3 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

3.1 Conformance to General Design Criteria

Section 3.1 of the William States Lee III Nuclear Station (WLS) combined license (COL) Final Safety Analysis Report (FSAR), Revision 11, incorporates by reference, Section 3.1, "Conformance with NRC General Design Criteria," of Revision 19 of the AP1000 Design Control Document (DCD). In addition, in the WLS COL FSAR, the applicant provided the following:

Departure

- WLS DEP 6.4-1

The applicant provided additional information about WLS DEP 6.4-1 in Section 3.1.2 of the FSAR related to design changes affecting habitability of the main control room and changes to the calculated doses to control room operators. This information, as well as related WLS DEP 6.4-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.2 of this report.

The U.S. Nuclear Regulatory Commission (NRC) staff (the staff) reviewed the application 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 section.[1] The NRC staff's review confirmed that the applicant addressed the required information to satisfy the evaluation criteria. There is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. Section 21.2 of this report evaluates the departure from the DCD provided in WLS DEP 6.4-1.

3.2 Classification of Structures, Components, Equipment, 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

[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).

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. In a nuclear plant, there may be equipment, considered to be non-safety- related that do not have safety functions, however, they may enhance the ability of the plant to withstand or recover from off-normal conditions. For this equipment that are non-safety-related but said to have a risk-significant function, the regulatory treatment of non-safety systems (RTNSS) process is applied to define seismic requirements for those SSCs.

The methodology in the referenced AP1000 DCD is incorporated by reference in the WLS COL application and classifies SSCs into three seismic categories: Seismic Category I, Seismic Category II and Non-seismic (NS). Those plant features designed to remain functional, if an SSE occurs, are designated Seismic Category I. Seismic Category I applies to both functionality and integrity of equipment for an SSE event, and Seismic Category II applies only to integrity. If the failure of a NS SSC during an SSE could result in the loss of function of safety-related items, then they 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.

3.2.1.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.2, incorporates by reference AP1000 DCD, Revision 19, Section 3.2. In addition, in WLS COL FSAR Section 3.2, the applicant provided the following:

Departures

- WLS DEP 3.2-1

The applicant provided additional information about WLS DEP 3.2-1 in Section 3.2 of the FSAR related to design modifications to the condensate return portion of the Passive Core Cooling System. This information, as well as related WLS DEP 3.2-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.1 of the SER.

Supplemental Information

- Standard (STD) Supplement (SUP) 3.2-1

The applicant provided supplemental information by adding text to the end of AP1000 DCD Section 3.2.1, “Seismic Classification,” which stated that there are no safety-related SSCs at WLS outside the scope of the AP1000 DCD. The applicant also stated that the non-safety-related SSCs outside the scope of the AP1000 DCD are classified as non-seismic (NS).

3.2.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for the seismic classification are given in NUREG-0800, "Standard Review Plan [SRP] for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 3.2.1.

The regulatory basis for acceptance of the supplemental information of defining the scope of safety-related SSCs is established in 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 2, "Design Bases for Protection Against Natural Phenomena," which requires that all SSCs that are 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 staff reviewed Section 3.2 of the WLS COL application 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 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 staff's evaluation of the information incorporated by reference in the WLS COL application is documented in NUREG-1793 and its supplements.

Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the safety evaluation report (SER) for the Reference COL application (i.e., Vogtle Electric Generating Plant (VEGP) Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the WLS COL application, as applicable) resulting from requests for additional information (RAIs).

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the WLS COL FSAR.

- The staff verified that the site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content to be directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double-indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the Bellefonte Nuclear Plant (BLN), Units 3 and 4 COL application.

The staff reviewed the following information in the WLS COL FSAR:

Supplemental Information

- STD SUP 3.2-1

The staff reviewed STD SUP 3.2-1, related to the seismic classification of safety-related SSCs included under WLS COL FSAR Section 3.2.1, which states that there are no safety-related SSCs outside the scope of the DCD. Therefore, the seismic classification is acceptable.

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.2.1.4 and concludes that the seismic classification is acceptable:

> *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.

3.2.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

3.2.1.6 *Conclusion*

The staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff concludes that the relevant information presented in the WLS 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:

- WLS DEP 3.2-1, related to design modifications to the condensate return portion of the Passive Core Cooling System, is reviewed and found acceptable by the staff in Section 21.1 of this SER.

- STD SUP 3.2-1 is acceptable because the WLS COL FSAR states that there are no safety-related SSCs outside the scope of the AP1000 DCD. The WLS COL FSAR also states that the non-safety-related SSCs outside the scope of the DCD are classified as NS. 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 Classification Systems

3.2.2.1 *Introduction*

The system and component quality group classification addresses, in part, the general design criterion that nuclear power plant SSCs that are 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 non-safety-related but perform risk significant functions.

The system and component quality group classification in combination with the RTNSS process define appropriate classifications, codes and standards and special treatment for 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 and the appropriate quality standards.

3.2.2.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.2, incorporates by reference AP1000 DCD, Revision 19, Section 3.2. In addition, in WLS COL FSAR Section 3.2, the applicant provided the following:

Supplemental Information

- STD SUP 3.2-1

The applicant provided supplemental information by adding text to the end of AP1000 DCD Section 3.2.2, “AP1000 Classification System,” and stated that there are no safety-related SSCs at WLS outside the scope of the AP1000 DCD.

3.2.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. In addition, the acceptance criteria associated with the relevant requirements of NRC regulations for the system quality group classification are given in NUREG-0800, Section 3.2.2.

The basis for acceptance is established in RG 1.26, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 4, and applicable American Society of Mechanical Engineers (ASME) Codes and industry standards. RG 1.26 provides regulatory guidance for classifying SSCs important to safety and applying the appropriate quality standards. Conformance to the guidance contained in RG 1.26 is one way to ensure 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 staff reviewed Section 3.2 of the WLS COL application and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic. The 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 staff's evaluation of the information incorporated by reference in the WLS application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the COL FSAR.

- The staff verified that the site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content is directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double-indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4 application.

The staff reviewed the following information in the WLS COL FSAR:

Supplemental Information

- STD SUP 3.2-1

The staff reviewed STD SUP 3.2-1 related to the seismic classification of safety-related SSCs included under WLS COL FSAR Section 3.2.2, which states that there are no safety-related SSCs outside the scope of the AP1000 DCD at WLS.

The staff reviewed STD SUP 3.2-1 related to quality group classification of systems included under WLS COL FSAR Section 3.2.2. The staff notes that STD SUP 3.2-1 is identical to STD SUP 3.2-1 in the BLN FSAR with respect to quality group classification of systems included under WLS COL FSAR Section 3.2.2. The staff noted that additional information was needed to evaluate BLN STD SUP 3.2-1 resulting in RAIs being issued to the BLN COL applicant. The WLS COL applicant endorsed the BLN RAI response in a February 5, 2009, letter. As such, the staff's review of STD SUP 3.2-1 is addressed through the comparison with the BLN SER. As discussed below, there are no site-specific non-safety-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 WLS COL FSAR Section 3.2.

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.2.2.4*:*

> *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 staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff concludes that the relevant information presented in the WLS 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:

- STD SUP 3.2-1 is acceptable with regard to quality group classifications because no change was made to the quality group classifications in AP1000 DCD Section 3.2 and there are no site-specific non-safety-related SSCs outside the scope of the AP1000 DCD that are important to safety. Therefore, the staff finds that the requirements of 10 CFR Part 50, Appendix A, GDC 1, the acceptance criteria in NUREG-0800, Section 3.2.2, and the guidelines in RG 1.26 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 in GDC 2 in Appendix A to 10 CFR Part 50 that states SSCs that are 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 this section of the report, 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 report.

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. The staff also reviews the procedures that are used to transform the design wind speed into an equivalent pressure applied to structures taking into consideration the geometrical configuration and physical characteristics of the structures and the distribution of wind pressure on the structures.

3.3.1.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.3, incorporates by reference AP1000 DCD, Revision 19. In WLS COL FSAR Section 3.3.1, the applicant provided the following:

AP1000 COL Information Items

- WLS COL 3.3-1

The applicant provided information in WLS COL FSAR Section 3.3.1.1, “Design Wind Velocity,” to address COL Information Item 3.3-1 stating that the wind velocity characteristics for the WLS site are given in WLS COL FSAR Section 2.3.1.2.8. The applicant stated 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 stated, in part, that the effects of wind 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. The portion of WLS COL 3.3-1 relating to tornado loadings is reviewed in Section 3.3.2 of this report.

3.3.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for wind loadings are given in NUREG-0800, Section 3.3.1.

The regulatory basis for WLS COL 3.3-1 is 10 CFR Part 50, Appendix A, GDC 2, that states SSCs that are 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 and related regulatory guidance in RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1.

3.3.1.4 *Technical Evaluation*

The staff reviewed WLS COL Section 3.3 and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The 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 staff's evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff reviewed the information in the WLS COL FSAR:

AP1000 COL Information Item

- WLS COL 3.3-1

The staff reviewed WLS COL 3.3-1 related to design wind loads applied on safety-related SSCs included under WLS COL FSAR Section 3.3.1.1. The application states in WLS COL 3.3-1 that the wind velocity characteristics for WLS are given in WLS COL FSAR Section 2.3.1.2.8. The COL states that these values are bounded by the DCD design wind velocity values for the standard AP1000 plant.

