).

The generic AP1000 DCD seismic analysis is based on detailed 3-D response analysis while the site-specific analyses are two-dimensional (horizontal and vertical responses). The site-specific report (SVO-1000-S2R-802) cites WEC Technical Report, APP-GW-S2R-010, TR-3, "Extension of Nuclear island Seismic Analyses to Soil Sites." Section 6.1 of TR-3 states that using 2-D models is adequate and conservative for horizontal response comparisons; however, using the shell model (3-D) allows the development of design response spectra that reflect the seismic response across an elevation (floor) that is more realistic, and that in using the shell model more realistic vertical seismic response spectra are developed.

AP1000 DCD Section 2.5.2.1 states that 2-D SASSI results should be compared to the 2-D CSDRS results in AP1000 DCD Appendix 3G; however, no 2-D-based vertical response spectra are given in Appendix 3G. In addition, this section concludes that if the results are not clearly enveloped then a 3-D analysis is indicated. Referring to the figures in Section 6.1 of TR-3, the vertical responses for the 2-D response analysis are significantly, and unconservatively, under-predicted in selected frequency ranges in the vertical (Z) direction when compared to the 3-D response analysis.

To address this issue, the staff issued RAI 3.7.2-1, requesting that the applicant justify the adequacy of the 2-D SSI models. In response, the applicant submitted a summary report entitled, "3-D SSI Analysis of AP1000 at Vogtle Site Using NI15 Model for VEGP Units 3 and 4," which provides a description of the VEGP site-specific 3-D SSI analysis. The details of the NI structural modeling are described in Section 5, "Structural Model." Section 5 states that the AP1000 structural model used for VEGP site-specific SSI analysis is a 3-D finite element model defined as NI15, developed by WEC. The report stated that the NI15 was verified by WEC by assuring that the mass distribution, the modal behavior and FRS results were consistent in ANSYS with WEC's most detailed model, NI10, used for hard rock.

Upon review of the applicant's response, the staff issued an additional RAI, RAI 3.7.2-3, requesting that the applicant provide: 1) the details of the applicant's comparison of the NI15 and NI10 model results (referenced in Section 5 of the aforementioned report); 2) the details of the applicant's comparison of the NI15 and NI20 SASSI model results; and 3) whether the applicant's use of the NI15 model constitutes a departure from the AP1000 DCD. The applicant's responses were included in two separate Southern Nuclear Operating Company (SNC) letters, NRC ND-09-0331, dated March 2, 2009, which addressed RAI 3.7.2-1 and NRC ND-09-1040, dated July 1, 2009, which addressed RAI 3.7.2-3.

The applicant performed an additional, VEGP site-specific, SASSI SSI analysis using a refined 3-D model of the NI (referred to as the NI15 model) developed from the standard 3-D NI20 model used in the AP1000 DCD analyses. The refined model was intended to capture the high frequency range of response where the VEGP GMRS exceeds the AP1000 CSDRS given the soil profile at the VEGP site. Unlike the 2-D SSI analyses, which were considered to be inappropriate, the 3-D results were consistent with the approach used in the AP1000 DCD seismic analyses and provided an appropriate basis for comparison with the AP1000 DCD ISRS.

The analyses considered the variation in soil properties consistent with the NUREG-0800 requirements and incorporated the RG 1.61 OBE level structural damping of 4 percent. Additionally the adequacy of the SSI input motion was checked following the requirements in two Nuclear Energy Institute (NEI) documents, a draft white paper, "Consistent Site-Response/Soil-Structure Interaction Analysis and Evaluation," and the "White Paper in Support of New Plant Applications."

The results of the VEGP site-specific 3-D SSI analysis ISRS were compared with the enveloping 3-D CSDRS-based ISRS, which showed overall large margin at six key locations in the NI structures. The VEGP 3-D SSI analyses ISRS showed small exceedances in a narrow low frequency range at two locations high in the NI structure in the East-West direction. An evaluation of the structural and system components was performed to confirm that the minor exceedances at about 2 Hz at higher elevation have no impact on the design.

The applicant concluded that the site-specific three-dimensional SSI analysis confirmed that the AP1000 design is applicable to the VEGP site and added a summary report, "3-D SSI Analysis of AP1000 at Vogtle Site Using NI15 Model for VEGP Units 3 and 4," dated February 2009, to VEGP COL FSAR Section 3.7.1 as Appendix 3GG. Although, Interim Staff Guidance (ISG)-1, "Interim Staff Guidance on Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combined License Applications," requires that SSI analyses be performed to at least a frequency of 50 Hz, the review of the summary report showed that the SSI analyses was cut off at 15, 17, and 30 Hz for the lower bound, best estimate, and upper bound soil cases, respectively. In spite of the low cutoff frequency used in the analyses, the staff has made an assessment, based on experience and judgment, that the SSI analyses performed are sufficient to demonstrate that ISRS for the VEGP site-specific analyses are enveloped by the AP1000 DCD ISRS at high frequency. The summary report described the evaluation of the VEGP ISRS exceedances over the AP1000 DCD ISRS frequencies less than about 2 Hz. The considerations evaluated in making the judgment that the cut off frequency used will not change the conclusion of the summary report were based on the following:

(1) cutting off the analyses at frequencies as low as 15 Hz won't affect the computed low frequency regions of the ISRS;

(2) significant margin exists between the site-specific VEGP ISRS and the AP1000 DCD ISRS at high frequency;

(3) experience with SSI analyses at similar sites with similar footprint size and embedment indicate that the high frequency response is not significantly amplified for these type structures; and

(4) the upper bound, with frequencies computed to 30 Hz, about twice that of the lower bound and best estimate cases, shows little increase in ISRS at high frequency.

In addition to the response to RAI 3.7.2-1, the applicant responded to the three questions in RAI 3.7.2-3 by providing a comparison of the fixed base responses for each of the three models described, NI10, NI15, and NI20. The comparisons demonstrated dynamic equivalence between the models. Additionally, the applicant provided a basis for the use of site-specific evaluations that are permitted by Tier 1; thereby, justifying that the use of the NI15 model does not constitute a departure from the AP1000 DCD.

Though the staff considered the applicant's response to RAI 3.7.2-3 to be acceptable, because of the changes to the AP1000 NI20 SASSI model concerning the shield building design changes, the staff requested that the applicant verify that the modeling corrections have been adequately addressed by comparing the VEGP site-specific 3-D SSI results developed from the revised 3-D NI20 model, with the enveloping 3-D CSDRS-based ISRS.

The applicant provided a supplemental response to the staff concern in a letter dated October 15, 2010. The applicant stated that Westinghouse revised the NI20 SASSI model to incorporate the recent shield building design changes and made corrections to the NI20 SASSI model. Subsequently, Westinghouse reran the NI10 ANSYS and the NI20 SASSI models and developed a revised AP1000 CSDRS broadened envelope ISRS.

As a result to the changes to the AP1000 NI20 SASSI model and the revised AP1000 CSDRS broadened ISRS, the applicant updated its NI15 SASSI model to reflect those changes. The changes to the VEGP NI15 SASSI model to account for the modeling changes to the NI20 SASSI model include:

1. Updated the properties of the shield building walls and air-inlet.

2. Modeling corrections to the Westinghouse AP1000 NI20 SASSI model: beam to solid element connectivity and improve the stress distribution in the basemat. There were no issues with VEGP NI15 SASSI model because the NI15 connections were properly modeled between the solid element and the beam elements. The NI15 model used solid elements for the entire basemat, thus, there were no issues with the stress distribution of the basemat interface between the auxiliary building and the containment internal surface.

3. The NI20 SASSI model was revised to account for stiffness due to out-of-plane flexure where the walls, which are modeled as the shell elements, connect to the floors, which are modeled as solid elements. Accordingly, the VEGP NI15 SASSI model was revised by extending the wall shell elements the depth of one solid element to capture the effect of out-of-plane flexural stiffness.

The applicant reran the SASSI analyses using the updated VEGP NI15 SASSI model to generate revised VEGP ISRS at the six key locations for the VEGP soil profile cases: Lower bound, best estimate, and upper bound. The applicant provided detail analyses by comparing the 5 percent damped ISRS to the revised AP1000 CSDRS broadened envelope ISRS.

The staff observed that the revised AP1000 CSDRS broadened envelope ISRS at the six key locations has changed such that above 1 Hz there are no exceedances by the revised VEGP NI15 SASSI ISRS. Below 1 Hz, there were exceedances near 0.55 Hz, which have shown to have no impact on the AP1000 design.

The NRC staff concluded that the site-specific SSI analyses performed by the applicant to evaluate exceedances between the GMRS and the CSDRS demonstrated that the AP1000 DCD design is adequate for use at the VEGP site.

The applicant showed that the AP1000 DCD ISRS envelopes the VEGP site-specific ISRS, with the exception of exceedances in the low frequency range higher up in the NI structure. The exceedances in the site-specific ISRS have been evaluated and justified that the minor exceedances would not impact the AP1000 DCD design. The staff concluded that the use of

cutoff frequencies lower than those required by ISG-1 do not affect the conclusion that the AP1000 DCD ISRS are adequate for design at the VEGP site.

In its October 15, 2010, letter, the applicant provided a proposed revised VEGP COL FSAR Appendix 3GG, which shows the 5 percent damped VEGP ISRS compared to the revised AP1000 CSDRS broadened envelope ISRS at the six key locations. The incorporation of the planned changes to the VEGP COL FSAR will be tracked as **Confirmatory Item 3.7-1**.

AP1000 COL Information Item

- VEGP COL 3.7-1

The NRC staff reviewed the resolution to the COL information item related to the evaluation of existing and new dams included under Section 3.7.2.12 of the VEGP COL FSAR.
VEGP COL 3.7-1 addresses the evaluation of existing and new dams whose failure could affect the site interface flood level specified in AP1000 DCD Section 2.4.1.2. The applicant references VEGP ESP SSAR Section 2.4.1.2.4 for the details of the evaluation. The applicant states that the U.S. Army Corps of Engineers has no current plans for the construction of additional reservoirs on the Savannah River. The staff already reviewed Section 2.4.1.2.4 of the VEGP ESP SSAR and found the information included therein to be acceptable as documented in NUREG-1923. Therefore, the NRC staff finds the information added to the VEGP COL FSAR by VEGP COL 3.7-1 to be acceptable.

License Conditions

- Part 10, License Condition 2, Item 3.7-3

The applicant has proposed a license condition requiring a seismic interaction review by the licensee for as-built information. This review is performed in parallel with the seismic margin evaluation. The review is based on as-procured data, as well as the as-constructed condition. The as-built seismic interaction review is to be completed prior to fuel load. The Staff has reviewed and approved this review methodology in Section 3.7.5.3 in the AP1000 DCD. Therefore, the staff finds the proposed License Condition 2 acceptable.

- Part 10, License Condition 2, Item 3.7-4

The applicant has proposed a license condition requiring a seismic analysis for detail design changes, such as those due to as-procured or as-built changes in component mass, center of gravity, and support configuration based on as-procured equipment information. The reconciliation of seismic analysis of NI structures will be performed by the licensee and will be complete prior to fuel load.

Conducting the seismic interaction review and the seismic analysis for detail design changes based on as-procured data, as well as the as-constructed condition, does not alter the methods of seismic evaluation required to ensure the as-built design parameters are consistent with the standard design and have been reviewed by the staff as part of VEGP COL 3.7-1, as well as the information incorporated by reference from the AP1000 DCD. In addition, the NRC staff understands and agrees with the need to have as-procured data and the as-constructed condition in order to properly conduct these analyses.

3.7.2.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the staff proposes to include the following license conditions:

- License Condition (3-2) – Prior to initial fuel load, the seismic interaction review will be updated by the licensee for as-built information. This review is performed in parallel with the seismic margin evaluation. The review is based on as-procured data, as well as the as-constructed condition.

- License Condition (3-3) - Prior to initial fuel load: The licensee will reconcile the seismic analyses described in Section 3.7.2 of the DCD for detail design changes, such as those due to as-procured or as-built changes in component mass, center of gravity, and support configuration based on as-procured equipment information. Deviations are acceptable based on an evaluation consistent with the methods and procedure in Section 3.7 of the DCD provided that the amplitude of the seismic FRS, including the effect due to these deviations, does not exceed the design basis FRS by more than 10 percent.

3.7.2.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the seismic system analysis, 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.

In addition, the staff concludes that, pending closure of **Confirmatory Item 3.7-1**, the relevant information presented in the VEGP COL FSAR is acceptable and meets the guidance in Section 3.7.2 of NUREG-0800. The staff based its conclusion on the following:

- VEGP SUP 3.7-3 is acceptable because the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDC 2, Appendix S, 10 CFR Part 100 and the guidance in Section 3.7.2 of NUREG-0800.

- VEGP COL 3.7-1 is acceptable because the staff has reviewed and accepted the information related to the evaluation of existing and new dams in Section 2.4.1.2.4 of NUREG-1923.

3.7.3 Seismic Subsystem Analysis

Seismic input motion, seismic analysis methods, and modeling procedure used for the analysis and design of AP1000 SC-I subsystems are described. In particular, this review focused on such subsystems as the miscellaneous steel platforms, steel frame structures, tanks, cable trays and supports, heating, ventilation, and air conditioning (HVAC) ductwork and supports, and conduit and supports.

Specifically, the criteria and methods for the seismic analysis of safety-related SSCs and equipment include the following:

- Seismic analysis methods
- Determination of number of earthquake cycles
- Procedures used for modeling
- Basis for selection of frequencies
- Equivalent static load method of analysis
- Three components of earthquake motion
- Combination of modal responses
- Analysis procedure for piping
- Vertical static factors
- Torsional effect of eccentric mass
- Seismic Category I buried piping systems and tunnels
- Interaction of other systems with seismic Category I systems
- Seismic analysis of reactor internals
- Analysis procedure for damping
- Analysis of seismic Category I tanks
- Time history analysis of piping systems

Section 3.7.3 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.7.3 of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.7.4 Seismic Instrumentation

3.7.4.1 Introduction

Installation of instrumentation that is capable of adequately measuring the effects of an earthquake at the plant site is addressed. The criteria for the seismic instrumentation include the following:

- Comparison with RG 1.12, "Nuclear Power Plant Instrumentation for Earthquakes," Revision 2
- Location and description of instrumentation
- Control room operator notification
- Comparison of measured and predicted responses
- Tests and inspections

3.7.4.2 Summary of Application

Section 3.7 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.7 of the AP1000 DCD, Revision 17. Section 3.7 of the DCD includes Section 3.7.4.

In addition, in VEGP COL FSAR Section 3.7.4, the applicant provided the following:

AP1000 COL Information Items

- STD COL 3.7-2

In a letter dated October 15, 2010, the applicant proposed STD COL 3.7-2 in Section 3.7.4.4 of the VEGP COL FSAR to address the measurement of the post-seismic event gaps between the new fuel rack and walls of the new fuel storage pit, between the individual spent fuel racks, and from the spent fuel racks to the spent fuel pool walls.

- VEGP COL 3.7-2

The applicant provided additional information in VEGP COL 3.7-2 in Section 3.7.4.4 to resolve COL Information Item 3.7-2 (COL Action Item 3.7.5-2) on post-earthquake procedures to compare measured and predicted ground motions. In VEGP COL 3.7-2, the applicant also stated that post-earthquake operating procedures utilize the guidance of Electric Power Research Institute (EPRI) Reports NP-5930, TR-100082, and NP-6695, as modified and endorsed by the NRC in RG 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Postearthquake Actions" and RG 1.167, "Restart of a Nuclear Power Plant Shut Down by a Seismic Event." A response spectrum check up to 10Hz will be based on the foundation instrument. The cumulative absolute velocity (CAV) will be calculated based on the recorded motions at the free field instrument. If the OBE ground motion is exceeded or significant plant damage occurs, the plant must be shutdown in an orderly manner.

- VEGP COL 3.7-5

The applicant provided additional information in VEGP COL 3.7-5 in Section 3.7.4.2.1 to resolve COL Information Item 3.7-5 (COL Action Item 3.7.5-4) on free field triaxial acceleration sensors. In VEGP COL 3.7-5, the applicant stated that a free-field sensor will be located and installed within the protected area to record the ground surface motion representative of the site. It will be located on the ground surface of the engineered backfill, which supports the NI and adjacent structures. The applicant further stated that the free-field sensor will be located where the backfill vertically extends from the top of the Blue Bluff Marl to the ground surfaces, but horizontally at a distance where the possible effects on recorded ground motion associated with surface features, buildings, and components would be minimized.

Supplemental Information

- STD SUP 3.7-1

The applicant provided supplemental information in VEGP COL FSAR Section 3.7.4.1 to address the requirements of RG 1.12 by stating that administrative procedures define the maintenance and repair of the seismic instrumentation to keep the maximum number of instruments inservice during plant operation and shutdown.

- STD SUP 3.7-2

The applicant provided supplemental information in VEGP COL FSAR Section 3.7.4.5 to address the test and inspection requirements for the acceleration sensors. In this section, the applicant stated that installation and acceptance testing of the triaxial acceleration sensors described in DCD Section 3.7.4.2.1 is completed prior to initial startup. Installation and acceptance testing of the time-history analyzer described in DCD Section 3.7.4.2.2 is completed prior to initial startup.