In Section 2.3.1.4 of this report, the staff concluded that a site characteristic 3-second gust basic wind speed value of 43 meters per second (m/s) (96 miles per hour (mph)) is an acceptable wind speed for this site. Since this value is bounded by the AP1000 design wind speed of 62.8 m/s (145 mph), the staff concludes that the design wind velocities for the WLS site comply with GDC 2 and are acceptable; therefore, WLS 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 staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of GDC 2.

- WLS COL 3.3-1, as it relates to design wind loads, is acceptable based on the site-specific wind velocities, reviewed in Section 2.3 of this report, being bounded by the AP1000 DCD design wind velocities and, therefore, complies with GDC 2.

3.3.2 Tornado Loading

3.3.2.1 *Introduction*

Tornado loadings are considered for design in accordance with AP1000 DCD Section 3.3.2, "Tornado Loadings." AP1000 DCD Section 3.3.2 addresses tornado loadings for Seismic Category I structures using applicable tornado design parameters to determine forces on structures as explained in AP1000 DCD Section 3.3.1.2. Also AP1000 DCD Section 3.3.2.1 states that the estimated probability of tornado wind speeds to be greater than the design basis tornado is between $10E^{-6}$ and $10E^{-7}$ per year at a "worst location" anywhere within the contiguous United States. The WLS COL FSAR discusses and supplements the AP1000 DCD in Sections 3.3.2.1, "Applicable Design Parameters," and 3.3.2.3, "Effect of Failure of Structures or Components Not Designed for Tornado Loads."

3.3.2.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.3, incorporates by reference AP1000 DCD, Revision 19. In WLS COL FSAR Section 3.3.2, the applicant provided the following:

AP1000 COL Information Items

- WLS COL 3.3-1

The applicant provided information in WLS COL FSAR to resolve COL Information Item 3.3-1. In WLS COL 3.3-1, the applicant stated in WLS COL FSAR Section 3.3.2.1 that tornado characteristics for WLS, given in WLS COL FSAR Section 2.3.1.2.2, are bounded by the tornado design parameters given in AP1000 DCD Section 3.3.2.1 for the standard AP1000 plant. In addition, the applicant stated 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. The portion of WLS COL 3.3-1 relating to design wind velocity characteristics is reviewed in Section 3.3.1 of this report.

- STD COL 3.3-1

The information provided in WLS COL FSAR Section 3.3.2.3 to address STD COL 3.3-1 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 plant.

3.3.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for tornado loading are given in NUREG-0800, Section 3.3.2. Acceptance of WLS COL 3.3-1 is established based on site-specific parameters and verification of bounding conditions for relevant parameters related to the AP1000 DCD interface criteria for tornado, site arrangement, and building construction. The design of AP1000 safety-related SSCs for tornado loads must meet the requirements of 10 CFR Part 50, Appendix A, GDC 2 that states 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 staff reviewed WLS COL FSAR Section 3.3.2 and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The 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 staff's evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff reviewed the information in the WLS COL FSAR:

AP1000 COL Information Item

- WLS COL 3.3-1

The staff reviewed WLS COL 3.3-1 included under WLS COL FSAR Sections 3.3.2 and 3.5.1. Specific information provided by the applicant includes development of site-specific parameters and verification of bounding conditions, site arrangement and building construction. In WLS COL 3.3-1, the applicant stated that the tornado characteristics for WLS, given in WLS COL FSAR Section 2.3.1.2.2, are bounded by the tornado design parameters given in AP1000 DCD Section 3.3.2.1 for the standard AP1000 plant design. In addition, the applicant stated 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 of this report, 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 WLS site comply with GDC 2.

The scope of WLS COL 3.3-1 also includes the effects of wind and tornado on the safety-related SSCs due to failure of non-safety-related buildings in an adjacent AP1000 plant and WLS. The applicant stated that these effects are bounded by the evaluation of the buildings and structures in a single unit. 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 had the following three options in AP1000 DCD Section 3.3.2.3.

1. design the adjacent non-safety-related structure to the design basis tornado loading

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

3. design a structural barrier to protect Seismic Category I SSCs from adjacent structural collapse

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

- STD COL 3.3-1

COL standard information item STD COL 3.3-1 addresses the effect of failure of SSCs not designed for tornado loadings in WLS COL FSAR Section 3.3.2.3. COL standard information item STD COL 3.3-1 involves consideration of a tornado-initiated failure of site-specific structures and components whose failure could compromise the safety of AP1000 safety-related structures and components at WLS site.

The staff reviewed the resolution to the COL Information Item STD COL 3.3-1 relating to the effect of failure of SSCs not designed for tornado loadings included under WLS COL FSAR Section 3.3.2.3. To ensure 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 AP1000 DCD Section 3.3.2.3:

1. design the adjacent non-safety-related structure to the design basis tornado loading

2. analyze the effect of failure of adjacent non-safety-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 STD COL 3.3-1, the applicant used Option 2. Since the applicant has not placed any additional structures adjacent to the standard unit, the original analysis done in AP1000 DCD Section 3.7.2.8 is still valid. The staff's review of this analysis is provided in NUREG-1793 and its supplements. Based on the above discussion, the staff consider STD COL 3.3-1 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 staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff concludes that the relevant information presented in the WLS COL FSAR Section 3.3.2 is acceptable and meets the requirements of 10 CFR Part 50, Appendix A, GDC 2.

- WLS COL 3.3-1, as it relates to design tornado loads, is acceptable based on the design tornado site characteristics, reviewed in Section 2.3 of this report, matching the AP1000 DCD design tornado site characteristics and, therefore, complying with GDC 2. WLS COL 3.3-1, as it relates to the effects of wind and tornado on the safety-related SSCs due to failure of non-safety-related buildings in an adjacent AP1000 plant and WLS is acceptable because the applicant incorporated by reference acceptable methodology from AP1000 DCD Section 3.7.2.8.

- STD COL 3.3-1, as it relates to the effects of wind and tornado on the safety-related SSCs due to failure of non-safety-related buildings in an adjacent AP1000 plant is acceptable because the applicant incorporated by reference an acceptable assessment methodology from AP1000 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*

WLS COL FSAR, Revision 11, Section 3.4 incorporates by reference AP1000 DCD, Revision 19, Section 3.4. In WLS COL FSAR Section 3.4, the applicant provided the following:

AP1000 COL Information Item

- WLS COL 3.4-1

The applicant provided information to resolve COL Information Item 3.4-1, which addresses plant-specific information on site-specific flooding hazards protective measures. That information, for WLS COL 3.4-1, in WLS COL FSAR Section 3.4.1.3, "Permanent Dewatering System," and WLS COL FSAR Section 3.4.3, "Combined License Information," states that no permanent dewatering system is required because site groundwater levels are 0.6 meters (m) (2 feet (ft) or more below site grade level and the site-specific water levels satisfy the interface requirements identified in AP1000 DCD Section 2.4, respectively.

3.4.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The regulatory acceptance criteria associated with the relevant requirements of NRC regulations for flood protection measures are given in NUREG-0800, Section 3.4.1. The acceptance criteria associated with the relevant requirements of NRC regulations for the identification of floods and flood design considerations are given in NUREG-0800, Section 2.4.12.

3.4.1.4 *Technical Evaluation*

The staff reviewed this application 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 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 staff's evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff reviewed the following information in the WLS COL FSAR:

AP1000 COL Information Item

- WLS COL 3.4-1

The staff reviewed WLS COL 3.4-1 addressing the permanent dewatering system and site-specific water levels in WLS COL FSAR Sections 3.4.1.3 and 3.4.3, respectively. This site-specific COL item states that the 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 applicant may propose protective measures as discussed in Section 2.4. In WLS COL FSAR Section 3.4, the applicant provided the following plant-specific information:

- WLS COL FSAR Section 3.4.1.3, "Permanent Dewatering System," states that no permanent dewatering system is required because site groundwater levels are 0.6 m (2 ft) or more below site grade level as described in WLS COL FSAR Section 2.4.12.5.

- WLS COL FSAR Section 3.4.3, "Combined License Information," states that the site-specific water levels given in WLS COL FSAR Section 2.4 satisfy the interface requirements identified in AP1000 DCD Section 2.4.

In Section 2.4.12 of this report, the staff accepted the WLS applicant's position that no permanent dewatering system is required and that the site-specific groundwater characteristics for the WLS site fall within the Tier 1 and Tier 2 AP1000 DCD parameter values. Therefore, the staff concludes that the site-specific information in WLS 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 staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the regulatory guidance in NUREG 0800, Sections 2.4.12 and 3.4.1. :

- WLS COL 3.4-1, is acceptable based the staff's conclusions in NUREG-1793 regarding the need for a permanent dewatering system and on the staff's conclusions in Section 2.4.12 of this report that no permanent dewatering system is required and that the site-specific groundwater characteristics for the WLS site fall within the Tier 1 and Tier 2 AP1000 DCD groundwater parameter values.

3.4.2 Analytical and Test Procedures

Analysis methods and test 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. WLS COL FSAR, Revision 11, Section 3.4 incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19, Section 3.4.2, "Analytical and Test Procedures." AP1000 DCD Section 3.4.2 states that the analytical approach for external and internal flooding events is described in AP1000 DCD Section 3.4.1.2, "Evaluation of Flooding Events." The staff reviewed the application and checked the referenced AP1000 DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS 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). When a missile hazard is identified, its statistical significance is determined (a missile is significant when it 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*

The design credits safety-related structures, systems, and components to establish and maintain safe shutdown conditions following a postulated event such as internally generated missiles. The SSCs needed to bring the plant to safe shutdown, including the main control room and the recirculating service water system are located inside the auxiliary building and containment shield building, respectively. Both the auxiliary and containment shield buildings are Seismic Category I NI structures having thick structural concrete walls that provide internal and external missile protection. The missiles generated outside containment by rotating or pressurized (high-energy fluid system) equipment are included. Aircraft hazards and missiles generated by human activities offsite as well as those generated by weather are also considered. SSCs considered "important to safety" are protected against internally generated missiles (outside containment), in accordance with NUREG-0800, Section 3.5.1.1.

3.5.1.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.5, "Missile Protection," incorporates by reference AP1000 DCD, Revision 19, with site-specific information and supplements. WLS COL FSAR Section 3.5.1, "Missile Selection and Description," which includes Sections 3.5.1.1, "Internally Generated Missiles (Outside Containment)"; 3.5.1.2, "Internally Generated Missiles (Inside Containment)"; 3.5.1.3, "Turbine Missiles"; 3.5.1.4, "Missiles Generated by Natural Phenomena"; 3.5.1.5," Missiles Generated by Events Near the Site"; and 3.5.1.6, "Aircraft Hazards." In WLS COL FSAR Section 3.5, the applicant provided the following:

AP1000 COL Information Item

- WLS COL 3.5-1

The applicant provided information in the WLS COL FSAR to resolve WLS COL 3.5-1. WLS COL FSAR Section 3.5.1.5, "Missiles Generated by Events Near the Site," states that certain buildings, such as the gate house, administrative building water service building, et al., at the WLS site are common structures located at a nuclear power plant. Therefore, any missiles resulting from a tornado-initiated failure of those common structures are not more energetic than tornado missiles postulated for design of the AP1000. Furthermore, the WLS COL FSAR states that the missiles generated by events near the site are evaluated in accordance with WLS COL FSAR Section 2.2.3. With regard to WLS COL 2.5-1, WLS COL FSAR Section 3.5.1.6, "Aircraft Hazards," states that the approach and methodology from NUREG-0800, Section 3.5.1.6 has been used to calculate the probability of an aircraft crash into areas of safety-related structures. Descriptions of Airports and Airways are addressed in WLS COL FSAR Section 2.2.2.7 and aircraft hazards are evaluated in WLS COL FSAR Section 3.5.1.6.

Supplemental Information

- STD SUP 3.5-1

The applicant provided information in WLS COL FSAR Section 3.5.1.3, "Turbine Missiles," to address STD SUP 3.5-1. This supplemental information states that the potential for a turbine missile from another AP1000 plant in close proximity has been considered for WLS in accordance with RG 1.115, "Protection Against Low-Trajectory Turbine Missiles," Revision 1. The WLS COL FSAR also states that in addition to low potential for turbine missile strike, the design of safety-related structures such as the shield building provide additional protection for safety-related SSCs from this event.

- STD SUP 3.5-2

The applicant provided supplemental information WLS COL FSAR Section 3.5.1.3, "Turbine Missiles," by stating that the turbine system maintenance and inspection program is discussed in WLS COL FSAR Section 10.2.3.6.

3.5.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," September 2004, and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for missile selection and description are given in NUREG-0800, Sections 3.5.1.1 through 3.5.1.6.

The design of safety-related structures for protection against missiles using acceptable procedures must meet the requirements of 10 CFR Part 50, Appendix A, GDC 2.
10 CFR 100.21(e), "Non-seismic site criteria," provides regulatory requirements for potential hazards associated with nearby transportation routes, industrial and military facilities. The regulatory basis for acceptance of WLS COL 3.5-1 is that the applicant developed sufficient site-specific parameters and verification of bounding conditions compared to the AP1000 DCD interface criteria for missile generation, site arrangement, and building construction. Additional regulatory guidance related to the review in this report is contained in RG 1.76 on design-basis

tornado and tornado missiles, RG 1.91 on evaluation of explosions postulated to occur on transportation routes, RG 1.115, Sections C.1 and C.3, on protection against low trajectory turbine missiles, and RG 1.117, Regulatory Positions C.1 through C.3 on tornado design classification.

3.5.1.4 *Technical Evaluation*

The staff reviewed this application and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the WLS COL application and incorporated by reference addresses the required information relating to missile protection of safety-related SSCs. The staff's evaluation of the information incorporated by reference in the WLS COL application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the Reference COL application (VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews.

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the COL application, as applicable) resulting responses to from RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the COL FSAR.

- The staff verified that the site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusions.

The staff completed its review and concluded that the evaluation performed for the standard content is directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double-indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4 COL application. The staff reviewed the information in the WLS COL FSAR:

AP1000 COL Information Items

- WLS COL 3.5-1

The staff reviewed information related to missiles generated near the site included under WLS COL FSAR Section 3.5.1.5 related to missiles generated by events near the site included under WLS COL FSAR Section 3.5.1.5. The applicant provided site-specific information to resolve the COL information items stating that the effects of explosions have been evaluated and it has been determined that the over pressure criteria of RG 1.91 is not exceeded. Since the staff did not identify any over pressure criteria, no further evaluation of postulated missiles is required as the effect of postulated missiles will be less than those associated with the over-pressure levels considered in RG 1.91.

WLS COL FSAR Section 3.5.1.6, "Aircraft Hazards," states that based on the description of nearby aircraft handling facilities and air routes in WLS COL FSAR Section 2.2.2.7, and the methodology outlined in NUREG-0800, "Standard Review Plan," Section 3.5.1.6, "Aircraft Hazards," the applicant concludes that it can be qualitatively shown that the total aircraft crash hazard probability of for WLS is much lower than was conservatively calculated to be 1.8×10^{-7}/year. Therefore, the applicant concludes the aircraft hazards pose no undue risk to the health and safety of the public.

The applicant evaluated potential aircraft hazards and effects on safety-related structures following the approach and methodology outline in NUREG-0800 Section 3.5.1.6, "Aircraft Hazards." and determined the effects of an aircraft crash on safety-related structures in the site. The probability of aircraft accidents resulting in radiological consequences that may exceed the 10 CFR Part 100 radiological dose requirements was evaluated by the applicant based on its one Federal airway that passes within 6.4 km (4 mi) of the plant. Low altitude Airway V54 runs between Spartanburg Downtown Memorial Airport (SPA) (located 42 km (26.1 mi) from WLS) and Charlotte/Douglas International Airport (CLT). CLT is located 55 km (34.4 mi) from WLS. Information was provided regarding the number of flights using this airway V54. No airports having flights more than $500D^2$ per year located within 16 km (10 mi) of WLS. There are no military training routes within 16 km (10 mi) of the site.

The staff performed independent confirmatory probability calculations using the most conservative total highest annual flight data within 9 km (5 mi) of the plant obtained from the Federal Aviation Administration (FAA) covering the 5-year period from 2004-2008 and applying to Airway V54. Based on using this FAA annual flight data for the year 2007 conservatively, the staff also concluded the total aircraft accident probability of about 1.8×10^{-7} per year, which is less than the acceptance criteria of 10^{-6} per year in NUREG-0800, Section 3.5.1.6.

On the basis of the confirmatory analysis and the review of the applicant's assumptions and data used for the estimation of aircraft accident probability, the staff concludes that the operation of the WLS in the vicinity of the CLT does not present an undue risk to the health and safety of the public and meets the relevant requirements of 10 CFR Part 100 and 10 CFR 100.10 (or 10 CFR 100.20, as appropriate) and meets the acceptance criteria provided in NUREG-0800, Sections 3.5.1.5 and 3.5.1.6. This conclusion is based on information provided in the WLS COL FSAR and the staff's independent verification of the applicant's assessment of aircraft hazards at the site that resulted in a probability on the order of magnitude of 10^{-7} per year for an accident having radiological consequences worse than the exposure guidelines of 10 CFR Part 100.

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

> *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.*

<u>Resolution of the Standard Content Evaluation Concerning Open Item 1-1 for Turbine Missiles</u>

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.

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.

3.5.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

3.5.1.6 *Conclusion*

The staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the WLS COL applicant addressed the required information relating to missile protection, and there is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the regulatory guidance in NUREG-0800, Sections 3.5.1.1 through 3.5.1.6.

- WLS COL 3.5-1 is acceptable because it meets the regulatory requirements by meeting the acceptance criteria provided in NUREG-0800, Sections 3.5.1.5 and 3.5.1.6.

- 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, it ensures that the requirements of 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases," 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, and conclusions on, the turbine maintenance and inspection program is included in Section 10.2 of this report.

3.5.2 Protection from Externally Generated Missiles

Systems required for safe shutdown are protected from the effects of missiles. Protection of SSCs from external missiles, including those generated by natural phenomena, is generally provided by the external walls and roof of the Seismic Category I NI structures. The external walls and roofs are generally reinforced concrete. The structural design requirements for the shield building and auxiliary building are outlined in AP1000 DCD Section 3.8.4. Where openings through these walls are provided, they are evaluated on a case-by-case basis to

demonstrate 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.

WLS COL FSAR, Revision 11, Section 3.5, incorporates by reference AP1000 DCD, Revision 19, Section 3.5.2, "Protection from Externally Generated Missiles," without any departures or supplements. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS 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.