3.7.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for seismic instrumentation are given in Section 3.7.4 of NUREG-0800.

The regulatory guidance documents for VEGP COL 3.7-2 and VEGP COL 3.7-5 are RG 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post Earthquake Actions," and RG 1.167, "Restart of a Nuclear Power Plant Shut Down by a Seismic Event," and RG 1.12, "Nuclear Power Plant Instrumentation for Earthquakes" which requires installation of free field triaxial acceleration sensors and establishment of post earthquake procedures to comparing measured and predicted responses.

3.7.4.4 Technical Evaluation

The NRC staff reviewed Section 3.7.4 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 seismic instrumentation. 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.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Items

- STD COL 3.7-2

As a result of the review in Sections 9.1.1.2 and 9.1.2.2 of the AP1000 DCD, STD COL 3.7-2 in Section 3.7.4.4 of the VEGP COL FSAR was identified to clarify the measurement of the post-seismic event gaps between the new fuel rack and walls of the new fuel storage pit, between the individual spent fuel racks, and from the spent fuel racks to the spent fuel pool wall. In a letter dated October 15, 2010, the applicant committed to specify the site-specific procedures, following the guidance of EPRI Reports NP-5930, TR-10082, and NP-6695, for: 1) checking the gaps between the new fuel rack and walls of the new fuel storage pit, between the individual spent fuel racks, and from the spent fuel racks to the spent fuel pool walls following an earthquake; and 2) to take, if needed, appropriate corrective actions in the event of

an earthquake such as repositioning the racks or analysis of the as-found condition. The staff considered the applicant response to be acceptable based on the applicant's commitment to use the post-earthquake procedures described in Section 3.7.5.2 of the AP1000 DCD, which comply with the requirements of Appendix S to 10 CFR Part 50. Therefore, the NRC staff considers STD COL 3.7-2 to be resolved. The incorporation of the planned VEGP COL FSAR changes will be tracked as **Confirmatory Item 3.7-2**.

- VEGP COL 3.7-2

The NRC staff reviewed VEGP COL 3.7-2 related to COL Information Item 3.7-2 (COL Action Item 3.7.5-2) included under Section 3.7.4.4 of the VEGP COL FSAR.

The applicant provided additional information in VEGP COL 3.7-2 to resolve COL Information Item 3.7-2. COL Information Item 3.7-2 states:

> Combined License applicants referencing the AP1000 certified design will prepare site-specific procedures for activities following an earthquake. These procedures will be used to accurately determine both the response spectrum and the cumulative absolute velocity of the recorded earthquake ground motion from the seismic instrumentation system. The procedures and the data from the seismic instrumentation system will provide sufficient information to guide the operator on a timely basis to determine if the level of earthquake ground motion requiring shutdown has been exceeded. The procedures will follow the guidance of EPRI Reports NP-5930, TR-100082, and NP-6695, as modified by the NRC staff.

The commitment was also captured as COL Action Item 3.7.5-2 in Appendix F of NUREG-1793, which states:

> The COL applicant will specify site-specific procedures for activities following an earthquake and those procedures will follow the guidance of Reports NP-5930, TR-100082, and NP-6695 promulgated by the Electric Power Research Institute (EPRI).

In VEGP COL 3.7-2, the applicant stated the following:

> Post-earthquake operating procedures utilize the guidance of EPRI Reports NP-5930, TR-100082, and NP-6695, as modified and endorsed by the NRC in Regulatory Guides 1.166 and 1.167. A response spectrum check up to 10Hz will be based on the foundation instrument. The cumulative absolute velocity will be calculated based on the recorded motions at the free field instrument. If the operating basis earthquake ground motion is exceeded or significant plant damage occurs, the plant must be shutdown in an orderly manner.

The NRC staff reviewed the resolution to VEGP COL 3.7-2 related to comparison of measured and predicted seismic responses included under Section 3.7.4.4 of the VEGP COL FSAR. The applicant committed to specify site-specific procedures, which follow the guidance of EPRI Reports NP-5930, TR-10082, and NP-6695, for activities following an earthquake, which were endorsed by RGs 1.166 and 1.167. In RAI 3.7.4-1, issued to the BLN applicant, the staff asked the applicant to clarify if CAV will be used as one of the criteria to determine if a power plant should be shutdown should the OBE ground motion be exceeded or significant plant damage

occurs. The BLN applicant responded by stating "As indicated in FSAR Subsection 3.7.4.4, use of the guidance of Regulatory Guide 1.166 and NP-5930 signifies that CAV is to be used as one of the post-earthquake criteria for determining whether the plant should be shutdown. In addition, BLN COL FSAR Appendix 1AA indicates conformance to the guidance of Regulatory Guide 1.166." The staff considered the applicant's response to be adequate because the BLN applicant confirmed that it will use the recommended criteria from the RG 1.166 to determine a potential plant shutdown, and the staff concludes that this RAI is closed. Furthermore, the BLN response to RAI 3.7.4-4 was endorsed as standard for VEGP by SNC letter dated December 17, 2008.

Based on the VEPG applicant's commitment to use the procedures accepted by NRC for post-earthquake activities and the clarification on the use of CAV in RAI 3.7.4-1, the NRC staff concludes that the applicant provided adequate information regarding the post earthquake activities and procedures to determine if a power plant needs to be shutdown and considers VEGP COL 3.7-2 resolved.

- VEGP COL 3.7-5

The applicant provided additional information in VEGP COL 3.7-5 to resolve COL Information Item 3.7-5 (COL Action Item 3.7.5-4) included under Section 3.7.4.2.1 of the VEGP COL FSAR. COL Information Item 3.7-5 states:

> The Combined License applicant will determine the location for the free-field acceleration sensor as described in [DCD] Subsection 3.7.4.2.1.

The commitment was also captured as COL Action Item 3.7.5-4 in Appendix F of NUREG-1793, which states:

> The COL applicant will determine the location for the free-field acceleration sensor.

In VEGP COL 3.7-5, the applicant stated the following:

> A free-field sensor will be located and installed to record the ground surface motion representative of the site. To be representative of this site in regards to seismic response of structures, systems, and components, the free-field sensor is located on the ground surface of the engineered backfill. The backfill directly supports the Nuclear Island and the adjacent structures and extends out from these structures a significant distance. The free field sensor is located where the backfill vertically extends from the top of the Blue Bluff Marl to the ground surface, but horizontally at a distance where possible effects on recorded ground motion associated with surface features, buildings, and components would be minimized. The trigger value is initially set at 0.01g.

The NRC staff reviewed the resolution to VEGP COL 3.7-5 related to triaxial acceleration sensors included under Section 3.7.4.2.1 of the VEGP COL FSAR. The applicant used the guidance in RGs 1.166 and 1.167 and supplemented information in the DCD with appropriate content, as required by Appendix S to 10 CFR Part 50, "Earthquake Engineering Criteria for Nuclear Power Plants." The applicant also committed to determining the location of the free field acceleration sensor and installing the sensor in a protected area. Based on the applicant's commitment to determine the location of the free-field acceleration sensor and the description of

the location provided in STD COL 3.7-5, the staff concludes that the applicant presented sufficient information on the description and locations of field triaxial acceleration sensors and considers VEGP COL 3.7-5 resolved.

Supplemental information

- STD SUP 3.7-1

The applicant added the following supplemental information at the end of VEGP COL FSAR Section 3.7.4.1 to address RG 1.12:

> Administrative procedures define the maintenance and repair of the seismic instrumentation to keep the maximum number of instruments inservice during plant operation and shutdown in accordance with Regulatory Guide 1.12.

The NRC staff reviewed the resolution to STD SUP 3.7-1 using the guidance in RG 1.12 and in Appendix S to 10 CFR Part 50. Because of the equivalence of the applicant's proposed resolution to the administrative procedures, maintenance and repair plans of RG 1.12, the staff concludes the applicant has adequately resolved STD SUP 3.7-1.

- STD SUP 3.7-2

The applicant added the following supplemental information at the end of VEGP COL FSAR Section 3.7.4.4 to address comparison of measured and predicted responses:

> Installation and acceptance testing of the triaxial acceleration sensors described in DCD Subsection 3.7.4.2.1 is completed prior to initial startup. Installation and acceptance testing of the time-history analyzer described in DCD Subsection 3.7.4.2.2 is completed prior to initial startup.

The NRC staff reviewed the resolution to STD SUP 3.7-2, related to the timing of installation and acceptance testing of the triaxial acceleration sensors described in DCD Section 3.7.4.2.1 for the VEGP site. Because of the equivalence of the proposed resolution of STD SUP 3.7-2 to the general operability guidance for seismic equipment addressed in RG 1.12, RG 1.166 and RG 1.167, the staff concludes the applicant adequately resolved STD SUP 3.7-2.

3.7.4.5 Post Combined License Activities

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

3.7.4.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to seismic instrumentation, 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.

In addition, the staff concludes that, pending closure of **Confirmatory Item 3.7-2,** the relevant information presented in the VEGP COL application is acceptable and meets the requirements of Appendix S to 10 CFR Part 50 and complies with the guidance provided in RGs 1.166, 1.167, and 1.12. The staff based its conclusions on the following:

- STD COL 3.7-2 is acceptable because the applicant has provided sufficient information for satisfying the requirements Appendix S to 10 CFR Part 50 by committing to address the measurement of the post-seismic event gaps between the new fuel rack and walls of the fuel storage pit and to take appropriate corrective actions.

- VEGP COL 3.7-2 is acceptable because the applicant is committed to use the procedures endorsed by RGs 1.166 and 1.167.

- VEGP COL 3.7-5 is acceptable because the applicant has provided sufficient information for satisfying the requirement Appendix S to 10 CFR Part 50 by committing to determining the location of the free field acceleration sensor and installing the sensor in the protected area.

- STD SUP 3.7-1 is acceptable because the applicant is committed to follow RG 1.12, to include developing administrative procedures to define the maintenance and repairing of the seismic instrumentation in order to keep the maximum number of instruments in service during plant operation and shutdown.

- STD SUP 3.7-2 is acceptable because the applicant has provided sufficient information for satisfying the requirement of Appendix S to 10 CFR Part 50 by committing to complete installation and acceptance testing of the seismic instrumentation prior to initial startup.

3.8 Design Of Category I Structures

3.8.1 Concrete Containment

This section is not applicable to the VEGP design, because AP1000 uses a steel containment.

3.8.2 Steel Containment

The steel containment in the AP1000 DCD provides the following information:

- Description of the containment
- Applicable codes, standard, and specifications
- Loads and load combinations
- Design and analysis procedures
- Structural acceptance criteria
- Materials, quality control, and special construction techniques
- Testing and ISI requirements

Section 3.8.2 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.8.2 of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.8.3 Concrete and Steel Internal Structures of Steel or Concrete Containment

Structures inside the containment are not part of the containment pressure boundary. They support the reactor coolant system components and related piping systems and equipment inside the containment. They also provide radiation shielding. The containment internal structures consist of the primary shield wall, reactor cavity, secondary shield walls, in-containment refueling water storage tank (IRWST), refueling cavity walls, operating floor, intermediate floors, and various platforms.

The containment internal structures are constructed by reinforced concrete and structural steel. At the lower elevations conventional concrete and reinforcing steel are used, except that permanent steel forms are used in some areas in lieu of removable forms based on constructability considerations. These steel form modules (liners) consist of steel plates reinforced with steel angle stiffeners and tee sections. The angles and the tee sections are on the concrete side of the plate. Welded studs, or similar embedded steel elements, are attached to the back of the permanent steel form where surface attachments to the plate transfer loads into the concrete. Where these surface attachments are seismic Category I, the portion of the steel form module transferring the load into the concrete is classified as seismic Category I.

Section 3.8.3 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.8.3 of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.8.4 Other Seismic Category I Structures

3.8.4.1 Introduction

The AP1000 DCD defines other seismic Category I structures as the shield building and the auxiliary building.

3.8.4.2 Summary of Application

Section 3.8 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.8 of the AP1000 DCD, Revision 17. Section 3.8 of the DCD includes Section 3.8.4.

In addition, in VEGP COL FSAR Section 3.8.4.3, the applicant provided the following:

Supplemental Information

- VEGP SUP 3.8-2

The applicant provided supplemental information in VEGP SUP 3.8-2, addressing the loads and load combinations. The applicant states that the application of the 48-hour probable maximum

winter precipitation (PMWP) and the 100-year return period ground level snowpack in the roof design of safety-related structures is addressed in VEGP ESP SSAR Section 2.3.1.3.4.

3.8.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for other seismic Category I structures are given in Section 3.8.4 of NUREG-0800.

3.8.4.4 Technical Evaluation

The NRC staff reviewed Section 3.8.4 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 other seismic Category I structures. 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.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 3.8-2

The NRC staff reviewed the resolution of the supplemental information item related to the 100-year return period ground level snowpack and finds that Section 2.3.1.3.4 of the VEGP ESP SSAR states that the 48-hour PMWP is about 147 pounds-force per square foot (lb/ft^2), and that the roof design of safety-related structures with respect to that design basis (147 lb/ft^2) would be described in the COL application. VEGP COL FSAR Section 2.3.1.3.4 states that:

(1) the AP1000 DCD design basis snow load for the roof was 63 lb/ft^2;

(2) the roof will not deflect enough to hold water under the snow load; therefore, ponding of rain water with pre-existing snow pack conditions will not occur; and

(3) the physical arrangement of the AP1000 sloped roof is designed such that the 100-year snow pack will not prevent the winter probable maximum precipitation (PMP) water from draining off the sloped roof system.

Based on its review of the information provided in VEGP COL FSAR Section 2.3.1.3.4, the staff finds that:

(1) the applicant has not adequately addressed the 147 lb/ft^2 PMWP design basis for VEGP while using the AP1000 DCD, which has a roof design basis of 63 lb/ft^2, as stated by the applicant;

(2) no evidence indicating that the AP1000 DCD roofs will not have a ponding problem; and

(3) the AP1000 DCD roofs are relatively flat and thus the rain water is not easily drained off from the roofs.

To address this concern, the staff issued RAI 3.8.4-1 to request that the applicant provide:

(1) the required design basis in lb/ft^2 for the VEGP roof;

(2) the magnitude of the maximum roof deflection under the roof design load for the 100-year snow pack and precipitation extremes at VEGP, and demonstrating no roof ponding problems; and

(3) the evidence that the roofs in the AP1000 DCD was so designed that all the winter PMP water will drain off from the roof.

In response to RAI 3.8.4-1, the applicant stated that the required design basis for the VEGP roof is the same as the design basis for all AP1000 roofs, which is based on a 75 pounds per square foot (lb/ft^2) ground snow load and 63 lb/ft^2 roof design basis.

The staff reviewed the winter precipitation roof loads for the VEGP site in SER Section 2.3.1.4, as part of its evaluation of VEGP SUP 2.3-1. In the evaluation of VEGP SUP 2.3-1, the staff utilized the guidance in 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. In ISG-7, the staff states that an appropriate source for the 100-year return period snowpack is American Society of Civil Engineers (ASCE 7-05), and also provides guidance for converting snowpack depth to a snow load. In SER Section 2.3.1.4, the staff found acceptable the applicant's design snowpack of 10 lb/ft^2, and also found acceptable the applicant's design extreme frozen winter precipitation event of 17.2 lb/ft^2. Both loads are significantly less than roof design basis of 63 lb/ft^2 for all AP1000 roofs.

In addition, the applicant referenced ASCE 7-98, “Minimum Design Loads for Buildings and Other Structures," which states that in Section 8.4, “Ponding Instability,” that the roof slopes of ¼ in/ft or greater are not subject to ponding and do not need to be analyzed for ponding. The applicant stated that all NI buildings have a minimum slope of 2 percent, and, therefore, the AP1000 NI roof design meets the ASCE 7-98 requirements since ¼ in/ft equates to 2 percent slope. Therefore, the applicant concludes that NI roofs are not subject to ponding.

The staff' review of the applicant's position that NI roofs are not subject to ponding included examining the effects of the minimum slope of 2 percent on the potential for ponding, in conjunction with margin between the applicant's design extreme frozen winter precipitation event of 17.2 lb/ft^2 and the AP1000 design basis roof snow load site parameter value of 63 lb/ft^2. The difference between the design roof load and the extreme frozen winter precipitation event is 45.8 lb/ft^2, which is equivalent to approximately 5 in. of water. The staff finds it reasonable that a slope of 2 percent will not result in the accumulation of this amount of water ponding on the building roofs. Therefore, the staff concludes that the design loading value of 63 lb/ft^2 used for the NI roofs at the VEGP site is acceptable.

Based on the above discussion, the staff considers RAI 3.8.4-1 closed and finds VEGP SUP 3.8-2 to be acceptable.

3.8.4.5 Post Combined License Activities

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

3.8.4.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to other seismic Category I structures, 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.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of 10 CFR Part 50, Appendix A. The staff based its conclusion on the following:

- VEGP SUP 3.8-2 is acceptable because the applicant has demonstrated compliance with 10 CFR Part 50, Appendix A, GDCs 1, 2, 4 and 5, "Sharing of structures, systems, and components," for roof loads and load combinations due to precipitation.