WLS COL FSAR, Revision 11, Section 3.5, incorporates by reference AP1000, Revision 19, Section 3.5.3, "Barrier Design Procedures," without any departures or supplements. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS 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

WLS COL FSAR, Revision 11, Section 3.6, incorporates by reference AP1000 DCD, Revision 19, Section 3.6. In WLS COL FSAR Section 3.6.4, the applicant provided the following additional information:

AP1000 COL Information Items

- STD COL 3.6-1

The applicant provided information in WLS COL FSAR Section 3.6.4.1, "Pipe Break Hazard Analysis," and in 14.3.3, "CDM Section 3.0, Non-System Based Design Descriptions and ITAAC," for STD COL 3.6-1 to address the applicable AP1000 DCD information item. Specifically, the applicant stated: (1) the as-designed pipe rupture hazards evaluation will be in accordance with AP1000 DCD criteria with SSCs identified to be essential targets will be protected, and (2) 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 for high- and moderate energy piping. The applicant further stated that the final design of these activities will be completed prior to installation of the piping and connected components. The as-built reconciliation of the pipe rupture hazards evaluation whip restraint and jet shield design will be completed prior to fuel load and will be available for NRC review.

- STD COL 3.6-4

The applicant provided information in STD COL 3.6-4 to address the information item, regarding the use of Alloy 690 and as-built verification of LBB piping.

License Condition

- Part 10, License Condition 2, "COL Holder Items," Item 3.6-1

The applicant proposed a license condition addressing the as-designed pipe rupture hazards analysis completion schedule and the contents of a related design report.

Inspections, Tests, Analyses and Acceptance Criteria (ITAAC)

In a November 3, 2010, letter, the applicant endorsed the April 23, 2010, letter from the VEGP applicant that proposed adding to the AP1000 DCD, Tier 1, Section 3.3, an ITAAC in the WLS COL, Part 10, Appendix B, "Inspections, Tests, Analysis, and Acceptance Criteria," denoted as Table 3.3-8, "Pipe Rupture Hazards Analysis (Sheet 1 of 1)," requiring the completion of an as-designed pipe rupture hazards analysis to demonstrate that SSCs required to be functional during and following a design basis event are protected against or qualified to withstand the dynamic and environmental effects with analyses of postulated pipe failures in high- and moderate-energy piping.

3.6.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. In addition, the acceptance criteria associated with the relevant requirements of NRC regulations (10 CFR Part 50, Appendix A, GDC 4) for the piping design

against pipe breaks, pipe break locations and characteristics in safety-related piping, and LBB evaluation procedures are given in NUREG-0800, Sections 3.6.1, 3.6.2, and 3.6.3.

3.6.4 Technical Evaluation

The staff reviewed this application section and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic. The staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the protection against dynamic effects associated with the postulated rupture of piping. The staff's evaluation of the information incorporated by reference in the WLS application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content for the Reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews.

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the WLS COL FSAR.

- The staff verified that site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content to be directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (VEGP) contains evaluation material from the SER for the Bellefonte Nuclear Plant, Units 3 and 4 COL application. The staff reviewed the following information in the WLS COL FSAR.

AP1000 COL Information Items

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

- *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-# [where # is the next sequential number] 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 14.3.3related 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.# [where # is the next sequential number], 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.

Resolution of Standard Content Confirmatory Item 3.6-1

Confirmatory Item 3.6-1 is an applicant commitment to revise its FSAR Section 3.6.4.1 and, Section 14.3.3.2, to verify the incorporation of the as-designed pipe rupture hazard analysis and add an ITAAC (Table 3.8-1) for the as-designed pipe rupture hazard analysis. The staff verified that the VEGP COL FSAR and Part 10 of the application (ITAAC Table 3.8-1) were appropriately updated. As a result, Confirmatory Item 3.6-1 is now closed.

- WLS COL 3.6-1

The staff reviewed WLS COL 3.6-1 included under WLS COL FSAR Section 3.6. The applicant replaced the last paragraph in AP1000 DCD Section 3.6.4.1, stating that after a COL is issued, the COL holder will complete an as-designed pipe rupture hazard evaluation that will be available for review. The evaluations will be provided prior to fabrication and installation of the piping and connected parts. In a July 22, 2011, letter, the applicant committed to remove this

additional information because the standard content provided in WLS COL FSAR, Revision 2 provides all the necessary information for resolving STD COL 3.6-1. This is being tracked as Confirmatory Item 3.6-2.

Resolution of Confirmatory Item 3.6-2

Confirmatory Item 3.6-2 was an applicant commitment to remove excess information from the WLS COL FSAR Section 3.6.4.1. The staff verified that the information was removed. As a result, Confirmatory Item 3.6-2 is now closed.

3.6.5 Post Combined License Activities

The license condition language in this section has been clarified from previously considered language. In a letter dated March 22, 2016 (ADAMS Accession No. ML16084A099), the applicant did not identify any concerns with the clarified license condition language. The changes do not affect the staff's above analysis of the conditions, and therefore, for the reasons discussed in the technical evaluation section above, the staff finds the following ITAAC and license condition acceptable:

- The licensee shall perform and satisfy the pipe rupture hazards analysis described in WLS COLA, Part 10, Appendix B, ITAAC Table 3.3-8, "Pipe Rupture Hazards Analysis (Sheet 1 of 1)."

- License Condition (3-1) – Before commencing installation of individual piping segments and connected components in their final locations, the licensee shall complete the as-designed pipe rupture hazards analysis for compartments (rooms) containing those segments in accordance with the criteria outlined in the AP1000 DCD, Rev. 19, Sections 3.6.1.3.2 and 3.6.2.5, and shall inform the Director of NRO, or the Director's designee, in writing, upon the completion of this analysis and the availability of the as-designed pipe rupture hazards analysis reports.

3.6.6 Conclusion

The staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant addressed the required information relating to the pipe design against pipe break, pipe break locations, characteristics in safety-related piping, and LBB evaluation procedures and there is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In addition, the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of 10 CFR Part 50, Appendix A, GDC 4. The staff based its conclusion on the following:

- STD COL 3.6-1 is acceptable because the applicant's proposed resolution in WLS 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 to these guidelines provides an acceptable basis to satisfy, in part, the requirements of 10 CFR Part 50, Appendix A, GDC 4.

- STD COL 3.6-4 is acceptable because the applicant's proposed resolution in WLS COL FSAR Section 3.6.4.4 meets the relevant guidelines of NUREG-0800, Section 3.6.3 and RG 1.206, Section C.III.1, Chapter 3, C.I.3.6.3 and is, thus, acceptable. Conformance to these guidelines provides an acceptable basis to satisfy, in part, the requirements of 10 CFR Part 50, Appendix A, GDC 4

3.7 Seismic Design

Section 3.7 of this report focuses on the seismic analyses of NI structures (Seismic Category I) and adjacent Seismic Category II structures. Seismic design of the AP1000 Seismic Category I and II structures, systems, equipment, and components are based on the SSE. Low-level seismic effects are included in the design of certain equipment that are potentially sensitive to a number of low-level 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. Seismic Category I SSCs are designed to withstand the effects of the SSE and maintain the specified design functions. Seismic Category II and NS SSCs are designed or physically arranged (or both) so that the SSE would not cause unacceptable structural interaction with or failure of Seismic Category I SSCs.

On April 25, 2012, the staff issued RAI 105, Question 01.05-1 pertaining to the implementation of the Fukushima Near-Term Task Force (NTTF) Recommendations for the WLS. RAI 105, Question 01.05-1 addressed NTTF Recommendation 2.1, requested that the applicant (1) evaluate the potential impacts of the new Central and Eastern United States Seismic Source Characterization model (CEUS-SSC; NUREG-2115) on the seismic hazard curves and the site-specific ground motion response spectra (GMRS)/foundation input response spectra (FIRS) and (2) modify the GMRS/FIRS as necessary.

In a January 30, 2014, response, the applicant addressed the implementation of the CEUS-SSC in updating the site-specific seismic hazards and response spectra for the WLS and the respective effects on the Nuclear Island (NI) structures. In a supplemental response, dated February 28, 2014, the applicant addressed the effects of the updated site-specific hazards on the seismic Category II structures adjacent to the NI. The aforementioned responses also included changes to the WLS FSAR. The staff's review of the development of the updated site-specific hazard is discussed in Section 2.5 of this report. Section 3.7 of this report focuses on the seismic analyses of NI structures and adjacent seismic Category II structures. These seismic analyses are based on the new WLS site-specific seismic hazard. On the basis of the above discussion, the staff considers this RAI resolved

3.7.1 Seismic Design Parameters

3.7.1.1 *Introduction*

In this section, the input seismic design GMRS for the SSE in the free field at plant grade is addressed.

3.7.1.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.7, incorporates by reference AP1000 DCD, Revision 19, In addition, in WLS COL FSAR Section 3.7, the applicant provided the following:

Departures

- WLS DEP 2.0-1

The seismic design of the AP1000 standard plant is based on the Certified Seismic Design Response Spectra (CSDRS) as addressed in AP1000 DCD Section 3.7.1.1. The AP1000 DCD also includes hard rock high frequency (HRHF) spectra for evaluation of site-specific GMRS. The WLS site-specific horizontal and vertical spectra exceed the CSDRS and HRHF spectra; therefore, constituting a departure from the AP1000 certified design. This departure is identified in WLS COL FSAR Table 2.0-201 and WLS COL FSAR Sections 3.7.1.1.1, 3.7.2.8.4, 3.7.2.15, Appendix 3I, and WLS COL FSAR Section 19.55.6.3. Consistent with the requirements of the AP1000 DCD Tier 1, Table 5.0-1, AP1000 DCD Section 2.5.2.1, paragraph 4b, and AP1000 DCD Section 3.7.2.8.4, the applicant performed site-specific analysis to demonstrate the adequacy of the standard design for the WLS site. The staff's evaluation of WLS DEP 2.0-1 and supporting site-specific analysis is included in Section 3.7.2.4 of this report.

Supplemental Information

- WLS SUP 3.7-3

The applicant provided information in WLS SUP 3.7-3 by adding Section 3.7.1.1.1, "Design Foundation Spectra," to the WLS COL FSAR, with site-specific foundation input response spectra for each WLS unit.

3.7.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for the seismic design parameters are given in NUREG-0800, Section 3.7.1 and interim staff guidance (ISG) in the form of DC/COL-ISG-1, "Interim Staff Guidance on Seismic Issues of High Frequency Ground Motion in Design Certification and Combined License Applications."

3.7.1.4 *Technical Evaluation*

The horizontal and vertical design GMRS for the AP1000 were developed based on the response spectra in RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 1, with special consideration of high-frequency amplification effects. The staff reviewed WLS COL FSAR Section 3.7 and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and that incorporated by reference addresses the required information relating to seismic design parameters. The results of the staff's evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff's review of the information in the WLS COL FSAR is as follows:

Supplemental Information

- WLS SUP 3.7-3

WLS SUP 3.7-3 addresses site-specific NI FIRS for each of the WLS units, separately. The applicant stated that individual foundation response spectra were provided for the certified design portion of the Units 1 and 2 plants based on their unique foundation conditions. WLS COL FSAR Sections 2.5.2.7 and 3.7.1.1.1 describe the applicant's site-specific seismic velocity model and associated calculation of the WLS site-specific FIRS. The applicant developed site-specific dynamic velocity models and used the probabilistic method of random vibration theory (RVT), as described in NUREG/CR-6728 as Approach 3, to compute the location-specific FIRS at the WLS site.

The applicant developed three site-specific dynamic velocity models to represent localized foundation conditions – Unit 1 A1, Unit 1 A5, and Unit 2 C4. WLS COL FSAR Section 2.5.4.7 describes the material dynamic properties and WLS COL FSAR Figures 2.5.4-252a, 2.5.4-252b, and 2.5.4-252c show the dynamic velocity profiles for Base Cases A1, A5, and C4, respectively, which represent the Unit 1 FIRS A1, Unit 1 FIRS A5, and Unit 2 FIRS C4 configurations.

As described in WLS COL FSAR Section 2.5.2.7 the WLS Unit 1, FIRS A1 represents the Unit 1 nuclear island centerline foundation input motion that supports the Unit 1 nuclear island. The applicant based its Unit 1 FIRS A1 on the GMRS developed at the hard rock condition, as defined by CEUS attenuation relationships (2,830 m/s (9,282 fps)), at 161 m (530 ft) (NAVD), transferred up through previously placed Cherokee Nuclear Station (CNS) concrete materials and newly placed WLS concrete materials to the basemat foundation level at 168.7 m (553.5 ft) (NAVD). The applicant's site-specific dynamic velocity model for Unit 1 A1 contains approximately 2.4 m (8 ft) of new fill concrete overlying an average of about 4.5 m (15 ft) of existing fill concrete, structural basemat concrete and native rock from the former CNS foundation. In total, the applicant's Unit 1 FIRS A1 site-specific seismic velocity profile contains 7 m (23.5 ft) of fill concrete material of shear wave velocities of 2286 m/s (7,500 fps) overlying hard rock (WLS COL FSAR Figure 2.5.4-252a).

The applicant also described that the WLS Unit 1 FIRS A5 represents the Unit 1 localized condition where the nuclear island overlies legacy CNS pump rooms. The applicant based its WLS FIRS A5 on the WLS GMRS developed at the hard rock condition and transferred up through 9 m (30.5 ft) of previously placed CNS concrete materials and newly placed WLS concrete materials to the basemat foundation level at 168.7 m (553.5 ft) (NAVD) (WLS COL FSAR Figure 2.5.4-252b).

The applicant described that the WLS Unit 2 FIRS C4 represents the eastern edge of the Unit 2 nuclear island which may be supported by up to 6 m (20 ft) of new leveling fill concrete. The applicant's Unit 2 FIRS C4 is based on the WLS GMRS developed at the top of the hard rock condition fixed at 155 m (509 ft) (NAVD) and transferred up through 6 m (20 ft) of newly placed WLS concrete materials to the basemat foundation level at 168.7 m (553.5 ft) (NAVD) (WLS COL FSAR Figure 2.5.4-252c). The applicant randomly varied each site-specific seismic velocity base profile by ± 1 m (± 3 ft).

The applicant first generated randomized site-specific seismic velocity model profiles and associated shear moduli and damping parameters that represent possible variations from the base seismic mode, consistent with RG 1.208. Then the applicant calculated site-specific response amplification functions for each randomized profile using the RVT methodology. The

use of RVT in site response calculations is described in RG 1.208 as a possible methodology that can be used. RG 1.208 specifically states, "…RVT methods are acceptable as long as the strain dependent soil properties are adequately accounted for in the analysis." Similar to the time series methodology, RVT analysis produces an amplification function that is then applied to the rock spectra to obtain the response spectra defined at the ground surface (or at any intermediate point within the soil profile), which accounts for the effects of soil amplification (or deamplification) on the input base hard rock ground motion. To accommodate the possibility of distance-dependent transfer functions in a linear analysis, the applicant used a suite of spectral shapes as control motions at distances of 1, 20, 100, 200, and 400 km (0.6, 12, 62,125, 250 mi). The applicant shows those results in WLS COL FSAR Figures 2.5.2-241a, 2.5.2-241b, and 2.5.2-241c, which display a small site resonance at high frequencies. Following the guidance of RG 1.208, the staff focused its review on the input parameters used in the site amplification functions calculations. Inputs to the RVT method include response spectra which are based on the hard rock UHRS, 60 randomized velocity profiles, effective strain ratio, and strong motion duration. Having reviewed the applicant's input parameters; the staff concludes that the applicant's selection of input parameters is adequate to calculate the FIRS amplification functions at the WLS site.

In WLS COL FSAR Section 3.7.1.1.1, the applicant described that it used the envelope of the Unit 1 and Unit 2 FIRS, referring to the enveloped spectra as NI FIRS. The resulting horizontal NI FIRS is shown in Figure 3.7.1.4-1 of this report and the vertical NI FIRS is shown in WLS COL FSAR Figure 3.7-202.

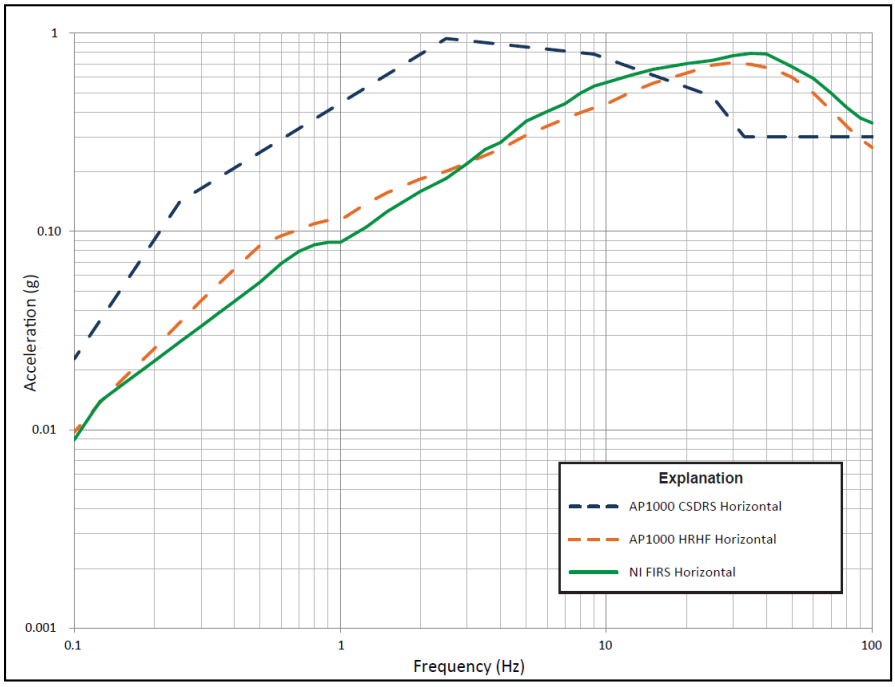

Figure 3.7.1.4-1 The WLS horizontal NI FIRS, the AP1000 horizontal certified seismic design response spectra (CSDRS), and the AP1000 horizontal hard rock high frequency spectra (HRHF). (Ref. WLS COL FSAR Revision 9, FSAR 3.7-201)

To determine the adequacy of the applicant's FIRS calculations, the staff completed confirmatory calculations. As input, the staff used the static and dynamic properties provided in WLS COL FSAR Section 2.5.4 and 2.5.2.7 for base cases A1, A5, and C4. To represent the input rock motions, the staff used the applicant's low- and high-frequency 10^{-4} and 10^{-5} rock spectra. The staff completed its site response calculations using the Strata software (Kottke and Rathje, 2008). The staff compared its calculated horizontal NI FIRS with the applicant's in Figure 3.7.1.4-2 of this report. Figure 3.7.1.4-2 of this report shows that the staff's NI FIRS calculation is similar to the applicant's NI FIRS across the frequency range typically important for engineering purposes (i.e., 0.5 to 10 Hz).