3.8.5 Foundations

3.8.5.1 Introduction

The foundation for the NI structures supports the containment building, the shield building, and the auxiliary building, and is a cast-in-place, reinforced concrete structure. The staff reviewed VEGP COL FSAR Section 3.8.5 as part of the applicant's LWA request. The LWA-2 request involved the construction of foundation preparation elements, such as installation of reinforcing steel, sumps and drain lines and other embedded items in the NI foundation base slab, placement of concrete for the NI foundation base slab.

3.8.5.2 Summary of Application

Section 3.8 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.8 of the AP1000 DCD, Revision 17 and Section 3.8.5 of the VEGP ESP SSAR, Revision 5. Section 3.8 of the DCD includes Section 3.8.5.

In addition, in VEGP COL FSAR Section 3.8.5, the applicant provided the following:

Supplemental Information

- VEGP SUP 3.8-1

The applicant provided supplemental information in VEGP SUP 3.8-1, addressing the depth of overburden and depth of embedment.

- VEGP SUP 3.8-3

The applicant provided supplemental information in VEGP SUP 3.8-3, addressing a description of the safety-related backfill, which supports Category I structures.

ESP Variance

- VEGP ESP VAR 1.6-2

This ESP variance (VAR) item proposed two changes to the VEGP ESP SSAR associated with VEGP ESP SSAR Section 3.8.5. The first paragraph of VEGP ESP SSAR Section 3.8.5, which pertains to AP1000 DCD, Revision 15, is not incorporated by reference. The first sentence of the second paragraph of VEGP ESP SSAR Section 3.8.5.1.1 is replaced with the following: "For VEGP Units 3 and 4, the Sprayed-on Waterproofing Membrane is the selected option presented in the DCD."

AP1000 COL Information Items

- VEGP COL 2.5-17

In a letter dated July 1, 2010, the applicant proposed identifying as VEGP COL 2.5-17 the information in Section 3.8.5.1 that addresses the type of waterproofing system to be used for the below grade, exterior walls exposed to flood and groundwater under seismic Category I structures.

- STD COL 3.8-5

In a letter dated August 17, 2010, the applicant proposed STD COL 3.8-5, adding new Sections 3.8.3.7, 3.8.4.7, and 3.8.5.7 to the VEGP COL FSAR, addressing the construction inspection program related to seismic Category I and II structures.

- STD COL 3.8-6

In a letter dated October 1, 2010, the applicant proposed STD COL 3.8-6, adding a new Section 3.8.6.6 to the VEGP COL FSAR, addressing the construction procedure program related to safety-related Category I structures.

Limited Work Authorization

In Part 6, "LWA Request," Revision 1, of the VEGP COL application, the applicant requested certain activities be allowed under a LWA as part of the COL application, in accordance with 10 CFR 50.10(d), "Request for limited work authorization." This LWA request involves installing reinforcing steel, sumps and drain lines and other embedded items in the NI foundation base slab, and placement of concrete for the NI foundation base slab.

ITAAC

- ESP Permit ITAAC

  The applicant incorporated ITAAC (waterproof membrane) identified in early site permit (ESP) application site safety analysis report (SSAR) section 3.8.5 in the VEGP Aplication.

License Condition

- Part 10, License Condition 6

In its letter dated October 1, 2010, the applicant proposed to add another line item to proposed License Condition 6, addressing the availability to NRC inspectors of the schedule for the implementation of construction and inspection procedures related to concrete activities.

3.8.5.3 Regulatory Basis

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for foundations are given in Section 3.8.5 of NUREG-0800.

3.8.5.4 Technical Evaluation

The NRC staff reviewed Section 3.8.5 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 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.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 3.8-1

The information added by VEGP SUP 3.8-1 to the VEGP COL FSAR states that the depth of overburden and depth of embedment are given in VEGP ESP SSAR Section 2.5.4.5. In Section 2.5.4.5.1 of the VEGP ESP SSAR, the applicant states the VEGP plant grade for Units 3 and 4 will be at Elevation (El.) 220 ft above mean sea level (msl) and that the base of the NI foundations for the new units will be about El. 180 ft msl. This level corresponds to a depth of approximately 40 ft below final grade (below El. 220 ft msl). In Section 2.5.4.4 of NUREG-1923, the staff concluded that depth of overburden and depth of embedment chosen by the applicant were acceptable. Since this depth of embedment is the same depth of the AP1000 DCD foundation, the NRC staff considers VEGP SUP 3.8-1 to be resolved.

- VEGP SUP 3.8-3

The information added by VEGP SUP 3.8-3 to the VEGP COL FSAR states that the description of the safety-related backfill, which supports Category I structures, is given in VEGP ESP SSAR Section 2.5.4.5. In Section 2.5.4.4 of NUREG-1923, the staff concluded that the description of the safety-related backfill provided by the applicant was acceptable. Therefore, the NRC staff considers VEGP SUP 3.8-3 to be resolved.

ESP Variance

- VEGP ESP VAR 1.6-2

The applicant incorporated by reference Section 3.8.5 of the VEGP ESP SSAR at the end of AP1000 DCD Section 3.8.5.1, with variance VEGP ESP VAR 1.6-2. The variance replaces the first sentence of the second paragraph of VEGP ESP SSAR Section 3.8.5.1.1 with the following: "For VEGP Units 3 and 4, the Sprayed-on Waterproofing Membrane is the selected option presented in the DCD." Section 3.4.1.1.1.1, "Waterproofing," of the AP1000 DCD describes three alternative approaches for limiting the infiltration of subsurface water for seismic Category I structures below grade. The staff reviewed the sprayed-on waterproofing membrane approaches provided in AP1000 DCD Section 3.4.1.1.1.1 and found, in Section 3.8.5 of NUREG-1793 and its supplements, the waterproofing materials and performance requirements to be acceptable based on the use of the applicable industry standards and industry practices. The applicant provided an acceptable waterproofing system that meets the requirement described in Section 3.4.1.1.1.1 of the AP1000 DCD. Therefore, the NRC staff considers VEGP ESP VAR 1.6-2 to be resolved.

AP1000 COL Information Items

- VEGP COL 2.5-17

In a letter dated July 1, 2010, the applicant proposed identifying as VEGP COL 2.5-17 the information in Section 3.8.5.1 that addresses the type of waterproofing system to be used for the below grade, exterior walls exposed to flood and groundwater under seismic Category I structures. The applicant provided a waterproofing system to be used for the below grade, exterior walls exposed to flood and groundwater under seismic Category I structures. The waterproofing membrane will 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 Section 3.4.1.1.1.1 of the AP1000 DCD. Thus, the NRC staff considers VEGP COL 2.5-17 to be resolved. The incorporation of the planned VEGP COL FSAR changes will be tracked as **Confirmation Item 3.8-1**.

- STD COL 3.8-5

In a letter dated August 17, 2010, the applicant proposed STD COL 3.8-5, adding a new Sections 3.8.3.7, 3.8.4.7, and 3.8.5.7 to the VEGP COL FSAR, addressing the construction inspection program related to seismic Category I and II structures. The construction inspection program will be consistent with the maintenance rule (10 CFR 50.65) and guidance in RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," in addressing maintenance requirements for the seismic Category I and seismic Category II structures. The staff concludes that the applicant has provided an acceptable construction inspection program that meets the requirement described in Section 3.8.4.8 of the AP1000 DCD. Therefore, the NRC staff considers STD COL 3.8-5 to be resolved. The incorporation of the planned VEGP COL FSAR changes will be tracked as **Confirmatory Item 3.8-2**.

- STD COL 3.8-6

In a letter dated October 1, 2010, the applicant proposed STD COL 3.8-6, adding a new Section 3.8.6.6 to the VEGP COL FSAR, addressing the construction procedure program related to safety-related Category I structures. The construction procedures program addresses the pre- and post-concrete placement, and use of construction mock-ups for the SC modules. The staff concludes that the applicant has provided an acceptable construction procedures program that meets the requirement described in Section 3.8.4.8 of the AP1000 DCD. Therefore, the NRC staff considers STD COL 3.8-6 to be resolved. The incorporation of the planned VEGP COL FSAR changes will be tracked as **Confirmatory Item 3.8-3**.

LWA Related to Foundation Base Slab

In Part 6 of the VEGP COL application, Revision 1, the applicant submitted details for performing work within the scope of the LWA request in accordance with 10 CFR 50.10(d). The scope of the applicant's LWA request involves: 1) the installation of reinforcing steel, sumps and drain lines and other embedded items in the NI foundation base slab; and 2) the placement of concrete for the NI foundation base slab.

In the LWA request, the applicant stated that the installation of the rebar and other embedded items will be above the mudmats and inside of the mechanically stabilized earth wall, which will serve as the permanent formwork for the NI foundation base slab. Additionally, the applicant stated the design of the NI foundation base slab reinforcing and concrete are in accordance with applicable codes and standards described in the Westinghouse AP1000 DCD Tier 2 Section 3.8, "Design of Category I Structures," and that no additional ITAAC are planned for the rebar and other embedded items and the concrete placement.

The staff used Section 3.8.5 of NUREG-0800 in its review of the applicant's LWA request that addresses the applicant's LWA request to construct the NI foundation base slab. The staff reviewed the applicant proposed scope of work: 1) the installation of reinforcing steel, sumps and drain lines and other embedded items in the NI foundation base slab; and 2) the placement of concrete for the NI foundation base slab for the purpose of safety analyses (i.e., the NI foundation base slab design and the site-specific seismic analysis). The applicant stated that the applicable safety analysis for the requested activities is addressed in the AP1000 DCD, the VEGP ESP SSAR, the VEGP COL FSAR and NUREG-1923. On the basis of its review of the applicable safety analysis as discussed above, the staff finds the applicant proposed scope of work to be acceptable. The staff's bases for accepting the applicant's proposed request was based on the applicant meeting the relevant requirements in 10 CFR 50.55(a), in that the foundation base slab is designed in accordance with American Concrete Institute (ACI)-349. Additionally, as part the AP1000 standard design review, the staff found the detailed design of the foundation base slab and method of construction to be consistent with NUREG-0800 Section 3.8.5 and, therefore, acceptable. The staff's review is described in the AP1000 SER, Section 3.8.5.

Consequently, the staff concludes that the LWA request is consistent with the applicable requirements of 10 CFR 50.10(d) for the installation of the NI foundation base slab, including placement of concrete.

ITAAC

- ESP Permit ITAAC

  To address ESP ITTAC related waterproof membrane, the applicant proposed, in Part 10 of the COL application, certain ITAAC (Waterproof Membrane). Specifically, the applicant stated that the ITAAC identified in ESP SSAR section 3.8.5 is incorporated by reference. The staff reviewed the VEGP ESP SSAR Section 3.8.5 and accepted the waterproof membrane ITAAC, as documented in the SER for the VEGP ESP and LWA applications. To complete the ITAAC, the applicant will conduct testing to confirm that the mudmat-waterproofing interface beneath the Nuclear Island basemat has a minimum coefficient of friction to resist sliding of 0.7. However, because at this time the applicant has not yet completed the previously-approved waterproof membrane ITAAC and thus has not closed the waterproof membrane ITAAC, this ESP ITAAC will be included as ITAAC in the COL License condition

License Condition

- Part 10, License Condition 6

In its letter dated October 1, 2010, the applicant proposed to add another line item to proposed License Condition 6, addressing the availability to NRC inspectors of the schedule for the implementation of construction and inspection procedures related to concrete activities. Specifically, the applicant has proposed to add a new standard item to proposed License Condition 6 to read (where # is the next appropriate letter):

> #. the implementation of construction and inspection procedures for concrete filled steel plate modules activities before and after concrete placement, use of construction mock-ups, and inspection of modules before and after concrete placement as discussed in DCD Subsection 3.8.4.8.

The applicant's proposed new standard item related to concrete construction and inspection procedures will allow the staff sufficient time to inspect the procedures. Therefore, the staff finds the addition of this line item to proposed License Condition 6 acceptable.

3.8.5.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the applicant proposed to include the following license condition:

- License Condition (3-4) – The licensee shall submit to the Director of NRO, a schedule, no later than 12 months after issuance of the COL that supports planning for and conduct of NRC inspections of the construction procedure program. The schedule shall be updated every six months until 12 months before scheduled fuel loading, and every six months thereafter until the construction procedures program has been fully implemented. This schedule include the implementation of construction and inspection procedures for concrete filled steel plate modules activities before and after concrete placement, use of construction mock-ups, and inspection of modules before and after concrete placement as described in AP1000 DCD Section 3.8.4.8.

For the reasons discussed in the technical evaluation section above, the staff proposes to include the following ITTAC

- The licensee shall perform and satisfy the Waterproof Membrane ITAAC defined in Table 3.8-1, Waterproof Membrane ITAAC.

3.8.5.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to 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.

In addition, the staff concludes, pending closure of **Confirmatory Items 3.8-1, 3.8-2, and 3.8-3,** that the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of 10 CFR Part 50, Appendix A. The staff based its conclusion on the following:

- VEGP SUP 3.8-1 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 2.5.4.5 of NUREG-1923. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDCs 1, 2, 4, and 5.

- VEGP SUP 3.8-3 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 2.5.4.4 of NUREG-1923. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDCs 1, 2, 4, and 5.

- VEGP ESP VAR 1.6-2 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 3.8.5 of NUREG-1923. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDCs 1, 2, 4, and 5.

- VEGP COL 2.5-17 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 3.8.5 of NUREG-1923 and Section 3.4.1.1.1.1 of the AP1000 DCD. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDCs 1, 2, 4, and 5

- STD COL 3.8-5 and STD COL 3.8-6 are acceptable because the applicant addressed the relevant information that meets the guidance in Sections 3.8.6.5 and 3.8.4.8 of the AP1000 DCD. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDCs 1, 2, 4, 5, RG 1.160 and 10 CFR 50.65.

3.9 Mechanical Systems and Components

Structural integrity and functional capability of various safety-related mechanical components are described. The design is not limited to ASME Code components and supports, but is extended to other components such as control rod drive mechanisms (CRDMs), certain reactor internals, and any safety-related piping designed to industry standards other than the ASME

Code. The design includes issues as load combinations, allowable stresses, methods of analysis, summary of results, and preoperational testing. The evaluation of this section is focused on determining whether there is adequate assurance of a mechanical component performing its safety-related function under all postulated combinations of normal operating conditions, system operating transients, postulated pipe breaks, and seismic events.

3.9.1 Special Topics for Mechanical Components

In Section 3.9.1, "Special Topics for Mechanical Components," design transients and methods of analysis are described for all seismic Category I components, component supports, core support (CS) structures, and reactor internals designated as Class 1, 2, 3 and CS under ASME Code, Section III, and those not covered by the ASME Code. Also included are the assumptions and procedures used for the inclusion of transients in the design and fatigue evaluation of ASME Code Class 1 and CS components and the computer programs used in the design and analysis of seismic Category I components and their supports, as well as experimental and inelastic analytical techniques.

Section 3.9 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.9.1, "Special Topics for Mechanical Components," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.9.2 Dynamic Testing and Analysis of Systems, Structures and Components

The criteria, testing procedures, and dynamic analyses employed to ensure the structural and functional integrity of piping systems, mechanical equipment, reactor internals, and their supports (including supports for conduit and cable trays, and ventilation ducts) under vibratory loadings, are addressed in this section. The loadings include those due to fluid flow (and especially loading caused by adverse flow conditions, such as flow instabilities over standoff pipes and branch lines in the steam system) and postulated seismic events.

Section 3.9 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.9.2, "Dynamic Testing and Analysis of Systems, Structures and Components," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.9.3 ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures

3.9.3.1 Introduction

The structural integrity and functional capability of pressure-retaining components, their supports, and CS structures are ensured by designing them in accordance with ASME Code, Section III, or other industrial standards. The loading combinations and their respective stress

limits, the design and installation of pressure-relief devices, and the design and structural integrity of ASME Code Class 1, 2, and 3 components and component supports are included.

The criteria for the SSC design include the following considerations:

- Loading combinations, design transients, and stress limits
- Pump and valve operability assurance
- Design and installation criteria of Class 1, 2, and 3 pressure-relieving devices
- Component and piping supports

3.9.3.2 Summary of Application

Section 3.9 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.9 of the AP1000 DCD, Revision 17. Section 3.9 of the DCD includes Section 3.9.3.

In addition, in VEGP COL FSAR Section 3.9.3, the applicant provided the following:

AP1000 COL Information Items

- STD COL 3.9-2

The applicant provided additional information in STD COL 3.9-2 (COL Information Item 3.9-2) that addresses reconciliation of the as-built piping design, to be completed by the COL holder after the construction of the piping systems and prior to fuel load. Evaluation of this particular COL Information Item is provided in Section 3.12 of this SER.

- STD COL 3.9-3

The applicant provided additional information in STD COL 3.9-3 (COL Information Item 3.9-3) that describes snubber design and testing, snubber installation requirements, and snubber preservice and inservice examination and testing.

- STD COL 3.9-5

The applicant provided additional information in STD COL 3.9-5 (COL Information Item 3.9-5) that addresses pressurizer surge line monitoring. Evaluation of this particular COL information item is provided in Section 3.12 of this SER.

- STD COL 3.9-7

In a letter dated April 23, 2010, the applicant proposed to add a new STD COL 3.9-7 to address COL Information Item 3.9-7. This COL item provides additional information on the process to be used to complete the piping design and ITAAC added to verify the design. Evaluation of this particular COL information item is provided in Section 3.12 of this SER.

Supplemental Information

- STD SUP 3.9-3

The applicant provided supplemental information in STD SUP 3.9-3 to describe snubber design and testing and snubber installation requirements.

3.9.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the ASME Code Class 1, 2, and 3 components, component supports, and CS structures are given in Section 3.9.3 of NUREG-0800.

3.9.3.4 Technical Evaluation

The NRC staff reviewed Section 3.9.3 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 functional design of ASME Code Class 1, 2, and 3 components and component supports and CS structures. 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.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the BLN Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. There is a discussion of a difference between the BLN and VEGP FSARs following the standard content material. This standard content material is identified in this SER by use of italicized, double-indented formatting.

The following portion of this technical evaluation section is reproduced from Section 3.9.3.4 of the BLN SER:

AP1000 COL Information Items

- *STD COL 3.9-3 and STD SUP 3.9-3*

AP1000 DCD, Section 3.9.8.3, "Snubber Operability Testing," states that COL applicants referencing the AP1000 design will develop a program to verify operability of essential snubbers as outlined in Section 3.9.3.4.3, "Snubbers Used as Component and Piping Supports," and Section 3.9.3.4.4, "Inspection, Testing, Repair and/or Replacement of Snubbers." In the BLN COL FSAR, the applicant states in Section 3.9.8.3, "Snubber Operability Testing," that STD COL 3.9-3 is addressed in BLN COL FSAR Section 3.9.3.4.4, which incorporates by reference AP1000 DCD Section 3.9.3.4.4, with supplemental snubber information added to the end of the existing Section 3.9.3.4.4.

As indicated in the BLN COL FSAR, STD COL 3.9-3 contains a wide range of supplemental information on snubber design and testing requirements, snubber installation requirements, and snubber preservice and inservice examination and testing. It was not clear to the staff, however, whether STD COL 3.9-3 had provided the required information called for by AP1000 DCD, Section 3.9.8.3. In RAI 3.9.3-1, the staff requested that the applicant address the following: (1) clarify what was meant by "snubber operability testing" when the applicant prepared the COL information; (2) discuss whether the entire STD COL 3.9-3 represents BLN's plant-specific, updated snubber requirements, not already covered in AP1000 DCD, Section 3.9.3; (3) clarify whether all or part of STD COL 3.9-3 is related to snubber operability testing; (4) for the portions of STD COL 3.9-3 which are not related to snubber operability testing, explain why they are included as part of the COL item; (5) discuss all the pertinent codes and standards on which STD COL 3.9-3 is based to assure snubber operability; and (6) discuss the need to modify the content and the physical placement of STD COL 3.9-3 in the BLN COL FSAR.

In its response, the applicant explained that information presented in BLN COL FSAR Section 3.9.3.4.4 regarding snubber testing includes information specific to qualification and installation tests and examinations for snubbers included in the inservice testing (IST) program and preservice examination and testing programs; and information specifically related to snubber inservice examination and testing. The applicant acknowledges, therefore, that not all information added by STD COL 3.9-3 is related specifically to snubber "operability testing." The applicant also noted that BLN COL FSAR Section 3.9.3.4.4 has been subjected to a revision responding to a separate staff RAI on snubber IST programs. Details of the applicant's responses to the RAI are provided in the following:

(1) For the purpose of STD COL 3.9-3, operability testing encompasses the preservice and inservice examinations and testing required by the ASME Code for Operation and Maintenance (OM) for Nuclear Power Plants (ASME OM Code), Subsection ISTD, "Preservice and Inservice Examination and Testing of Dynamic Restraints (Snubbers) in

Light-Water Reactor Nuclear Power Plants" as described in BLN COL FSAR Section 3.9.3.4.4.c and Section 3.9.3.4.4.d (as revised in applicant's response to RAI 3.9.6-3).

(2) In order to provide a complete description of the snubber operability testing program, that is, the preservice and IST programs for snubbers, additional information was provided in BLN COL FSAR Section 3.9.3.4.4 as indicated in the applicant's letter to the NRC in response to RAI 3.9.6-3. Previously, only snubber preservice examination and testing had been described in BLN COL FSAR Section 3.9.3.4.4.c.

(3) As noted above, some of the information provided in the original BLN COL FSAR Section 3.9.3.4.4 relates to snubber qualification testing and examinations and snubber installation verification requirements. These activities are considered precursors to the snubber operability testing that will be conducted in accordance with the ASME OM Code, Subsection ISTD.

(4) The information not specifically related to STD COL 3.9-3 operability testing, i.e., Sections 3.9.3.4.4.a and 3.9.3.4.4.b, should have been labeled as standard supplemental information, using the left margin annotation STD SUP 3.9-3.

(5) Snubber operability testing is to be conducted during implementation of the preservice and ISI and testing programs in accordance with the requirements of the ASME OM Code, Subsection ISTD. As indicated in the first paragraph of BLN COL FSAR Section 3.9.3.4.4, the description of the program provided in the BLN COL FSAR is based on the 2001 Edition through the 2003 Addenda of the ASME OM Code. However, the initial IST program for snubbers will incorporate the latest Edition and Addenda of the ASME OM Code approved in 10 CFR 50.55a(f) on the date 12 months before initial fuel load.

(6) BLN COL FSAR Section 3.9.3.4.4 will be revised as indicated in the Application Revision section of this response to segregate the snubber operability testing from the remaining portions of the section (i.e., the snubber design and qualification testing, and the snubber installation requirements) and to include the appropriate left margin annotation. In addition, to maintain consistency, to the extent possible, with other industry COL applications, Section 3.9.3.4.4.a is revised to clarify and expand on snubber qualification examination and testing. Finally, minor editorial changes are made to the Section 3.9.3.4.4.c changes provided in the applicant's letter to the NRC in response to RAI 3.9.6-3. Additionally, changes will be made to the introductory (roadmap) paragraph for BLN COL FSAR Section 3.9.3.4.4 indicating it is a new subsection to follow DCD Section 3.9.3.4.3.

The staff found that above responses provided by the applicant to be adequate in clarifying that the information for snubber operability testing originally provided in STD COL 3.9-3 was primarily intended for preservice and inservice examination

and testing. The staff also found that the supplemental information provided under a new STD SUP 3.9-3, for snubber design and qualification testing, and the snubber installation requirements includes a better description for snubber design and qualification testing, and is more consistent with other industry COL applications. The staff confirmed that Revision 1 has incorporated all the changes as required. RAI 3.9.3-1 is closed.

Clarification of BLN SER Standard Content

Based on the staff's review of the standard content, there were two minor changes of an editorial nature that were found not to affect the staff's conclusion. The first paragraph discussed in Item (5) above was moved in the final VEGP COL FSAR such that it is appropriately included with the write up specific to STD COL 3.9-3. The introductory (roadmap) paragraph was not changed as described following Item (6) above because the AP1000 DCD was modified to include a paragraph numbered "3.9.3.4.4." As a result, the new text was added to an existing section as opposed to being a standalone section.

Resolution of Difference Between FSARs

In Section 3.9.3.4.4 of the BLN COL FSAR, the BLN applicant stated that a list of snubbers on systems which experience sufficient thermal movement to measure cold to hot position, is included as part of the testing program after piping analysis has been completed. In Section 3.9.3 of the VEGP COL FSAR, the VEGP applicant provides Table 3.9-201 with this list of snubbers. The addition of a list of snubbers on systems which experience sufficient thermal movement to measure cold to hot position to the VEGP COL FSAR is acceptable to the staff.

3.9.3.5 Post Combined License Activities

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

3.9.3.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to ASME Code Class 1, 2, and 3 components, component supports and CS structures, 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.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of 10 CFR Part 52. The staff based its conclusion on the following:

- STD COL 3.9-3 and STD SUP 3.9-3 are acceptable because the applicant addressed the relevant information that meets the guidance in Section 3.9.3 of NUREG-0800. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDCs 1 and 4.

3.9.4 Control Rod Drive System

The control rod drive system (CRDS) consists of the control rods and the related mechanical components that provide the means for mechanical movement. As discussed in GDC 26, "Reactivity control system redundancy and capability" and GDC 27, "Combined reactivity control systems capability," the CRDS provides one of the independent reactivity control systems. The rods and the drive mechanism are capable of reliably controlling reactivity changes either under conditions of anticipated operational occurrences, or under postulated accident conditions. A positive means for inserting the rods is always maintained to ensure appropriate margin for malfunction, such as stuck rods. Because the CRDS is a safety-related system and portions of the CRDS are a part of the RCPB, the system is designed, fabricated, and tested to quality standards commensurate with the safety-related functions to be performed. This provides an extremely high probability of accomplishing the safety-related functions either in the event of anticipated operational occurrences or in withstanding the effects of postulated accidents and natural phenomena such as earthquakes, as discussed in GDC 1, 2, 14, and 29, "Protection against anticipated operational occurrences," and 10 CFR 50.55a. The CRDS includes electro-hydraulic fine-motion control rod drive (FMCRD) mechanisms, the hydraulic control unit (HCU) assemblies, the condensate supply system, and power for FMCRD motors. The system extends inside reactor pressure vessels (RPVs) to the coupling interface with the control rod blades.

Section 3.9 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.9.4, "Control Rod Drive System (CRDS)," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.9.5 Reactor Pressure Vessel Internals

AP1000 reactor internals consist of two major assemblies - the lower internals and the upper internals. The reactor internals provide the protection, alignment and support for the core, control rods, and gray rods to provide safe and reliable reactor operation. In addition, the reactor internals help to accomplish the following: direct the main coolant flow to and from the fuel assemblies; absorb control rod dynamic loads, fuel assembly loads, and other loads and transmit these loads to the reactor vessel; support instrumentation within the reactor vessel; provide protection for the reactor vessel against excessive radiation exposure from the core; and position and support reactor vessel radiation surveillance specimens.

Section 3.9 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.9.5, "Reactor Pressure Vessel Internals," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.9.6 Inservice Testing of Pumps and Valves (Related to RG 1.206, Section C.III.1, Chapter 3, C.I.3.9.6, "Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints")

3.9.6.1 Introduction

In this section, the NRC staff describes its review of the functional design, qualification, and IST programs for pumps, valves, and dynamic restraints as required by the NRC regulations in 10 CFR Part 52 and 10 CFR 50.55a, "Conditions of construction permits, early site permits, combined licenses, and manufacturing licenses," for VEGP Units 3 and 4. RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," discusses the Commission's position provided in SECY-05-0197, "Review of Operational Programs in a Combined License Application and General Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria" that operational programs should be fully described in COL applications to avoid the need to specify ITAAC for those programs. The applicant relies on the VEGP COL FSAR with its incorporation by reference of the AP1000 DCD and supplemental information to fully describe the IST and motor-operated valve (MOV) testing operational programs in support of the COL application for VEGP Units 3 and 4.

3.9.6.2 Summary of Application

Section 3.9 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.9 of the AP1000 DCD, Revision 17. Section 3.9 of the DCD includes Section 3.9.6.

In addition, in VEGP COL FSAR Section 3.9.6, the applicant provided the following:

AP1000 COL Information Item

- STD COL 3.9-4

The applicant provided additional information in several sections of VEGP COL FSAR Section 3.9.6 in response to STD COL 3.9-4 to supplement the AP1000 DCD provisions to fully describe the IST and MOV testing programs for VEGP Units 3 and 4. For example, the VEGP COL FSAR supplements the provisions in the AP1000 DCD with respect to the Edition and Addenda of the ASME OM Code applicable to the description of the IST program for VEGP Units 3 and 4, determination of the MOV testing frequency, operability testing of power-operated valves (POVs) other than MOVs, performance of check valve exercise tests, and plans to apply alternatives to the ASME OM Code. Under STD COL 3.9-3, the applicant supplemented the AP1000 DCD provisions for design, installation, preservice examination and testing, and inservice examination and testing of dynamic restraints (snubbers) in VEGP COL FSAR Section 3.9.3.4.4, "Inspection, Testing, Repair, and/or Replacement of Snubbers."

The AP1000 DCD addresses the functional design and qualification of mechanical equipment to be used at an AP1000 nuclear power plant in several DCD sections. For example, Section 3.9.3.2, "Pump and Valve Operability Assurance," states that criteria are developed to assess the functional capability of required components to operate. Section 3.9.3.2.2, "Valve Operability," indicates that operational tests will be performed to verify that valves open and close prior to installation. This section also specifies cold hydro tests, hot functional tests, periodic ISIs, and periodic inservice operations to be performed in situ to verify the functional capability of the valves. Section 5.4.8, "Valves," includes provisions regarding design and qualification, and preoperational testing of valves within the scope of those systems, and refers

to these activities for other safety-related valves. Section 5.4.8.3, "Design Evaluations," specifies that the requirements for qualification testing of power-operated active valves are based on ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants." Section 5.4.9, "Reactor Coolant System Pressure Relief Devices," includes provisions for design, testing, and inspection of relief devices in the reactor coolant system. Section 5.4.10, "Component Supports," includes provisions for design, testing, and inspection of component supports in the reactor coolant system. The VEGP COL FSAR incorporates by reference these specific sections in the AP1000 DCD.

With respect to flow-induced vibration (FIV) of plant components, AP1000 DCD Section 3.9.2, "Dynamic Testing and Analysis," describes tests to confirm that piping, components, restraints, and supports have been designed to withstand the dynamic effects of steady-state FIV and anticipated operational transient conditions. Section 14.2.9.1.7, "Expansion, Vibration and Dynamic Effects Testing," states that the purpose of the expansion, vibration and dynamic effects testing is to verify that the safety-related, high energy piping and components are properly installed and supported such that, in addition to other factors, vibrations caused by steady-state or dynamic effects do not result in excessive stress or fatigue to safety-related plant systems. The VEGP COL FSAR incorporates by reference these sections in the AP1000 DCD.

AP1000 DCD, Section 3.9.3.4.4, "Inspection, Testing, Repair, and/or Replacement of Snubbers," specifies that a program for inservice examination and testing of dynamic supports (snubbers) to be used in the AP1000 reactor will be prepared in accordance with the requirements of the ASME OM Code, Subsection ISTD, "Preservice and Inservice Examination and Testing of Dynamic Restraints (Snubbers) in Light-Water Reactor Nuclear Power Plants." Section 3.9.3.4.4 indicates that details of the snubber inservice examination and testing program, including test schedules and frequencies, will be reported in the ISI and testing plan included in the IST Program required by Section 3.9.8.3, "Snubber Operability Testing." Section 3.9.8.3 states that COL applicants referencing the AP1000 design will develop a program to verify operability of essential snubbers. The VEGP COL FSAR provides supplemental information for Section 3.9.3.4.4 regarding snubbers. For example, VEGP COL FSAR Section 3.9.3.4.4 includes provisions for snubber design and testing with specifications that snubber qualification and production testing will satisfy the applicable sections of the ASME *Boiler and Pressure Vessel Code* (B&PV Code); the ASME OM Code; and ASME Standard QME-1-2007. VEGP COL FSAR Section 3.9.3.4.4 also describes the inservice examination and testing of safety-related snubbers in accordance with the requirements of the ASME OM Code, Subsection ISTD. The description includes specifications for initial and subsequent examination intervals, visual examination attributes, IST methods and intervals, establishment of snubber test groups, response to examination and test results, snubber repair and replacement, post-maintenance examination and testing, and establishment and monitoring of snubber service life. VEGP COL FSAR Table 3.9-201, "Safety Related Snubbers," provides a list of safety-related snubbers to be installed at VEGP, including the snubber identification number and the associated system or component.

AP1000 DCD, Section 3.9.6, "Inservice Testing of Pumps and Valves," provides a general description of the IST Program to be developed for AP1000 reactors. Table 3.9-16, "Valve Inservice Test Requirements," in AP1000 DCD, lists valves within the scope of the IST Program provided in support of the AP1000 DC, and indicates the valve tag number, valve and actuator type, safety-related missions, safety functions, ASME Code Class and IST Category, and IST type and frequency. VEGP COL FSAR Section 3.9.6 incorporates by reference AP1000 DCD, Section 3.9.6 with supplemental information in several areas. For example, the applicant states

that the description of the IST Program for VEGP Units 3 and 4 is based on the ASME OM Code, 2001 Edition through 2003 Addenda. The applicant also indicates that the initial IST Program will incorporate the latest Edition and Addenda of the ASME OM Code approved in 10 CFR 50.55a(f) on the date 12 months before initial fuel load. In the VEGP COL FSAR, the applicant describes the periodic testing program for POVs other than MOVs that incorporates lessons learned based on nuclear power plant operating experience and research programs for MOV performance. The applicant also indicates its plan to apply Revision 1 to ASME OM Code Case OMN-1, "Alternative Rules for the Preservice and Inservice Testing of Certain Electric Motor-Operated Valve Assemblies in Light Water Reactor Power Plants," as an alternative to the quarterly MOV stroke-time testing provisions in the ASME OM Code, and to satisfy the supplemental requirements specified in 10 CFR 50.55a(b)(3)(ii) to ensure that MOVs continue to be capable of performing their design-basis safety functions. The VEGP COL FSAR does not identify any additional plant-specific valves to be included in the IST Program beyond those listed in AP1000 DCD, Table 3.9-16.