The staff noted a difference between the applicant's and the staff's NI FIRS results at high frequencies (between approximately 40 and 100 Hz). The staff noted the WLS FIRS amplification transfer functions show amplification from approximately 30 to 100 Hz due to the varying fill concrete beneath the WLS proposed structures, which means that at those frequencies the FIRS should have larger spectral accelerations than the WLS site-specific GMRS. In contrast, the WLS NI FIRS is less than the WLS GMRS at high frequencies. To investigate this issue, in RAI 118, Question 03.07.01-6, the staff requested that the applicant assess and evaluate the inconsistency of WLS FIRS amplification transfer functions, FIRS, and the GMRS and to provide a thorough description of the assessment and evaluation. The staff also requested that the applicant explain the basis and justify the conclusions regarding the relationship between the WLS site-specific amplification functions, FIRS, and GMRS.

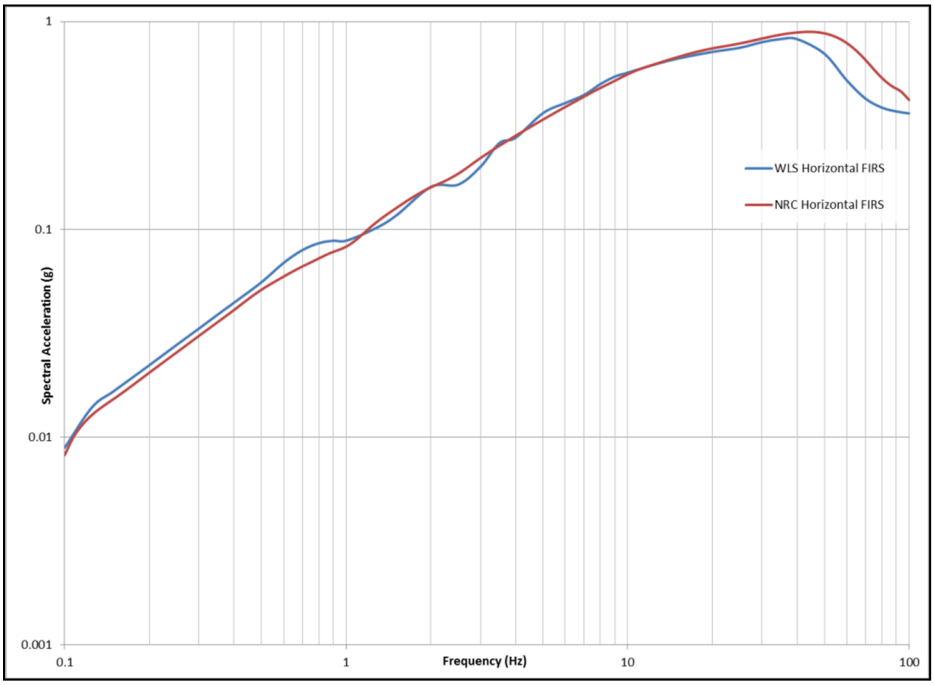

Figure 3.7.1.4-2 The WLS horizontal NI FIRS and the staff's (NRC) horizontal NI FIRS

In a July 24, 2014, response to RAI 118, Question 03.07.01-6, the applicant described that the noted differences in the relationships of the horizontal GMRS and FIRS are attributed to differences in high-frequency interpolation methods used to develop the rock (GMRS) and concrete (FIRS) spectral shapes. In Figure 3.7.1.4-3 of this report, the applicant presented the horizontal GMRS and FIRS A1 from WLS COL FSAR, Sections 2.5.2.6 and 2.5.2.7 (labeled as

"Orig") and compared them to alternative calculations of the horizontal GMRS and FIRS A1 based on the FIRS high-frequency interpolation method ("Altern"). The applicant's RAI response results demonstrated that using the same interpolation methods lead to consistent spectral shapes and resulting in a GMRS that is generally lower than the GMRS presented in WLS COL FSAR Revision 9.

Based on this review, the staff concludes that the WLS COL FSAR Revision 9 horizontal GMRS and FIRS spectra are considered appropriate. Additionally, the staff also concludes that the difference in interpolation methods explains the differences between the WLS NI FIRS and the NRC NI FIRS shown in Figure 3.7.1.4-2 of this report. Accordingly, the staff concludes that the WLS NI FIRS satisfy the acceptance criteria of RG 1.208 and the requirements of 10 CFR 100.23, and considers RAI 118, Question 03.07.01-6 resolved. Based upon its review of WLS COL FSAR Section 2.5.2.7 and 3.7.1.1.1, the applicant's response to RAI 118, Question 03.07.01-6, and the staff's confirmatory analysis, the staff concludes that the applicant's methodology and results for calculations of the site-specific NI FIRS are acceptable and resolved.

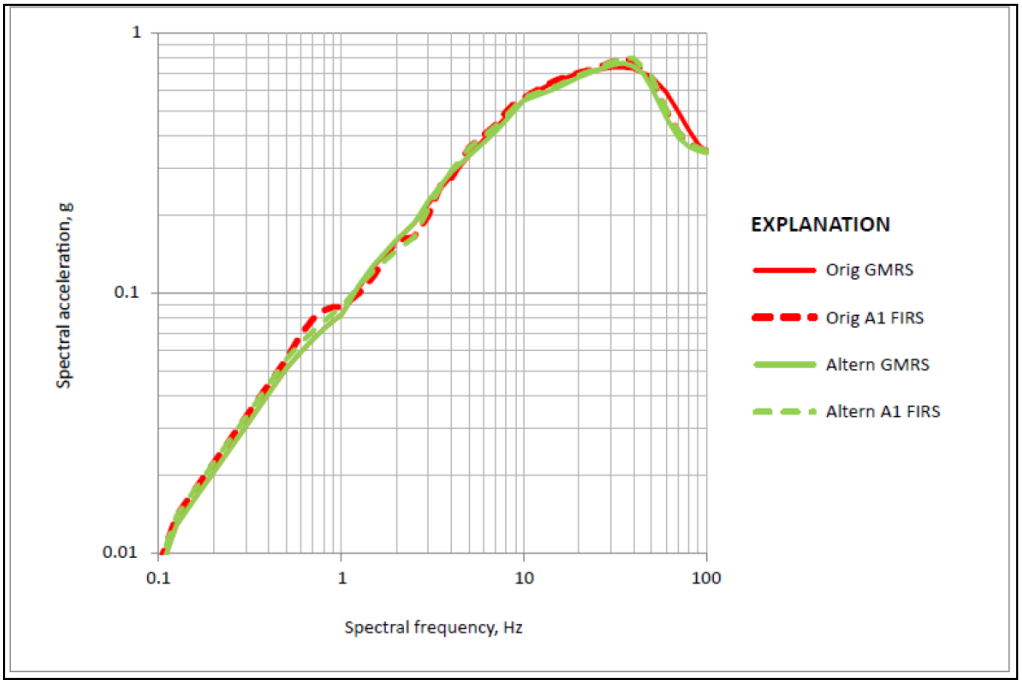

Figure 3.7.1.4-3 Comparison of the horizontal GMRS and FIRS A1 from the FSAR ("Orig") and horizontal GMRS and FIRS A1 using the methodology consistent with that used to develop the FSAR NI FIRS ("Altern"). (Ref. RAI 03.07.01-6 response Figure 9)

As shown in WLS COL FSAR Figures 3.7-201 (Figure 3.7.1.4-1 of this report) and 3.7-202, the horizontal NI FIRS exceeds the standard horizontal AP1000 CSDRS at frequencies above approximately 14 Hertz (Hz) and the vertical NI FIRS exceeds the CSDRS at frequencies above approximately 16 Hz. The peak ground acceleration (PGA) values for horizontal and vertical NI FIRS are 0.35g and 0.32g, respectively. The applicant also provided a comparison of the NI FIRS to the HRHF spectra. The horizontal NI FIRS exceeds the horizontal AP1000 HRHF spectrum above 3 Hz and the vertical NI FIRS exceeds the vertical HRHF at frequencies between about 3 and 55 Hz and between 80 and 100 Hz. The aforementioned exceedances of

the NI FIRS to both the CSDRS and the HRHF spectra are identified by the applicant as departure WLS DEP 2.0-1. To address this departure, the applicant stated that consistent with AP1000 DCD Section 2.5.2.1, paragraph 4b, a site-specific analysis of the AP1000 has been performed, similar to the analysis described in AP1000 DCD Appendix 3I, to demonstrate that the high frequency spectra exceedances are within the seismic design margin of the AP1000 certified design and will not adversely affect the structures, systems, or components of the plant.