License Conditions

- Part 10, License Condition 3, Items G2 and G5

The applicant proposed a license condition providing the implementation milestones for the Preservice Testing Program and MOV Testing Program.

- Part 10, License Condition 6

The applicant proposed a license condition to provide a schedule to support the NRC's inspection of operational programs including the Preservice Testing Program and MOV Testing Program.

3.9.6.3 Regulatory Basis

The regulatory basis of the design-related information incorporated by reference is addressed in the FSER related to the DCD.

The regulatory basis for the NRC staff's review of the VEGP COL FSAR is provided by 10 CFR Parts 50 and 52. Specifically, the NRC regulations in 10 CFR 52.79(a) require that the COL application include information at a level sufficient to enable the Commission to reach a final conclusion on all safety matters that must be resolved by the Commission before COL issuance. For example, paragraph (4) in 10 CFR 52.79(a) requires that a COL application include the design of the facility with specific reference to the GDC in Appendix A to 10 CFR Part 50, which establish the necessary design, fabrication, construction, testing, and performance requirements for SSCs that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. Paragraph (11) in 10 CFR 52.79(a) requires that a COL application provide a description of the programs and their implementation necessary to ensure that the systems and components meet the requirements of the ASME BPV Code and the ASME OM Code in accordance with 10 CFR 50.55a. Paragraph (29)(i) in 10 CFR 52.79(a) requires that a COL application provide plans for conduct of normal operations, including maintenance, surveillance, and periodic testing of SSCs. Paragraph (37) in 10 CFR 52.79(a) requires that a COL application provide the information necessary to demonstrate how operating experience insights have been incorporated into the plant design.

RG 1.206 provides guidance for a COL applicant in preparing and submitting its COL application in accordance with the NRC regulations. For example, Section C.IV.4 in RG 1.206 discusses the requirement in 10 CFR 52.79(a) for descriptions of operational programs that need to be included in the FSAR for a COL application to allow a reasonable assurance finding of acceptability. In particular, a COL applicant should fully describe the IST, MOV testing, and other operational programs as defined in Commission Paper SECY-05-0197 to avoid the need for ITAAC for the implementation of those programs. The term "fully described" for an operational program should be understood to mean that the program is clearly and sufficiently described in terms for scope and level of detail to allow a reasonable assurance finding of acceptability. Further, operational programs should be described at a functional level and an increasing level of detail where implementation choices could materially and negatively affect the program effectiveness and acceptability. The Commission approved the use of a license condition for operational program implementation milestones that are fully described or referenced in the FSAR as discussed in the SRM for SECY-05-0197, dated February 22, 2006.

The NRC staff followed Section 3.9.6, "Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints," of NUREG-0800 in its review of the VEGP COL application. The staff also compared the VEGP COL FSAR information with the guidance provided in RG 1.206. Appendix 1AA, "Conformance with Regulatory Guides," indicates that the COL application conforms to RG 1.206 without exceptions related to the IST Program. In addition, Table 1.9-202, "Conformance with SRP Acceptance Criteria," in the VEGP COL FSAR indicates that the COL application conforms to NUREG-0800, Section 3.9.6.

3.9.6.4 Technical Evaluation

The NRC staff reviewed Section 3.9.6 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 functional design, qualification and IST programs for pumps, valves, and dynamic restraints. The results of the NRC staff's evaluation of the design-related information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements. The results of the staff's review of the material in the AP1000 DCD related to the IST operational program for pumps, valves, and dynamic restraints are in this SER section.

In its letter dated December 17, 2008, Southern Nuclear Operating Company (SNC) listed the RAIs prepared by the NRC staff on the BLN Units 3 and 4 COL application. In that letter, SNC endorsed the responses, including proposed changes to the FSAR, submitted by the Tennessee Valley Authority (TVA) on 16 RAIs related to the functional design, qualification, and IST programs for pumps, valves, and dynamic restraints as applicable to the VEGP COL application. In letters dated December 14, 2009, and January 12, March 1, and May 14, 2010, SNC described its plans to resolve open items identified in the "SER with open items on the standard content information" prepared by the NRC staff on the description of the functional design, qualification, and IST programs for pumps, valves, and dynamic restraints in the BLN Units 3 and 4 COL application. The NRC staff has reviewed the SNC letters and Revision 2 to the VEGP COL FSAR to determine whether the description of the functional design, qualification, and IST programs for pumps, valves, and dynamic restraints in the VEGP COL application with its incorporation by reference of the AP1000 DCD meets the regulatory requirements to provide reasonable assurance that those components at VEGP will be capable

of performing their safety functions if these programs are developed and implemented consistent with the description in the VEGP COL FSAR and AP1000 DCD.

The staff reviewed the information in the VEGP COL FSAR, and the staff's review of the standard content open item is provided.

AP1000 COL Information Item

- STD COL 3.9-4

The NRC staff reviewed STD COL 3.9-4 related to COL Information Item 3.9-4 included in AP1000 DCD Tier 2, Section 3.9.8.4. COL Information Item 3.9-4 states:

> Combined License applicants referencing the AP1000 design will develop an inservice test program in conformance with the valve inservice test requirements outlined in subsection 3.9.6 and Table 3.9-16. For power-actuated valves, the requirements for operability testing shall be based on subsection 3.9.6.2.2. This program will include provisions for nonintrusive check valve testing methods and the program for valve disassembly and inspection outlined in subsection 3.9.6.2.3. The Combined License applicant will complete an evaluation as identified in subsection 3.9.6.2.2 to determine the frequency of power-operated valve operability testing.

The information item for COL applicants to develop an IST Program was specified as COL Action Item 3.9.6.4-1 in Appendix F of NUREG-1793, which states:

> The COL applicant will provide an inservice test (IST) program that complies with the inservice testing requirements for valves.

In STD COL 3.9-4, the applicant states that this COL item is addressed in Sections 3.9.6, 3.9.6.2.2, 3.9.6.2.3, 3.9.6.2.4, 3.9.6.2.5, and 3.9.6.3 for the VEGP COL application.

In this section of the SER, the NRC staff describes its review of the VEGP COL FSAR with the incorporation by reference of the AP1000 DCD for an acceptable description of the functional design, qualification, and IST programs, including the MOV Testing Program, for VEGP Units 3 and 4 to provide reasonable assurance that the safety-related components within the scope of the VEGP IST Program will be capable of performing their safety functions in accordance with the NRC regulations and the ASME Code requirements.

AP1000 DCD Tier 2, Section 3.9.6.1, "Inservice Testing of Pumps," specifies that the AP1000 reactor design does not include pumps with safety functions with the exception of the coastdown of the reactor coolant pumps. As determined in NUREG-1793, the NRC staff considers the IST Program scope for the AP1000 design with respect to pumps to be acceptable. Therefore, the NRC staff did not include pumps in the review of the IST Program for safety-related components at VEGP Units 3 and 4.

VEGP COL FSAR Section 3.9.6 states that the description of the IST Program for VEGP Units 3 and 4 is based on the ASME OM Code, 2001 Edition through 2003 Addenda, and that the limitations and modifications set forth in 10 CFR 50.55a will be incorporated. The NRC regulations in 10 CFR 50.55a incorporate by reference the ASME OM Code, 2001 Edition through 2003 Addenda, with certain limitations and modifications. Therefore, the NRC staff

considers the application of the ASME OM Code, 2001 Edition through 2003 Addenda, as incorporated by reference in the NRC regulations with applicable limitations and modifications, to be acceptable for the VEGP IST Program description in support of the VEGP COL application. As specified in 10 CFR 50.55a, a COL licensee is required to incorporate in its IST Program the latest Edition and Addenda of the ASME OM Code approved in 10 CFR 50.55a(f) on the date 12 months before initial fuel load.

The VEGP COL FSAR incorporates by reference AP1000 DCD Tier 2, Table 3.9-16, "Valve Inservice Test Requirements," that includes the valve type, safety-related missions, safety functions, the ASME Code IST category, and IST type and frequency. The NRC staff considers this table to be sufficient in describing the IST Program in support of the VEGP COL application. Following the issuance of the VEGP COL, the guidance in NUREG-1482, "Guidelines for Inservice Testing at Nuclear Power Plants," can be used to develop the VEGP IST Program, including the specific information to be included in the IST Program documentation and tables for NRC inspection.

On March 26 and 27, 2008, the NRC staff held a public meeting to discuss the NRC's review of the description of the functional design, qualification, and IST programs for pumps, valves, and dynamic restraints in COL applications referencing the AP1000 certified design and the AP1000 DC amendment application. At the public meeting, Westinghouse stated that it would make information available on the functional design and qualification of safety-related valves and dynamic restraints within the scope of the AP1000 DCD in design and procurement specifications that will be applicable to AP1000 COL applications. On October 14 and 15, 2008, the NRC staff conducted an audit of design and procurement specifications for pumps, valves, and dynamic restraints to be used for the AP1000 reactor at the Westinghouse office in Monroeville, Pennsylvania. In a memorandum dated November 6, 2008, the NRC staff documented the results of the onsite review with specific open items. For example, the staff found that Westinghouse had included ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," in its design and procurement specifications for AP1000 components. ASME QME-1-2007 incorporates lessons learned from valve testing and research programs performed by the nuclear industry and the NRC Office of Nuclear Regulatory Research. Also, AP1000 DCD Tier 2 has been revised in Section 5.4.8.3 to specify that the provisions for qualification testing of power-operated active valves will be based on ASME QME-1-2007. In September 2009, the NRC issued RG 1.100, "Seismic Qualification of Electric and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Revision 3, which accepts the use of ASME QME-1-2007, with certain staff positions, for the functional design and qualification of safety-related pumps, valves, and dynamic restraints. In a letter dated January 26, 2010, Westinghouse provided its planned response to the audit follow-up items. In a letter dated December 14, 2009, SNC stated, in response to Standard Content Open Item 3.9-1 in the "SER with open items" on the BLN COL application, that it had not identified any specific actions for the VEGP COL application based on the audit open items. The NRC staff discussion of the audit of the design and procurement specifications for pumps, valves, and dynamic restraints to be used for the AP1000 reactor is in the SER on the AP1000 DC amendment application. Therefore, the staff considers Standard Content Open Item 3.9-1 resolved.

The VEGP COL FSAR incorporates by reference AP1000 DCD Tier 2, Section 3.9.3.4, "Component and Piping Supports," and adds a new Section 3.9.3.4.4, "Inspection, Testing, Repair and/or Replacement of Snubbers." VEGP COL FSAR Section 3.9.3.4.4 specifies that snubber design and testing will satisfy the applicable sections of the ASME BPV Code, ASME OM Code, and ASME QME-1-2007. Further, VEGP COL FSAR Section 3.9.3.4.4

describes the snubber inservice examination and testing program for VEGP Units 3 and 4. For example, the FSAR specifies that the inservice examination and testing of safety-related snubbers will be conducted in accordance with the requirements of the ASME OM Code, Subsection ISTD. The inservice visual examination will be performed to identify physical damage, leakage, corrosion, degradation, indication of binding, misalignment or deformation, and potential defects generic to a particular design. Snubbers will be tested in service to determine operational readiness during each fuel cycle, beginning no sooner than 60 days before the start of the refueling outage. Defined test plan groups will be established and snubbers in each group will be tested each fuel cycle according to an established sampling plan. Unacceptable snubbers will be adjusted, modified, or replaced. Service life for snubbers will be established, monitored, and adjusted in accordance with ASME OM Code, ISTD-6000, "Service Life Monitoring," and ASME OM Code, Appendix F, "Dynamic Restraints (Snubbers) Service Life Monitoring Methods." In addition, VEGP COL FSAR Table 3.9-201 provides a list of safety-related snubbers to be installed at VEGP, including the snubber identification number and the associated system or component. Revision 3 to RG 1.100 accepts with certain conditions the use of ASME QME-1-2007 for the functional design and qualification of dynamic restraints. The NRC staff finds that the provisions in the VEGP COL FSAR, together with the AP1000 DCD, provide an acceptable description of the inservice examination and testing program for dynamic restraints that support a finding that the program, when developed and implemented, will satisfy the 10 CFR 50.55a regulatory requirements.

The VEGP COL FSAR incorporates by reference AP1000 DCD Tier 2, Section 3.9.6.2.2, "Valve Testing," with supplemental information. Table 3.9-16 in AP1000 DCD lists the valves in the IST Program for the AP1000 design. VEGP COL FSAR Section 3.9.6.2.2 includes provisions for (a) the establishment of reference values; (b) the prohibition of preconditioning that undermines the purpose of IST activities; (c) comparison of stroke time to the reference value except for fast-acting valves for which a stroke-time limit of 2 seconds is assigned; (d) determination of valve obturator movement during valve exercise tests; (e) testing of solenoid-operated valves; (f) preoperational testing of check valves; (g) acceptance criteria for check valve tests; (h) use of nonintrusive techniques for check valve tests; (i) test conditions for check valve tests; (j) post-maintenance testing for check valves; (k) check valve disassembly and testing; and (l) re-establishment of reference values following maintenance. The VEGP COL FSAR also includes provisions for valve disassembly and inspection; valve preservice tests; and valve replacement, repair, and maintenance in Sections 3.9.6.2.3 to 3.9.6.2.5. The NRC staff finds that these provisions in the VEGP COL FSAR are consistent with Subsection ISTC of the ASME OM Code incorporated by reference in 10 CFR 50.55a, and therefore, are acceptable.

In its letter dated March 1, 2010, SNC provided its planned response for VEGP to Standard Content Open Item 3.9-2 on POV operability tests discussed in the "SER with open items" on the BLN COL application. The NRC staff review of the response by SNC to the three issues in this open item is discussed below.

First, SNC states in its letter dated March 1, 2010, that TVA had indicated in its response to BLN RAI 3.9.6-8 that the BLN COL FSAR would be revised to indicate that MOV testing will apply the provisions of ASME OM Code Case OMN-1 (Revision 1) and the guidance in the Joint Owners Group (JOG) MOV Periodic Verification Program including the applicable NRC safety evaluation (and its supplement) for periodic verification of the design-basis capability of safety-related MOVs. SNC did not consider additional changes to the VEGP COL FSAR to be necessary. The NRC staff finds that the VEGP COL FSAR with its incorporation by reference of the AP1000 DCD (including the planned DCD changes) will address the use of JOG MOV Periodic Verification Program. As the AP1000 IST Program applies the JOG MOV Periodic

Verification Program, SNC will need to confirm that MOVs provided by the valve supplier and their application at VEGP Units 3 and 4 are within the scope of the JOG program. The planned use of ASME OM Code Case OMN-1 (Revision 1) is addressed below in this SER section.

Second, SNC provides in its letter dated March 1, 2010, a planned revision to the VEGP COL FSAR that specifies the use of Revision 1 to ASME OM Code Case OMN-1 as an alternative to the quarterly MOV stroke-time testing provisions in the ASME OM Code. In the letter, SNC notes that RG 1.192, "Operation and Maintenance Code Case Acceptability, ASME OM Code," accepts the use of Revision 0 to ASME OM Code Case OMN-1 with three conditions. SNC considers Revision 1 to ASME OM Code Case OMN-1 to represent a superior alternative to Revision 0 to ASME OM Code Case OMN-1 by addressing the conditions on the use of the Code case specified in RG 1.192. In a telephone discussion on April 13, 2010, the NRC staff requested that SNC address the specific provisions in RG 1.192 in justifying the use of Revision 1 to ASME OM Code Case OMN-1 as an alternative to the MOV stroke-time provisions in the ASME OM Code pursuant to 10 CFR 50.55a(a)(3)(i).

In a letter dated May 14, 2010, SNC modified its response to Standard Content Open Item 3.9-2 to provide a planned revision to the VEGP COL FSAR in Section 3.9.6.3 in support of the request to apply Revision 1 to Code Case OMN-1 as an alternative to the quarterly IST stroke-time provisions in the ASME OM Code. The NRC staff has accepted the application of ASME OM Code Case OMN-1 (Revision 0) in RG 1.192 with certain conditions. In the planned VEGP COL FSAR revision, SNC has addressed those conditions as they apply to the requested use of ASME OM Code Case OMN-1 (Revision 1) at VEGP Units 3 and 4. In particular, the VEGP COL FSAR revision specifies that the IST Program will incorporate the provisions in RG 1.192 by providing that the adequacy of the diagnostic test interval for each MOV will be evaluated and adjusted as necessary, but not later than 5 years or three refueling outages (whichever is longer) from the initial implementation of the Code case. The planned VEGP COL FSAR revision also states that the potential increase in core damage frequency (CDF) and risk associated with extending high-risk MOV test intervals beyond quarterly will be determined to be small and consistent with the intent of the Commission's Safety Goal Policy Statement. The VEGP COL FSAR also specifies this provision as consistent with the conditions specified in RG 1.192 for application of ASME OM Code Case OMN-11, "Risk-Informed Testing of Motor-Operated Valves," which has been incorporated into Revision 1 to ASME OM Code Case OMN-1. The planned VEGP COL FSAR revision specifies that risk insights will be applied using MOV risk ranking methodologies accepted by the NRC on a plant-specific or industry-wide basis, consistent with the conditions in the applicable safety evaluations. The planned VEGP COL FSAR revision also indicates that the benefits for performing any particular test will be balanced against the potential adverse effects placed on the valve or system caused by this testing. The VEGP COL FSAR indicates that use of Revision 1 to ASME OM Code Case OMN-1 will be appropriate for the ASME OM Code 2001 Edition with the 2003 Addenda that is the basis for the description of the VEGP Units 3 and 4 IST Program in support of the COL application. The NRC staff finds that the provisions to be specified in the VEGP COL FSAR for the use of Revision 1 to ASME OM Code Case OMN-1 satisfy the conditions specified in RG 1.192 for the use of Revision 0 to ASME OM Code Case OMN-1. The staff considers Revision 1 in ASME OM Code Case OMN-1 to continue to provide an acceptable technical approach for MOV diagnostic testing as an alternative to quarterly MOV stroke-time testing, and that the changes from Revision 0 to Revision 1 reflect improvements for user application and incorporation of ASME OM Code Case OMN-11. Pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorizes the use of ASME OM Code Case OMN-1 (Revision 1) requested by SNC as an alternative to the quarterly MOV stroke-time testing provisions in the ASME OM Code for VEGP Units 3 and 4 on the basis that the proposed alternative provides an acceptable level of quality

and safety and therefore, Standard Content Open Item 3.9-2 is resolved. The incorporation of the planned VEGP COL FSAR changes will be tracked as **Confirmatory Item 3.9-1**.

Third, SNC in its March 1, 2010, submittal provides several planned changes to the VEGP COL FSAR to clarify the provisions that would be redundant when combined with the valve testing provisions in the AP1000 DCD. The NRC staff considers the proposed changes to the VEGP COL FSAR to be acceptable because these provisions are incorporated by reference as part of the AP1000 DCD. The incorporation of the planned VEGP COL FSAR changes will be tracked as part of **Confirmatory Item 3.9-2.**.

In light of the weaknesses in the IST provisions in the ASME OM Code for quarterly MOV stroke-time testing, the NRC issued Generic Letter (GL) 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," to request that nuclear power plant licensees establish programs to assure the capability of safety-related MOVs to perform their design-basis functions on a periodic basis. Further, the NRC revised 10 CFR 50.55a to require that nuclear power plant licensees supplement the quarterly MOV stroke-time testing provisions specified in the ASME OM Code with a program to ensure that MOVs continue to be capable of performing their design-basis safety functions. In its letter dated March 1, 2010, SNC provided its response to Standard Content Open Item 3.9-3 related to MOV testing in the "SER with open items" on the BLN COL application. The NRC staff review of the response by SNC to the six issues in this open item is discussed below:

First, SNC notes the planned use of Revision 1 to ASME OM Code Case OMN-1 as part of the IST Program to be developed for VEGP. As discussed above in this SER section, the NRC staff authorized the use of Revision 1 to ASME OM Code Case OMN-1 at VEGP Units 3 and 4.

Second, SNC states that the MOV Testing Program at VEGP will implement the JOG MOV Periodic Verification Program as described in the VEGP COL FSAR and AP1000 DCD. As indicated above, the NRC staff finds that the VEGP COL FSAR with its incorporation by reference of the AP1000 DCD (including the planned DCD changes) will address the use of the JOG MOV Periodic Verification Program. Other necessary changes to the VEGP COL FSAR regarding MOV testing are discussed in this SER section.

Third, SNC indicates that MOV output capability will be determined using the provisions of ASME OM Code Case OMN-1. The NRC staff has reviewed ASME OM Code Case OMN-1 as part of its acceptance in RG 1.192, and has determined that the Code case provides acceptable provisions for diagnostic testing to determine the output capability of MOVs.

Fourth, SNC describes MOV testing using the guidance in the JOG MOV Periodic Verification Program and Revision 1 to ASME OM Code Case OMN-1 to periodically determine the capability of MOVs to perform under design-basis conditions. The NRC staff has reviewed the JOG MOV Periodic Verification Program as part of its acceptance in an NRC safety evaluation dated September 25, 2006 with a supplement dated September 18, 2008, and has reviewed ASME OM Code Case OMN-1 as part of its acceptance in RG 1.192. From those evaluations, the staff has determined that the JOG MOV Periodic Verification Program and ASME OM Code Case OMN-1 will demonstrate continued MOV capability to open and close under design-basis conditions. As discussed above in this SER section, the NRC staff authorized the use of Revision 1 to ASME OM Code Case OMN-1 at VEGP Units 3 and 4.

Fifth, SNC notes that the initial test frequency of POVs will be based on the ASME OM Code or applicable ASME OM Code cases. For example, the VEGP COL FSAR specifies that the IST

frequency will be determined as specified by ASME OM Code Case OMN-1. Further, the JOG MOV Periodic Verification Program with the NRC safety evaluation and its supplement includes provisions for MOV test frequencies based on risk ranking and functional margin with a maximum diagnostic test interval of 10 years. The staff considers these provisions in the VEGP COL FSAR and the AP1000 DCD for POV test frequency to incorporate lessons learned from MOV testing and research programs, and therefore, to be acceptable.

Sixth, SNC describes provisions for successful completion of MOV testing at VEGP in its March 1, 2010, letter, and provides several planned changes to the VEGP COL FSAR. For example, SNC provides a planned FSAR change to specify the use of ASME OM Code Case OMN-1, Revision 1. SNC also plans to revise the FSAR to specify that the design-basis capability testing of MOVs will apply guidance from GL 96-05 and the JOG MOV Periodic Verification Program. SNC will revise the FSAR to note the need to consider degraded voltage, control switch repeatability, and load-sensitive MOV behavior in ensuring that MOVs have adequate capability margin, in addition to the consideration of age-related degradation. SNC provides a proposed addition to the description of the MOV test frequency determination in the FSAR that will specify that maximum torque and/or thrust (as applicable) achieved by the MOV (allowing sufficient margin for diagnostic equipment inaccuracies and control switch repeatability) must not exceed the allowable structural and undervoltage motor capability limits for the individual parts of the MOV. SNC provides a proposed addition to the description of POV operability testing that specifies that successful completion of the preservice testing and IST of MOVs, in addition to MOV testing as required by 10 CFR 50.55a, will demonstrate that the following criteria are met for each valve tested: (i) valve fully opens and/or closes as required by its safety function; (ii) adequate margin exists and includes consideration of diagnostic equipment inaccuracies, degraded voltage, control switch repeatability, load-sensitive MOV behavior, and margin for degradation; and (iii) maximum torque and/or thrust (as applicable) achieved by the MOV (allowing sufficient margin for diagnostic equipment inaccuracies and control switch repeatability) does not exceed the allowable structural and undervoltage motor capability limits for the individual parts of the MOV. In its letter dated May 14, 2010, SNC provided an additional planned revision to the VEGP COL FSAR that clarifies the application of the JOG MOV Periodic Verification Program (including the applicable NRC safety evaluation and its supplement on the JOG program) in response to NRC staff comments provided during the telephone discussion on April 13, 2010. The NRC staff considers the planned changes to the VEGP COL FSAR to resolve Standard Content Open Item 3.9-3. The incorporation of the planned changes to the VEGP COL FSAR will be tracked as **Confirmatory Item 3.9-3**.

In addition to incorporating by reference AP1000 DCD Tier 2 Section 3.9.6.2.2, the VEGP COL FSAR includes a paragraph titled “Other Power-Operated Valve Operability Tests,” that states that POVs other than active MOVs are exercised quarterly in accordance with ASME OM Code, Subsection ISTC, unless justification is provided in the IST Program for testing these valves at other Code-mandated frequencies. Lessons learned from the resolution of weaknesses in the design, qualification, and testing of MOVs are also applicable to other POVs used at nuclear power plants. In discussing the MOV lessons learned applicable to other POVs in Regulatory Issue Summary (RIS) 2000-03, “Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions,” the NRC staff determined that the current regulations provide adequate requirements to ensure design-basis capability of safety-related POVs. For example, the staff noted that licensees are required by 10 CFR 50.65 (Maintenance Rule) to monitor the performance of SSCs in a manner sufficient to provide reasonable assurance that the SSCs are capable of fulfilling their intended functions. VEGP COL FSAR Section 3.9.6.2.2 provides a description of operability testing for POVs other

than MOVs to be implemented at VEGP. For example, the FSAR states that subsequent to verification of the design-basis capability of POVs as part of the design and qualification program, POVs that perform an active safety function will be tested after installation to ensure valve setup is acceptable to perform their required functions consistent with valve qualification. This testing will document the baseline performance of the valves and will include measurement of critical parameters with consideration of uncertainties associated with the performance of these tests and use of the test results. Additional periodic testing will be performed as part of the air-operated valve (AOV) program based on the JOG AOV program discussed in RIS 2000-03 with specific reference to NRC staff comments on that program. The AOV program will also include the attributes for a successful POV periodic verification program described in RIS 2000-03 by incorporating lessons learned from nuclear power plant operations and research programs as they apply to the periodic testing of AOVs and other POVs in the IST Program. The FSAR specifies AOV program attributes including valve categorization based on safety significance and risk ranking, AOV setpoints based on current vendor information or valve qualification diagnostic testing, periodic static testing to identify potential degradation, use of sufficient diagnostics to collect relevant data to verify that the valve meets functional requirements, specification of test frequency and evaluation based on data trends, post-maintenance procedures to ensure baseline testing will be re-performed as necessary when high-risk valve performance could be affected, inclusion of lessons learned from other valve programs, and retention and periodic evaluation of AOV test documentation.

The NRC staff has reviewed the VEGP COL FSAR, including the incorporation by reference of the AP1000 DCD, to determine whether it addresses the lessons learned from MOV operating experience and research programs in describing the program for the periodic verification of the design-basis capability of POVs other than MOVs. In its letters dated December 14, 2009, and March 1, 2010, SNC provided a response to Standard Content Open Item 3.9-4 related to other POV operability testing in the “SER with open items” on the BLN COL application. In particular, SNC provided planned changes to the VEGP COL FSAR to clarify the potential need for periodic dynamic testing of POVs other than MOVs based on the design qualification results or valve operating experience. The planned FSAR change will also clarify that post-maintenance procedures will be implemented for all safety-related POVs consistent with the QA requirements in 10 CFR Part 50, Appendix B, regardless of their specific risk ranking. SNC also provided a proposed change to the VEGP COL FSAR specifying that the attributes of the AOV testing program, to the extent that they apply to and can be implemented on other safety-related POVs (such as electro-hydraulic valves) will be applied to those other POVs. The NRC staff considers that the planned revision to the VEGP COL FSAR, when combined with the AP1000 DCD provisions incorporated by reference, will adequately describe the periodic testing program for POVs other than MOVs to be used at VEGP and resolves Standard Content Open Item 3.9-4. The incorporation of the planned changes to the VEGP COL FSAR will be tracked as **Confirmatory Item 3.9-4**.

The VEGP COL FSAR incorporates by reference AP1000 DCD Tier 2, Section 3.9.6.3, “Relief Requests,” with a discussion of the planned use of ASME OM Code Case OMN-1, Revision 1. The applicant stated that use of Revision 1 to ASME OM Code Case OMN-1 will require request for relief, unless it is approved by the NRC in RG 1.192 or incorporated into the ASME OM Code on which the IST Program is based and that Code Edition is incorporated by reference in 10 CFR 50.55a. As discussed above in this SER section, the NRC staff authorized the use of Revision 1 to the ASME OM Code Case OMN-1 at VEGP Units 3 and 4.

AP1000 DCD Tier 2, Section 3.9.2, “Dynamic Testing and Analysis,” describes tests to confirm that piping, components, restraints, and supports have been designed to withstand the dynamic

effects of steady-state FIV and anticipated operational transient conditions. Section 14.2.9.1.7, "Expansion, Vibration and Dynamic Effects Testing," in AP1000 DCD Tier 2, Chapter 14, "Initial Test Program," states that the purpose of the expansion, vibration and dynamic effects testing is to verify that safety-related, high energy piping and components are properly installed and supported such that, in addition to other factors, vibrations caused by steady-state or dynamic effects do not result in excessive stress or fatigue to safety-related plant systems. Nuclear power plant operating experience has revealed the potential for adverse flow effects from vibration caused by hydrodynamic loads and acoustic resonance on reactor coolant, steam, and feedwater systems. In its letter dated January 12, 2010, SNC provided its response for VEGP to Standard Content Open Item 3.9-5 related to FIV in the "SER with open items" on the BLN COL application. In its response, SNC stated that it intended to use the overall Initial Test Program to demonstrate that the plant has been constructed as designed and the systems perform consistent with design requirements. SNC referenced the provisions in the AP1000 DCD for vibration monitoring and testing to be implemented at VEGP. For example, the applicant notes that AP1000 DCD Tier 2, Section 3.9.2.1, "Piping Vibration, Thermal Expansion and Dynamic Effects," specifies that the preoperational test program for ASME BPV Code, Section III, Class 1, 2, and 3 piping systems simulates actual operating modes to demonstrate that components comprising these systems meet functional design requirements and that piping vibrations are within acceptable levels. SNC indicates that the planned vibration testing program described in AP1000 DCD Tier 2, Sections 14.2.9 and 14.2.10, with the preservice and IST programs described in AP1000 DCD Tier 2, Sections 3.9.3.4.4 and 3.9.6, will confirm component installation in accordance with design requirements, and address the effects of steady-state (flow-induced) and transient vibration to ensure the operability of valves and dynamic restraints in the IST Program. The NRC staff considers the response by SNC clarifies its application of the provisions in the AP1000 DCD to ensure that potential adverse flow effects will be addressed at VEGP. Therefore, the staff considers Standard Content Open Item 3.9-5 to be resolved for the VEGP COL application.

Subsection ISTC-5260, "Explosively Actuated Valves," in the ASME OM Code specifies that at least 20 percent of the charges in explosively actuated valves shall be fired and replaced at least once every 2 years. If a charge fails to fire, the ASME OM Code states that all charges with the same batch number shall be removed, discarded, and replaced with charges from a different batch. In light of the updated design and safety significance of squib valves in new reactors, the need for improved surveillance activities for squib valves is being considered by the nuclear industry, ASME, and U.S. and international nuclear regulators. In RAI 3.9.6-1, the NRC staff requested that SNC describe its plans for addressing the surveillance of squib valves that will provide reasonable assurance of the operational readiness of those valves to perform their safety functions in support of the VEGP COL application. In a letter dated May 27, 2010, SNC submitted a planned revision to VEGP COL FSAR Section 3.9.6 to specify that industry and regulatory guidance will be considered in the development of the IST Program for squib valves. The FSAR will also state that the IST Program for squib valves will incorporate lessons learned from the design and qualification process for these valves such that surveillance activities provide reasonable assurance of the operational readiness of squib valves to perform their safety functions. The NRC staff finds that the planned changes to the VEGP COL FSAR are sufficient to describe the IST Program for squib valves for incorporating the lessons learned from the design and qualification process in developing surveillance activities that will provide reasonable assurance of the operational readiness for squib valves to perform their safety functions. Therefore, the NRC staff considers the planned changes to the VEGP COL FSAR to resolve this RAI acceptable. The incorporation of the planned changes to the VEGP COL FSAR will be tracked as **Confirmatory Item 3.9-5**.

Technical Specifications

In its letter dated December 14, 2009, SNC provided a response to an open item related to Part 4, "Technical Specifications," (Standard Content Open Item 3.9-6) in the "SER with open items" on the BLN COL application. In its response, SNC stated that Part 4 of the VEGP COL application will be revised to ensure that Technical Specifications and Technical Specification Bases are consistent with the ASME OM Code, 2001 Edition through the 2003 Addenda. Therefore the NRC staff considers the planned changes to the VEGP COL application in Part 4 to resolve Standard Content Open Item 3.9-6. The incorporation of the planned changes to the VEGP COL FSAR will be tracked as **Confirmatory Item 3.9-6**.

License Conditions

- Part 10, License Condition 3, Items G2 and G5

The applicant proposed a license condition providing the implementation milestones for the Preservice Testing Program and MOV Testing Program.

- Part 10, License Condition 6

The applicant proposed a license condition to provide a schedule to support the NRC's inspection of operational programs including the Preservice Testing Program and MOV Testing Program.

These license conditions are consistent with the policy established in SECY-05-0197 and are, thus, acceptable.

3.9.6.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the staff proposes to include the following license conditions:

License Conditions

- License Condition (3-5) - Prior to initial fuel load, the licensee shall implement the pre-service testing and the MOV testing programs.

- License Condition (3-6) - The licensee shall submit to the Director of NRO, a schedule, no later than 12 months after issuance of the COL that supports planning for conduct of NRC inspections of IST program (including preservice and MOV testing). The schedule shall be updated every six months until 12 months before scheduled fuel loading, and every six months thereafter until the inservice testing program (including preservice testing and the MOV testing) has been fully implemented or the plant has been placed in commercial service, whichever comes first.

3.9.6.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the IST Program, 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 design-related information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements. The results of the staff's review of the material in the AP1000 DCD related to the IST operational program for pumps, valves, and dynamic restraints are in this SER section.