The WLS site-specific analyses for NI structures are described in WLS COL FSAR Section 3.7.2.15 and discussed in detail in Reference 206 to WLS COL FSAR Section 3.7 ("Effects of William S. Lee Site Specific Seismic Requirements on AP1000 SSCs," WLG-GW-GLR-815, Revision 0, January 30, 2014). Reference 206, Section 2.0 states that two site-specific Soil Structure Interaction (SSI) models were developed with dynamic soil profiles corresponding to the varied conditions beneath the WLS Unit 1 and 2 NIs. WLS COL FSAR Figures 2.5.4-250 and 2.5.4-252a show the dynamic velocity profiles for Unit 2 and Unit 1 respectively. The shear wave velocity immediately below Unit 2 is greater than 2,500 m/s (8,000 fps) and approximately 2,900 m/s (9,500 fps) at lower depths, whereas Unit 1 has a shear wave velocity of 2,300 m/s (7,500 fps_ (i.e., concrete layer) immediately below its NI foundation and approximately 2,900 m/s (9,500 fps) at lower depths. Reference 206, states that a comparison of the WLS SSI in-structure response spectra (ISRS) at the six key NI locations for Units 1 and 2 was made for both dynamic profiles and determined to be similar. On this basis, the WLS site-specific analyses are based on the SSI model with the Unit 1 dynamic velocity profile, which includes the effects of fill concrete beneath the NI basemat. The staff reviewed Reference 206 and noted that the applicant did not provide the ISRS comparisons for the models with Units1 and Unit 2 dynamic soil profiles. These ISRS comparisons were reviewed by the staff during the May 2014 WLS structural audit. Additionally, the staff issued RAI 119, Question 03.07.01-7, requesting that the applicant provide the ISRS (for Units 1 and 2 dynamic velocity profiles) at the six key NI locations. In an August 14, 2014, response, the applicant provided the ISRS at the six key locations for the two SSI analyses, one based on Unit 1 dynamic soil profile and the other based on Unit 2 dynamic soil profile. The staff also noted that the ISRS at the six key locations corresponding to the SSI models with Units 1 and 2 dynamic soil profiles were consistent in spectral shape with negligible differences in spectral acceleration amplitude. Additionally, the staff noted that the HRHF analyses in AP1000 DCD Appendix 3I are based on a shear wave limitation defined at the bottom of the basemat equal to or higher than 2286 m/s (7,500 fps), while maintaining a shear wave velocity equal to or above 2438 m/s (8,000 fps) at the lower depths. Based on the consistency with the limiting lower bound shear wave velocity for the AP1000 DCD Appendix 3I analyses and the consistent results of the ISRS at the six key locations for Units 1 and 2 dynamic profiles, the staff finds the Unit 1 dynamic profile acceptable for use in the WLS site-specific SSI analyses and considers the RAI resolved.

3.7.1.5 *Post Combined License Activities*

There are no post COL activities related to this section.

3.7.1.6 *Conclusion*

The staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information

incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of 10 CFR Part 50, Appendix A, Appendix S, and other pertinent staff guidance. The staff based its conclusion on the following:

- WLS SUP 3.7-3 is acceptable because the applicant addressed the relevant information and performed adequate analyses that meet the acceptance criteria in NUREG-0800, Section 3.7.1 and ISG-1. In conclusion, the applicant has provided sufficient information to comply with the requirements of 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23.

3.7.2 Seismic System Analysis

3.7.2.1 *Introduction*

This section describes seismic analysis methods and acceptance criteria for all Seismic Category I SSCs. The description includes 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 soil structure interaction (SSI) on the seismic responses of the NI structures are included in the section. The staff 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).

3.7.2.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.7, incorporates by reference AP1000 DCD, Revision 19. In WLS COL FSAR Section 3.7.2, the applicant provided the following departure and supplements:

Departures

- WLS DEP 2.0-1

The seismic design of the AP1000 certified nuclear plant is based, in part, on the CSDRS as addressed in AP1000 DCD Section 3.7.1.1. The AP1000 DCD also includes HRHF spectra, which provide an alternative set of spectra for evaluation of site-specific GMRS. The WLS site-specific horizontal and vertical spectra exceed the CSDRS and HRHF spectra, constituting a departure from the AP1000 certified design. This departure is identified in WLS COL FSAR Table 2.0-201 and Sections 3.7.1.1.1, 3.7.2.8.4, 3.7.2.15, AP1000 DCD Appendix 3I, and Section 19.55.6.3. Consistent with the requirements of AP1000 DCD Table 5.0-1 (Tier 1), AP1000 DCD Section 2.5.2.1, paragraph 4b, and AP1000 DCD Section 3.7.2.8.4, the applicant performed site-specific analysis to demonstrate the adequacy of the standard design for the WLS site. The staff‘s evaluation of WLS DEP 2.0-1 and supporting site-specific analysis is included in Section 3.7.2.4 of this report.

AP1000 COL Information Items

- WLS COL 3.7-1

The applicant provided information in WLS COL 3.7-1 in WLS COL FSAR Sections 3.7.2.12 and 3.7.5.1, regarding seismic analysis of existing and new dams that could affect the site to address COL Information Item 3.7- discussed in AP1000 DCD Section 3.7.5.1. The information in WLS COL FSAR Section 3.7.5.1 references Section 3.7.2.12 and will be discussed in Section 3.7.2.4 of this report and will not be discussed elsewhere in this report.

- STD COL 3.7-3

The applicant provided information to address STD COL 3.7-3 on the seismic interaction review, which is discussed in AP1000 DCD Section 3.7.5.3. The information added to the AP1000 DCD to address STD COL 3.7-3 is located in WLS COL FSAR Section 3.7.5.3 and is the subject of a proposed license condition (Part 10, License Condition 2, "COL Holder Items," Item 3.7-3, "Seismic Interaction Review," below). STD COL 3.7-3 will not be discussed elsewhere in this report.

- STD COL 3.7-4

The applicant provided information in STD COL 3.7-4 on the reconciliation of seismic analyses of NI structures, which is discussed in AP1000 DCD Section 3.7.5.4. The information added to the AP1000 DCD to address STD COL 3.7-4 is located in WLS COL FSAR Section 3.7.5.4 and is the subject of a proposed license condition (Part 10, License Condition 2, "COL Holder Items," Item 3.7-4, "Reconciliation of Seismic Analyses of Nuclear Island Structures," below). This COL item will not be discussed elsewhere in this report.

Supplemental Information

- WLS SUP 3.7-4

The applicant provided information at the end of AP1000 DCD Section 3.7.2.8.4 regarding seismic modeling and analysis of Seismic Category II building structures.

- WLS SUP 3.7-5

The applicant provided information in WLS SUP 3.7.5 by adding Section 3.7.2.15 to the WLS COL FSAR which addresses site-specific analysis of NI Seismic Category I structures.

- WLS SUP 3.7-6

The applicant added supplemental information to the end of AP1000 DCD Section 3.7.2.1.2 regarding the development of time histories for use in site-specific analyses.

License Conditions

- Part 10, License Condition 2, "COL Holder Items," Item 3.7-3

The applicant proposed a license condition requiring an update to the seismic interaction review for as-built information to be completed prior to initial fuel load. This review is performed in

parallel with the seismic margin evaluation and will follow the methodology in AP1000 DCD Section 3.7.5.3. The review is based on as-procured data, as well as the as-constructed condition.

- Part 10, License Condition 2, "COL Holder Items," Item 3.7-4

The applicant proposed a license condition requiring a reconciliation of 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. Acceptance criteria for deviations are specified. The reconciliation of seismic analysis of NI structures will be completed prior to initial fuel load.

3.7.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. In addition, the acceptance criteria associated with the relevant requirements of NRC regulations for the seismic system analysis are given in NUREG-0800, Section 3.7.2 and ISG-1, which provides guidance on implementation of evaluation methodology to determine the effects of high-frequency ground motion.

3.7.2.4 *Technical Evaluation*

The staff reviewed this application and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and that incorporated by reference addresses the required information relating to the seismic system analysis. The staff's evaluation of the information incorporated by reference in the WLS COL application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the Reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews.

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the WLS COL FSAR.

- The staff verified that the site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content to be directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double-indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (i.e., VEGP) contains evaluation material from the SER for the BLN,

Units 3 and 4 COL application. The staff reviewed the following information in the WLS COL FSAR:

Departures

- WLS DEP 2.0-1

The staff's evaluation of WLS DEP 2.0-1 is accomplished through the evaluation of three supplemental information sections: WLS SUP 3.7-4, WLS SUP 3.7-5, and WLS SUP 3.7-6. This supplemental information is evaluated below.

AP1000 COL Information item

- WLS COL 3.7-1

The staff reviewed the resolution to the COL information item related to the evaluation of existing and new dams included under WLS COL FSAR Section 3.7.2.12. WLS 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 WLS COL FSAR Section 2.4.4 for the details of the evaluation. The applicant stated that the WLS site is not subject to flooding from dam failures. The staff's review of WLS COL FSAR Section 2.4. found it to be acceptable. Therefore, the staff finds the information in the WLS COL FSAR addressing WLS COL 3.7-1 acceptable.

Supplemental Information

- WLS SUP 3.7-4

WLS SUP 3.7-4 addresses the site-specific seismic modeling and analysis of Seismic Category II building structures (i.e., Turbine Building First Bay (TBFB) and Annex Building). The purpose of the modeling and analysis is to demonstrate that adverse interaction between the Seismic Category II buildings and the adjacent NI is precluded under the site-specific demands. The staff's review focused on the adequacy of the minimum seismic gap, the adequacy of the bearing capacity of the backfill under the Category II buildings, the overall global stability of the Seismic Category II structures, and the adequacy of the Seismic Category II building designs to preclude local member failure and a consequential adverse interaction with the adjacent NI.

In the application, the analyses are also discussed in detail in the, "William S. Lee Site Specific Adjacent Buildings Seismic Evaluation Report," WLG-1000-S2R-804, Revision 3, February 2014 (Reference 205). The applicant's site-specific SSI analysis of these structures is performed with site-specific and building-specific performance-based surface response spectra (PBSRS) at plant grade as input. These PBSRS were developed using the same analytical methods used in calculating the Unit 1 FIRS. Furthermore, these analyses used hazard-consistent, strain-compatible properties for the granular material supporting the Seismic Category II building structures. Three soil profiles were considered in the analyses including a best estimate (BE), lower bound (LB), and upper bound (UP) soil profiles. These analyses, consistent with the AP1000 DCD analyses of Seismic Category II structures, are 2D SSI analyses with lump mass stick models of the Seismic Category II adjacent structures.