In addition, the staff concludes, pending closure of **Confirmatory Items 3.9-1 through 3.9-6**, that the relevant information presented in the VEGP COL FSAR is acceptable and meets the guidance in Section 3.9.6 of NUREG-0800 and in RG 1.206. The staff based its conclusion on the following:

- STD COL 3.9-4, regarding the operational program for pumps, valves, and dynamic restraints is acceptable because the requirements of 10 CFR 52.79(a) are satisfied.

3.9.7 Integrated Head Package

AP1000 DCD, Section 3.9.7, describes the integrated head package (IHP). The IHP combines several components in one assembly to simplify refueling the reactor. The IHP includes a lifting rig, seismic restraints for CRDM, support for reactor head vent piping, cable bridge, power cables, cables for in-core instrumentation, cable supports, and shroud assembly. The IHP provides the ability to rapidly disconnect cables, including the CRDM power cables, digital rod position indication cables, and in-core instrument cables from the components.

Section 3.9 of the VEGP COL FSAR, Revision 2, incorporates by reference, with no departures or supplements, Section 3.9.7, "Integrated Head Package" of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD 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.

3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

3.10.1 Introduction

Seismic and dynamic qualification of seismic Category I equipment includes the following types:

- Safety-related active mechanical equipment that performs a mechanical motion while accomplishing a system safety-related function. Examples include pumps, valves, and valve operators.

- Safety-related, nonactive mechanical equipment whose mechanical motion is not required while accomplishing a system safety-related function, but whose structural integrity must be maintained in order to fulfill its design safety-related function.

- Safety-related instrumentation and electrical equipment and certain monitoring equipment.

Mechanical and electrical equipment (including instrumentation and controls), and where applicable, their supports classified as seismic Category I must demonstrate that they are

capable of performing their intended safety-related functions under the full range of normal and accident (including seismic) loadings. This equipment includes devices associated with systems essential to safe shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment or in mitigating the consequences of accidents.

The criteria for the seismic and dynamic qualification include the following considerations:

- Adequacy of seismic and dynamic qualification input motions.
- Methods and procedures for qualifying electrical equipment, instrumentation, and mechanical components.
- Methods and procedures for qualifying supports of electrical equipment, instrumentation, and mechanical components.
- Documentation.

3.10.2 Summary of Application

Section 3.10 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.10 of the AP1000 DCD, Revision 17.

Section 3.10 of the VEGP COL FSAR does not include any COL information items or supplemental information related to AP1000 DCD, Section 3.10.

3.10.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the seismic and dynamic qualification of mechanical and electrical equipment are given in Section 3.10 of NUREG-0800.

3.10.4 Technical Evaluation

The NRC staff reviewed Section 3.10 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 seismic and dynamic qualification program. 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.

Section 1.2.3 of this safety evaluation report (SER) provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the

Bellefonte Nuclear Plant (BLN) Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs) and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. There was one open item (Open Item 3.10-1) to resolve. The resolution of the item is addressed in this SER.

Implementation Program

In RAI 3.10-1, dated August 7, 2008, the applicant was requested to provide an implementation program, including milestones and completion dates with appropriate information submitted with sufficient time for staff review and approval prior to installation of the equipment, not prior to fuel loading, in accordance with Section C.I.3.10.4 of RG 1.206.

In its response, the applicant stated that details of the implementation milestones for the seismic and dynamic qualification program are not currently available, and are not expected to be available until after a detailed construction schedule of the plant has been developed. Appropriate scheduling information will be provided, when available, to the NRC as necessary to support timely completion of their inspection and audit functions. Additionally, seismic and dynamic qualification is the subject of ITAAC, and 10 CFR 52.99(a) does not require that a schedule for implementing ITAAC be provided to the NRC until one year after issuance of the COL.

The NRC staff determined that the applicant's response to RAI 3.10-1 is not adequate because, in accordance with Section C.I.3.10.4 of RG 1.206, if the results of seismic and dynamic qualification is not available at the time of the COL application, the applicant is expected to submit the following before the issuance of the combined license: (1) descriptions of the implementation program such as identification of seismic qualification methods (Testing or Analysis) for each type of equipment; and (2) milestones for when the different aspects of the seismic qualification program will be complete - dates or condition should be such that the NRC staff will be able to audit the qualification results prior to the installation of the equipment (not before fuel loading as part of the ITAAC program). This is ***Open Item 3.10-1.***

Resolution of Open Item 3.10-1

In its responses dated February 5, 2010 and April 2, 2010, the VEGP applicant submitted a table providing the planned methods of seismic qualification for safety-related, seismic Category I equipment types listed in AP1000 DCD, Chapter 3, Table 3.2-3. Furthermore, the applicant stated that the seismic qualification packages will be available to the NRC as necessary to support timely completion of its inspection and audit functions. Because not all packages are expected to be completed within a year of the issuance of the COL (or at the start of construction as defined in 10 CFR 50.10(a), whichever is later), a schedule for the availability of the seismic qualification packages will be included with the schedule information for closure of ITAAC (as required by 10 CFR 52.99(a)). The staff finds the applicant's response acceptable, and Open Item 3.10-1 is closed. The incorporation of the planned changes to the VEGP COL FSAR will be tracked as **Confirmatory Item 3.10-1**.

3.10.5 Post Combined License Activities

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

3.10.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the seismic and dynamic qualification program, 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.

The staff compared the information in the application to the relevant NRC regulations, the acceptance criteria in Section 3.10 of NUREG-0800. The staff's review confirmed, pending resolution of the confirmatory item, that the applicant has adequately addressed the information relating to the seismic qualification of equipment in accordance with the requirements of GDC 2, GDC 4, GDC 14, "Reactor coolant pressure boundary."

3.11 Environmental Qualification of Mechanical and Electrical Equipment

3.11.1 Introduction

The objective of environmental qualification (EQ) is to reduce the potential for common failure due to specified environmental and seismic events, and to demonstrate that equipment within the scope of the EQ Program is capable of performing its intended design safety function under all conditions including environmental stresses resulting from design bases events. The information presented includes identification of the equipment required to be environmentally qualified and, for each item of equipment, the designated functional requirements, definition of the applicable environmental parameters, and documentation of the qualification process employed to demonstrate the required environmental capability. During plant operation, the licensee implements the EQ Program, which specifies the replacement frequencies of affected safety-related equipment in harsh environments, and nonsafety-related equipment whose failure under the postulated environmental conditions could prevent satisfactory performance of the safety functions of the safety-related equipment, and certain post-accident monitoring equipment. The seismic qualification of mechanical and electrical equipment is presented in

Section 3.10. The portions of post-accident monitoring equipment required to be environmentally qualified are identified in AP1000 DCD Table 7.5-1.

RG 1.206 discusses the Commission's position provided in SECY-05-0197 that operational programs should be fully described in COL applications to avoid the need to specify ITAAC for those programs. The applicant relies on the VEGP COL application with its incorporation by reference of the AP1000 DCD and supplemental information to fully describe the EQ and other related operational programs in support of the COL application for VEGP Units 3 and 4.

3.11.2 Summary of Application

Section 3.11 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 3.11 of the AP1000 DCD, Revision 17. Section 3.11 of the AP1000 DCD describes the EQ Program for electrical and mechanical equipment to be used in the AP1000 certified design.

AP1000 COL Information Item

- STD COL 3.11-1

In VEGP COL FSAR Section 3.11.5, "Combined License Information Item For Equipment Qualification File," the applicant provided additional information to address COL Information Item 3.11-1 (COL Action Item 3.11.2-1) regarding administrative control of the EQ Program for VEGP Units 3 and 4.

License Conditions

- Part 10, License Condition 3, Item G1

The applicant proposed a license condition providing the implementation milestone for the EQ Program.

- Part 10, License Condition 6

The applicant proposed a license condition to provide a schedule to support the NRC's inspection of operational programs including the EQ Program.

3.11.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the EQ of mechanical and electrical equipment are given in Section 3.11 of NUREG-0800.

The applicable regulatory requirements for the Operational EQ Program are as follows:

10 CFR 52.79(a)(10) requires that a COL application provide a description of the program, and its implementation, required by 10 CFR 50.49(a) for the EQ of electric equipment important to safety and the list of electric equipment important to safety that is required by 10 CFR 50.49(d).

10 CFR 52.79(a)(29)(i) requires that a COL application provide plans for conduct of normal operations, including maintenance, surveillance, and periodic testing of SSCs.

RG 1.206 provides guidance for a COL applicant in preparing and submitting its COL application in accordance with the NRC regulations. For example, Section C.IV.4 in RG 1.206 discusses the requirement in 10 CFR 52.79(a) for descriptions of operational programs that need to be included in the FSAR for a COL application to allow a reasonable assurance finding of acceptability. In particular, a COL applicant should fully describe EQ and other operational programs as defined in Commission Paper SECY-05-0197 to avoid the need for ITAAC for the implementation of those programs. The term "fully described" for an operational program should be understood to mean that the program is clearly and sufficiently described in terms for scope and level of detail to allow a reasonable assurance finding of acceptability. Further, operational programs should be described at a functional level and an increasing level of detail where implementation choices could materially and negatively affect the program effectiveness and acceptability. The Commission approved the use of a license condition for operational program implementation milestones that are fully described or referenced in the FSAR as discussed in the SRM for SECY-05-0197, dated February 22, 2006.

3.11.4 Technical Evaluation

The NRC staff reviewed Section 3.11 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 EQ of mechanical and electrical equipment. 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.

Section 1.2.3 of this safety evaluation report (SER) provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the Bellefonte Nuclear Plant (BLN) Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from requests for additional information (RAIs) and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is

identified in this SER by use of italicized, double-indented formatting. There was one open item (Open Item 3.11-1) to resolve. The resolution of the item is addressed in this SER.

The following portion of this technical evaluation section is reproduced from Section 3.11.4 of the BLN SER:

AP1000 COL Information Item

- *STD COL 3.11-1*

The COL information item for the EQ file in Section 3.11.5 of the AP1000 DCD, states:

> *Westinghouse Electric Company LLC will act as the agent for the COL holder during the equipment design phase, equipment selection and procurement phase, equipment qualification phase, plant construction phase, and ITAAC inspection phases.*
>
> *The COL holder will define the process and procedures for which the equipment qualification files will be accepted from Westinghouse and how the files will be retained and maintained in an auditable format for the period that the equipment is installed and/or stored for future use in the nuclear power plant.*

This commitment was also captured as COL Action Item 3.11.2-1 in the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

> *Pursuant to 10 CFR 50.49(j), the COL applicant shall keep the list and information in the file current and retain the file in auditable form for the entire period during which the covered item is installed in the nuclear power plant or is stored for the future use to permit verification that each item of electrical equipment important to safety (1) is qualified for its application, and (2) meets its specified performance requirements. To conform with 10 CFR 50.49, electrical equipment for PWRs referencing the AP1000 design should be qualified according to the criteria in Category I of NUREG-0588 and Revision 1 of RG 1.89.*

This commitment was also listed as COL Action Item 3.11.2-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

> *The COL applicant is responsible for maintaining the equipment qualification file during the equipment selection and procurement phase.*

In STD COL 3.11-1, the applicant describes under "Combined License Information Item for Equipment Qualification File," that the COL holder is responsible for the maintenance of the equipment qualification file. The NRC staff reviewed STD COL 3.11-1 related to equipment qualification file included under Section 3.11.5 of the BLN COL. The NRC staff's evaluation is as follows.

Section 3.11.5 of the BLN COL FSAR states that the COL holder is responsible for the maintenance of the equipment qualification file upon receipt from the reactor vendor. EQ files developed by the reactor vendor are maintained as applicable for equipment and certain post-accident monitoring devices that are subject to a harsh environment. The files are maintained for the operational life of the plant.

The Environmental Qualification Master Equipment List (EQMEL) identifies the electrical and mechanical equipment or components that must be environmentally qualified for use in a harsh environment. The BLN COL FSAR states that the EQMEL and a summary of equipment qualification results are maintained as part of the equipment qualification file for the operational life of the plant. Administrative programs are in place to control revision to the EQ files and the EQMEL. When adding or modifying components in the EQ Program, EQ files are generated or revised to support qualification. The EQMEL is revised to reflect these new components. Plant modifications and design basis changes are subject to change process reviews, e.g., reviews in accordance with 10 CFR 50.59 or Section VIII of Appendix D to 10 CFR Part 52, in accordance with appropriate plant procedures. Any changes to the EQMEL that are not the result of a modification or design basis change are subject to a separate review that is accomplished and documented in accordance with plant procedures.

Based on the above, the NRC staff concludes that the COL applicant would keep the equipment qualification file and information in the file current and retain the file in an auditable form for the entire period during which the covered item is installed in the nuclear power plant or is stored for the future use to permit verification that each item of electrical equipment important to safety: (1) is qualified for its application; and (2) meets its specified performance requirements. This is consistent with 10 CFR 50.49(j) and acceptable.

In addition, the staff requested additional information related to specific implementation of this program, which is discussed below.

BLN COL FSAR Section 3.11 incorporates by reference AP1000 DCD Tier 2 Section 3.11.2.2, "Environmental Qualification of Mechanical Equipment," in the AP1000 DCD, which references Appendix 3D, "Methodology for Qualifying AP1000 Safety-Related Electrical and Mechanical Equipment." In RAI 3.11-1, the NRC staff requested that the applicant describe in more detail the EQ Program for safety-related mechanical equipment to be used at BLN Units 3 and 4. In its response, the applicant stated that the EQ Program will be performed as described in Section 3.11 and Appendix 3D of the AP1000 DCD, by reference as stated in the BLN COL FSAR. The EQ Program will be implemented through design specifications, equipment procurement documents, and equipment qualification procedures. Equipment qualification specifications and equipment design specifications will be developed based on the AP1000 EQ requirements. The incorporation of the AP1000 DCD, Section 3.11 and Appendix 3D into the BLN COL FSAR also includes future maintenance, surveillance, and replacement activities to maintain EQ over the life of the BLN plant through operational programs and procedures. AP1000 DCD, Table 3.11-1 provides a listing of the safety-related mechanical equipment, its location, and the environment to be considered in the EQ Program. AP1000 DCD,

Appendix 3D, describes: (1) qualification methodology for the critical safety-related nonmetallic sub-components; (2) thermal and radiation information for the nonmetallic components used in safety-related mechanical equipment; (3) plant normal, abnormal, and accident environmental parameters; and (4) documentation requirements. On October 14 and 15, 2008, the NRC staff conducted an onsite review of design and procurement specifications, including EQ, for pumps, valves, and dynamic restraints to be used for the AP1000 reactor at the Westinghouse offices in Monroeville, PA. The staff found that Westinghouse had included ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," in its design and procurement specifications for AP1000 components, including ASME QME-1, Appendix QR-B, "Guide for Qualification of Nonmetallic Parts." At the conclusion of the onsite review, the staff provided comments on the AP1000 design procurement specifications, and Westinghouse indicated that those comments would be addressed in a future revision to the specifications. The staff also identified several items that remain open from the onsite review that are specified in Section 3.9.6 of the SER on the AP1000 DCD revision. As noted in Section 3.9.6 of the BLN COL FSAR, the NRC staff documented the results of the on-site review with follow-up items in a memorandum dated November 6, 2008, (ML083110154). ***This is Open Item 3.11-1.***

Section 3D.6.2.3, "Analysis of Safety-Related Mechanical Equipment," in the AP1000 DCD, Appendix 3D, summarizes the EQ of safety-related mechanical equipment by analysis methods, but does not discuss implementation of the EQ approach. In RAI 3.11-2, the NRC staff requested that the applicant discuss the implementation of the EQ approach, including the application of industry standards, prescribed in Section 3D.6.2.3 in Appendix 3D to Chapter 3 in the AP1000 DCD. In its response to this RAI, the applicant stated that equipment qualification specifications and equipment design specifications have been developed based on the AP1000 DCD EQ requirements. The applicant stated that these procurement documents reference ASME QME-1 and Institute of Electrical and Electronic Engineers (IEEE) Standard 323 for the EQ of active safety-related mechanical equipment. As noted above, the NRC staff conducted an onsite review of the Westinghouse design and procurement specifications for the AP1000 components on October 14 and 15, 2008. The issues in this RAI are being addressed under ***Open Item 3.11-1****. Therefore, RAI 3.11-2 is closed.*

AP1000 DCD, Appendix 3D, Section 3D.6.3, "Operating Experience in the Equipment Qualification Program," states that the COL applicant will provide documentation of the EQ methodology where seismic experience data are used. In RAI 3.11-3, the NRC staff requested that the applicant discuss the documentation of the EQ methodology where seismic experience data are used. In its response to this RAI, the applicant stated that Westinghouse would revise the AP1000 DCD to resolve this issue. Revision 17 to the AP1000 DCD, Appendix 3D, Section 3D.6.3 specifies that qualification by experience is not employed in the AP1000 equipment qualification program as a method of qualification. The applicant revised the BLN COL FSAR to reflect the revision to the AP1000 DCD. Therefore, RAI 3.11-3 is resolved.

The section titled "In-Service Vibration" in Section B.4.5, "External Stresses," in Attachment B, "Aging Evaluation Program," to Appendix 3D to Chapter 3 in the

AP1000 DCD, states that inservice pipe and FIV may be significant for line-mounted equipment. As a consequence, the section states that an additional vibration aging step is included in the aging sequence. Operating experience has revealed that FIV from acoustic resonance and hydraulic loading can adversely impact safety-related mechanical equipment at nuclear power plants. The COL applicant will demonstrate the performance of this additional vibration aging step specified in the AP1000 DCD in the EQ of safety-related mechanical equipment to be used at BLN Units 3 and 4. This technical issue is addressed in Section 3.9.6 of this SER.

License Conditions

Section 3, "Operational Program Implementation," in Part 10 of the BLN COL application provides proposed license conditions for operational program implementation. One specified license condition is that the EQ Program will be implemented prior to initial fuel loading. In addition, Section 6 in Part 10 provides a proposed license condition for operational program readiness that requires the licensee to submit a schedule no later than 12 months after COL issuance that supports planning and conducting NRC inspections of operational programs with periodic updating. These license conditions are consistent with the policy established in SECY-05-0197 and are, thus, acceptable.

Resolution of Standard Content Open Item 3.11-1

Standard Content Open Item 3.11-1 resulted from the identification of items that remained open from the October 14 and 15, 2008, onsite review at Westinghouse offices of design and procurement specifications, including EQ, for pumps, valves, and dynamic restraints to be used for the AP1000 reactor. As noted in Section 3.9.6.4 of the BLN COL FSAR, the NRC staff documented the results of the onsite review with follow-up items in a memorandum dated November 6, 2008. In a letter dated December 14, 2009, the VEGP applicant stated that it had not identified any specific actions for the VEGP COL application based on the audit open items. The NRC staff's discussion of the audit of the EQ specifications, which includes the issues in RAI 3.11-2 addressed to the BLN applicant, is in NUREG-1793 and its supplements. Therefore, Standard Content Open Item 3.11-1 is resolved for the VEGP COL application.

Supplemental Review of Operational Aspects of the EQ Program

As discussed in RG 1.206 and Commission Paper SECY-05-0197, COL applicants must fully describe their operational programs to avoid the need for ITAAC regarding those programs. In addition to the initial EQ of electrical and mechanical equipment, the NRC staff reviewed the VEGP COL FSAR Section 3.11 with its incorporation by reference of the AP1000 DCD and supplemental information for operational aspects of the EQ Program. For example, AP1000 DCD Tier 2, Appendix 3D, Section 3D.7, "Documentation," states that information regarding maintenance, refurbishment, or replacement of the equipment will be included in the equipment qualification package if necessary to provide confidence in the equipment's capability to perform its safety function. Further, Section 3D.7.1, "Equipment Qualification Data Package," states that equipment qualification data packages will specify preventive maintenance that is required to support qualification or the qualified life, including maintenance or periodic activities assumed as part of the qualification program or necessary to support qualification. With respect to safety-related mechanical equipment, AP1000 DCD Tier 2, Section 3D.6.2.3.8, "Equipment Qualification Maintenance Requirements," specifies that maintenance requirements resulting

from EQ activities will be based on: (1) qualification evaluation results (for example, periodic replacement of age-susceptible parts before the end of their qualified life); (2) equipment qualification-related maintenance activities derived from the qualification report; and (3) vendor recommended equipment qualification maintenance, if required, in order to maintain qualification. The staff finds that the VEGP COL applicant provides an acceptable description of the transition from the initial to the operational aspects of the EQ Program in support of the VEGP COL application through the VEGP COL FSAR with its incorporation by reference of the AP1000 DCD Tier 2, Section 3.11. The NRC staff will evaluate the implementation of the EQ Program through inspections conducted during plant construction and operation. The NRC inspection activities will include consideration of: (1) evaluation of EQ results for design life to establish activities to support continued EQ; (2) determination of surveillance and preventive maintenance activities based on EQ results; (3) consideration of EQ maintenance recommendations from equipment vendors; (4) evaluation of operating experience in developing surveillance and preventive maintenance activities for specific equipment; (5) development of plant procedures that specify individual equipment identification, appropriate references, installation requirements, surveillance and maintenance requirements, post-maintenance testing requirements, condition monitoring requirements, replacement part identification, and applicable design changes and modifications; (6) development of plant procedures for reviewing equipment performance and EQ operational activities, and for trending the results to incorporate lessons learned through appropriate modifications to the EQ Program; and (7) development of plant procedures for the control and maintenance of EQ records.

Based on the above discussion, the NRC staff finds the information added to the VEGP COL application as part of STD COL 3.11-1 to be acceptable.

License Conditions

- Part 10, License Condition 3, Item G1

The applicant proposed a license condition providing the implementation milestone for the EQ Program.

- Part 10, License Condition 6

The applicant proposed a license condition to provide a schedule to support the NRC's inspection of operational programs including the EQ Program.

These license conditions are consistent with the policy established in SECY-05-0197 and are, thus, acceptable.

3.11.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the staff proposes to include the following license conditions:

- License Condition (3-7) - Prior to initial fuel load, the licensee shall implement the Environmental Qualification Program

- License Condition (3-8)- The licensee shall submit to the Director of NRO, a schedule, no later than 12 months after issuance of the COL that supports planning for conduct of

NRC inspections of the Environmental Qualification Program. The schedule shall be updated every six months until 12 months before scheduled fuel loading, and every six months thereafter until the Environmental Qualification Program has been fully implemented or the plant has been placed in commercial service, whichever comes first.

3.11.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the EQ Program, 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.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the guidance in Section 3.11 of NUREG-0800 and in RG 1.206. The staff based its conclusion on the following:

- STD COL 3.11-1, regarding the administrative control of the EQ Program for VEGP Units 3 and 4, is acceptable because the requirements of 10 CFR 52.79(a)(10) and 10 CFR 52.79(a)(29)(i) are satisfied.

3.12 Piping Design (Related to RG 1.206, Section C.III.1, Chapter 3, C.I.3.12, "Piping Design Review")

3.12.1 Introduction

This section covers the design of the piping system and piping support for seismic Category I, Category II, and nonsafety systems. It also discusses the adequacy of the structural integrity, as well as the functional capability, of the safety-related piping system, piping components, and their associated supports. The design of piping systems should ensure that they perform their safety-related functions under all postulated combinations of normal operating conditions, system operating transients, postulated pipe breaks, and seismic events. This includes pressure-retaining piping components and their supports, buried piping, instrumentation lines, and the interaction of NS Category I piping and associated supports with seismic Category I piping and associated supports. This section covers the design transients and resulting loads and load combinations with appropriate specified design and service limits for seismic Category I piping and piping support, including those designated as ASME Code Class 1, 2, and 3.

3.12.2 Summary of Application

Chapter 3 of the VEGP COL FSAR, Revision 2, incorporates by reference Chapter 3 of the AP1000 DCD, Revision 17. Sections 3.7 and 3.9 of the AP1000 DCD address Section 3.12, "ASME Code Class 1, 2, and 3 Piping Systems, Piping Components and their Associated Supports" of NUREG-0800.

In addition, in VEGP COL FSAR Sections 3.7 and 3.9, the applicant provided the following:

Supplemental Information

- VEGP SUP 3.7-3

VEGP SUP 3.7-3 adds a new Section 3.7.1.1.1 to demonstrate that the AP1000 plant designed for the CSDRS is acceptable for the VEGP site.

AP1000 COL Information Items

- STD COL 3.9-2

The applicant provided additional information in STD COL 3.9-2 to address COL Information Item 3.9-2, which states that design specifications and design reports for the ASME Code, Section III piping will be available for the NRC's review and that reconciliation of these documents is completed after construction and prior to fuel load.

- STD COL 3.9-5

The applicant provided additional information in STD COL 3.9-5 to address COL Information Item 3.9-5, which provides a description for pressurizer surge line monitoring.

- STD COL 3.9-7

In a letter dated April 23, 2010, the applicant proposed to add new STD COL 3.9-7 to the VEGP COL FSAR. This COL item provides additional information on the process to be used to complete the piping design and ITAAC added to verify the design.

License Condition

- Part 10, License Condition 2, Item 3.9-7

In a letter dated April 23, 2010, the applicant proposed a license condition addressing the as-designed piping analysis completion schedule.

ITAAC

In a letter dated April 23, 2010, the applicant has proposed ITAAC requiring the completion of a design report referencing the as-designed piping calculation packages, including the ASME Code, Section III piping analysis, support evaluations and piping component fatigue analysis for Class 1 piping using the methods and criteria outlined in AP1000 DCD Table 3.9-19.

3.12.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in the FSER related to the AP1000 DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the pipe and support analysis are given in Section 3.12 of NUREG-0800.

3.12.4 Technical Evaluation

The NRC staff reviewed Section 3.9 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD 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 piping design review. 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.

Due to the significant amount of new information provided by both the VEGP applicant and Westinghouse on the piping design issues since the development of the BLN SER for Section 3.12, the NRC staff decided not to use the BLN SER material as a starting point for the evaluation of these issues.

AP1000 COL Information Items

- STD COL 3.9-2

COL Information Item 3.9-2 states that design specifications and design reports for the ASME Code, Section III piping will be available for the NRC's review and that reconciliation of the piping is completed prior to fuel load in accordance with an ITAAC in AP1000 DCD Tier 1, Section 2. The discussion on STD COL 3.9-7 below addresses design specifications and design reports.

The staff acknowledged that an ITAAC in the AP1000 DCD Tier 1 addresses verification of this aspect of the design and that COL Information Item 3.9-2 has been addressed.

- STD COL 3.9-5

The staff reviewed STD COL 3.9-5 (surge line thermal monitoring) and determined that the proposed program did not provide sufficient information for the staff to determine reasonable assurance for safety. The staff issued RAI 3.12-2 to ask the applicant to provide additional information including a test abstract including stating the standard operating conditions in Chapter 14 that identifies the objective, prerequisites, test method, data required, and acceptance criteria for surge line thermal monitoring that complies with NRC Bulletin 88-11. In this RAI, the staff also noted that

> For subsequent SCOLs, the design is such that assumptions are made that the layout will be the same such that monitoring of the follow-on plants is not required. However, all plants are required to comply with NRC Bulletin 88-11. Given that the heatup and cooldown procedures have not been developed and the affect on the plant, even with similar layout, will be different depending on the procedures used, subsequent plants will need to verify that they will be using the same heatup and cooldown procedures as the monitored plant to comply with NRC Bulletin 88-11.

In a letter dated July 2, 2010, the applicant provided its response to address the staff's concern. In the response, the applicant stated that VEGP COL FSAR Section 3.9.3.1.2 would be revised to add the following paragraph:

> Subsequent AP1000 plants (after the first AP1000 plant) confirm that the heatup and cooldown procedures are consistent with the pertinent attributes of the first AP1000 plant surge line monitoring. In addition, changes to the heatup and cooldown procedures consider the potential impact on stress and fatigue analyses consistent with the concerns of NRC Bulletin 88-11.

In this letter, the applicant also added a new Section 14.2.9.2.22 to provide a test abstract. The test abstract included the purpose, prerequisites, general test methods, and acceptance criteria.

In a subsequent letter dated August 6, 2010, the applicant provided additional information for the location of test instruments. In the response, the applicant stated that VEGP COL FSAR Section 3.9.3.1.2 would be revised to add the following paragraph:

> In addition to the existing permanent plant temperature instrumentation, temperature and displacement monitoring will be included at critical locations on the surge line. The additional locations utilized for monitoring during the hot functional testing and the first fuel cycle (see Subsection 14.2.9.2.22) are selected based on the capability to provide effective monitoring.

The staff reviewed the RAI responses and concluded the position is acceptable to comply with NRC Bulletin 88-11. On this basis, the proposed program for surge line thermal monitoring is acceptable. The incorporation of the planned changes to the VEGP COL FSAR detailed in the applicant's July 2, 2010, letter will be tracked as **Confirmatory Item 3.12-1**.

- STD COL 3.9-7

In letter dated April 23, 2010, the applicant proposes that the as-designed piping analysis is made available for NRC review. Additionally in this letter, License Condition 2, Item 3.9-7, proposed by the applicant, calls for the design to be made available for review prior to installation of the piping and adding a site-specific ITAAC in Table 3.8-# of Part 10 of the VEGP COL application for verification of the ASME Code design reports. In this letter, the applicant also proposed adding Section 14.3.3.# to the VEGP COL FSAR, describing the process to be followed to address closure of the piping DAC during the construction period, to complete the review of the piping design including an ITAAC to review the design, and an ITAAC to review reconciliation of the design after it is built.

The staff reviewed the applicant's proposed approach of including ITAAC for verification of the design and reconciliation of the design, and a license condition to address timing of when the initial design verification would occur. The approach, including the ITAAC and the license condition, is acceptable to the staff as it allows verification that the methodology described in the AP1000 DCD and VEGP COL FSAR and the general requirements of the ASME Code, as specified in 10 CFR 50.55a, were met.

Proposed VEGP COL FSAR Section 14.3.3.# also states that "The piping design completed for the first standard AP1000 plant will be available to subsequent standard AP1000 plants under the "one issue, one review, one position" approach for closure." Westinghouse letter dated August 17, 2010, as supplemented by letter dated August 23, 2010, stated that the ASME Code Class 1, 2 and 3 piping systems will be evaluated as part of the piping DAC for hard rock site to address hard rock site seismic issue. The standard AP1000 plant will have analysis that

addresses both CSDRS and HRHF GMRS effect. Therefore, the one issue, one review, one position approach applies and the staff finds this acceptable for piping analysis.

The incorporation of the planned changes to the VEGP COL application detailed in the applicant's April 23, 2010, letter and in response to hard rock seismic issues will be tracked as **Confirmatory Item 3.12-2**.

Supplemental Information

- VEGP SUP 3.7-3

This item discussed GMRS exceedances above the CSDRS. The input for the piping analysis is the ISRS. The applicant has performed its site-specific seismic evaluation and concluded that the ISRS is still enveloped by the CSDRS. The detailed evaluation is documented in Section 3.7.2 of this SER. On this basis, the staff finds GMRS exceedances is acceptable for piping design using CSDRS.

3.12.5 Post Combined License Activities

For the reasons discussed in the technical evaluation section above, the applicant proposes to include the following ITAAC for the as-design piping analysis:

- The licensee shall perform and satisfy the piping design analysis ITAAC in SER Table 3.12-1.

For the reasons discussed in the technical evaluation section above, the applicant proposes to include the following license condition

- License Condition (3-9) - The licensee will complete, prior to installation of the piping and connected components in their final location, the as-design piping analysis for the piping lines chosen to demonstrate all aspects of the piping design. The availability of the piping design information and design reports for the piping packages is identified to the NRC.

3.12.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to piping design, 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.

In addition, the staff concludes that, pending closure of **Confirmatory Items 3.12-1 and 3.12-2**, the relevant information presented in the VEGP COL application is acceptable and meets the NRC regulations. The staff based its conclusion on the following:

- STD COL 3.9-2 and STD COL 3.9-7 are acceptable because ITAAC have been put in place to allow staff to verify the VEGP COL FSAR, 10 CFR 50.55a, and the ASME Code are met prior to fuel load.

- STD COL 3.9-5 is acceptable because it is consistent with pressurizer surge line monitoring discussed in Appendix D, 10 CFR Part 52.

Table 3.6-1. Pipe Rupture Hazards Analysis ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Systems, structures, and components (SSCs), that are required to be functional during and following a design basis event shall be protected against or qualified to withstand the dynamic and environmental effects associated with analyses of postulated failures in high and moderate energy piping.	Inspection of the as-designed pipe rupture hazard analysis report will be conducted. The report documents the analyses to determine where protection features are necessary to mitigate the consequence of a pipe break. Pipe break events involving high-energy fluid systems are analyzed for the effects of pipe whip, jet impingement, flooding, room pressurization, and temperature effects. Pipe break events involving moderate-energy fluid systems are analyzed for wetting from spray, flooding, and other environmental effects, as appropriate.	An as-designed pipe rupture hazard analysis report exists and concludes that the analysis performed for high and moderate energy piping confirms the protection of systems, structures, and components required to be functional during and following a design basis event.

Table 3.12-1 Piping Design ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
The ASME Code, Section III piping is designed in accordance with the ASME Code, Section III requirements.	Inspection of the ASME Code Design Reports (NCA-3550) and required documents will be conducted for the set of lines chosen to demonstrate compliance.	The ASME Code Design Report(s) (NCA-3550) (certified, when required by the ASME Code) exist and conclude that the design of the piping for lines chosen to demonstrate all aspects of the piping design complies with the requirements of the ASME Code section.

Table 3.8.5-1. Waterproof Membrane Inspections, Tests, Analyses, and Acceptance Criteria (SSAR Table 3.8.5.1-1)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
The friction coefficient to Resist sliding is 0.7 or higher	Testing will be performed to confirm that the mudmat-waterproofing-mudmat interface beneath the Nuclear Island basemat has a mimimum coefficient of friction to resist sliding of 0.7.	A report exists and documents that the as-built waterproof system (mudmat-waterproofing-mudmat interface) has a minimum coefficient of friction of 0.7 as demonstrated through material qualification testing.