Reference 205 provided the calculated site-specific displacements of the Seismic Category II building structures relative to the NI. As stated in Reference 205, Section 6.2, relative

displacements were calculated to verify that there would be no contact between the NI and the Seismic Category II adjacent structures. As per AP1000 DCD, Revision 19, Section 3.8.5.1, buildings adjacent to the NI, such as the TBFB and Annex Building are structurally separated from NI structures by a 5-cm (2-in.) gap at and below grade and a minimum gap of 10-cm (4-in.) above grade. The applicant provided the site-specific relative displacements at four locations including, (1) TBFB foundation to NI, (2) top of the TBFB to the NI (El. 52 m (170 ft)), (3) Annex Building foundation to the NI, and (4) top of Annex Building to the NI (El. 55 m (180 ft)). The staff reviewed Reference 205, Section 6.2 and noted that the relative displacements for the TBFB bound those of the Annex Building. The staff notes that the calculated maximum relative displacements for the TBFB are 0.5 cm (0.197 in,) below grade and 1.5 cm (0.576 in.) above grade, which are significantly lower than the aforementioned minimum required gaps between the NI and adjacent structures. On this basis, the staff finds that the minimum required seismic gaps in the AP1000 DCD continue to provide adequate separation to prevent interaction between the NI and the adjacent Seismic Category II structures at the WLS site.

In RAI 120, Question 03.07.02-4, the staff requested that the applicant include in the WLS COL FSAR the site-specific values for the relative displacements between the NI and the adjacent Seismic Category II structures. In addition, the staff requested that the applicant include in the WLS COL FSAR the relative displacements for the 1.67 times the site-specific seismic demand. In an August 7, 2014, response, the applicant provided markups to WLS COL FSAR Section 3.7.2.8.4 that addressed the relative displacement information. On this basis, the staff considered the applicant's response acceptable. Accordingly, the staff considers RAI 120, Question 03.07.02-4 resolved.

In terms of the backfill bearing pressure, Reference 205 provided the site-specific dynamic bearing pressure demand vs capacity comparisons. Consistent with the AP1000 analysis of Seismic Category II structures, these pressure demands combine dead weight and seismic pressures to obtain a total bearing pressure on the soil elements under the basemat of the Seismic Category II structures. These comparisons showed that the bearing capacity of the supporting granular fill is greater than the bearing demand for the seismic Category II structures under the site-specific demands. On this basis the staff finds that the supporting granular fill is adequate for withstanding the bearing demand from the Seismic Category II structures at the WLS site.

To ensure no potential adverse interaction between the NI and the Seismic Category II structures as a result of global sliding or overturning of the Seismic Category II buildings under the effects of the site-specific seismic hazard, in RAI 121, Question 03.08.05-7, the staff requested that the applicant provide the factors of safety against sliding and overturning for the Seismic Category II structures for both the site-specific seismic demand and the 1.67 times the site-specific seismic demand. In an August 14, 2014, response, the applicant provided a qualitative assessment regarding the sliding and overturning stability of the Seismic Category II structures. The staff reviewed the applicant's response and noted that it contained insufficient details pertaining to the stability of the Seismic Category II structures. In a clarification call with the applicant, the staff requested that the applicant provide additional information including the calculation of factors of safety against sliding and overturning of the Seismic Category II structures. In an October 22, 2014, supplemental response, the applicant provided the factors of safety against sliding and overturning for the Seismic Category II structures. The staff's review of the factors of safety for the 1.67 times the site-specific demand is in Section 19.55 of this report. The smallest site-specific factors of safety for demand to resist sliding and overturning were 2.6 and 2.3, respectively. These factors of safety are greater than the

1.1 minimum required factor of safety for the NI specified in AP1000 DCD Table 3.8.5-1. Furthermore, the applicant provided markups to WLS COL FSAR Section 3.7.2.8.4, which addressed the sliding and overturning consideration in the detailed design of Seismic Category II structures. Based on the site-specific factors of safety provided by the applicant, the staff finds sufficient margin exists for Seismic Category II buildings against sliding and overturning as to preclude adverse interaction with the adjacent NI under the site-specific seismic demands. As such, the minimum seismic gap is adequate for the WLS site. Therefore, the staff finds this acceptable and, therefore, considers RAI 121, Question 03.08.05-7 resolved.

In terms of the impact of the site hazard exceedance above the CSDRS and HRHF on the design of the Seismic Category II buildings and the potential for failure leading to an adverse impact on the adjacent NI, the staff reviewed the applicant's approach to address this issue. Consistent with AP1000 DCD Section 3.7.2.8.4, the applicant computed the WLS site-specific Seismic Category II foundation response spectra (FRS) and provided comparisons of the site specific FRS with the corresponding AP1000 generic design envelop spectra. The generic design envelop spectra in AP1000 DCD Section 3.7.2.8.4, are those used in the design of Seismic Category II structures. Comparisons provided by the applicant are found in WLS COL FSAR Figures 3.7-213a and 3.7-213g for the Annex Building and 3.7-214a and 3.7-214b for the TBFB. These figures show that the site-specific horizontal FRS fall beneath the AP1000 envelope FRS for both the TBFB and the Annex Building, except for a minor exceedance between 3 Hz and 5 Hz for the TBFB. In the vertical direction, for both the TBFB and the Annex Building, there are vertical FRS exceedances between approximately 6 Hz and 25 Hz. The staff assessed the impact of the exceedance and concluded that both the horizontal and vertical exceedances have a negligible impact on the global stability of the Seismic Category II buildings, as demonstrated by sufficient margin against sliding and overturning as well as the small displacements of the Seismic Category II building structures relative to the NI. Furthermore, the applicant stated in WLS DEP 2.0-1 and in WLS COL FSAR Section 3.7.2.8.4 that the design of the Seismic Category II buildings will be performed to both the AP1000 generic design demand envelop and the WLS site-specific demands to ensure that the Seismic Category II building members are adequately designed so as not to fail and potentially negatively impact the adjacent NI SSCs. The staff finds that the design of the Seismic Category II buildings to the larger of the demands obtained from the AP1000 generic design envelop spectra and the WLS site-specific spectra to be adequate to ensure that these buildings will have adequate member capacity to preclude failure and avoid negatively impacting the safety-related functions of the adjacent NI SSCs.

Based on its review, the staff finds that the applicant has provided adequate and sufficient information to demonstrate that the Seismic Category II buildings will be supported and designed so as to preclude adverse interactions with the adjacent Seismic Category I SSCs when subjected to the WLS site-specific seismic hazard. Accordingly, WLS SUP 3.7-4 and the associated portion of DEP 2.0-1 are acceptable.

- WLS SUP 3.7-5

WLS SUP 3.7.5 addresses site-specific analyses of the NI Seismic Category I structures. The purpose of the site-specific analysis is to demonstrate that the NI Seismic Category I structures site-specific seismic demands are enveloped by the generic AP1000 DCD seismic demands. The staff's review focused on the adequacy of the modeling approach, the appropriate application of the incoherency function, and the verification of the adequacy of the AP1000 DCD demands for the design of the NI structures. WLS COL FSAR Section 3.7.2.15 describes the NI

analyses that included three-dimensional incoherent SSI analysis based on the NI FIRS. The WLS NI FIRS exceeds both the AP1000 CSDRS and HRHF. As such, the applicant stated that site-specific analyses are performed to confirm that the site specific demands will not adversely affect the SSCs of the WLS. This site-specific evaluation implements the evaluation described in AP1000 DCD Appendix 3I, which describes the methodology and criteria used in the evaluation to confirm that the HRHF input is not damaging to the equipment and structures qualified by the analysis for the AP1000 CSDRS. The staff notes that while WLS COL FSAR Section 3.7.2.15 also discusses the applicant's site-specific evaluation for primary coolant loop, piping, and equipment, this report section focuses on the staff's evaluation of the structures. The staff's review of the applicant's evaluation regarding primary coolant loop, piping, and equipment is discussed in Sections 3.9, 3.12, and 3.10 of this report, respectively.

The methodology in the AP1000 DCD, Appendix 3I uses the NI20 nuclear island model described in AP1000 DCD Appendix 3G. The WLS site-specific analyses use an updated version of the NI20 model referred to as the NI20u model. The updates included in NI20u are described in Reference 206 and were discussed in detail during the May 2014 audit. The NI10 model was used in the AP1000 DCD analyses for defining the seismic response for the hard rock site. Additionally, AP1000 DCD Appendix 3G, Section 3G.2.2.2 states that the results of fixed base analyses of the NI20 model were compared to those of the NI10 model to confirm the adequacy of the NI20 model for use in the SSI analyses. In Reference 206, the applicant provided the ISRS at the six AP1000 key locations, comparing the response between the NI20u model and the NI10 model. The results provided were for fixed base analyses. During the May 2014 audit, the staff reviewed additional ISRS (at additional locations) and effective modal mass comparisons between the NI20u and NI10 models. During the review the staff noted that the comparisons included in Reference 206 and the ones presented during the May 2014 audit, demonstrate dynamic equivalence between the models. Additionally, the staff noted that the NI20u model yields responses that are consistent with the NI10 model and conservative with respect to the NI10 response. The staff also reviewed the model updates included in the NI20u model in conjunction with the NI20 model parameters provided in AP1000 DCD Appendix 3G. The staff reviewed the updates included in the NI20u model and noted that the model updates do not deviate from or alter the model parameters provided in AP1000 DCD Appendix 3G and are acceptable. Based on its consistency with the AP1000 DCD and its conservative response prediction discussed above, the staff finds the NI20u model adequate for the WLS site-specific evaluation.

As stated above, the WLS site-specific evaluation implements the three-dimensional incoherent SSI analysis based on the NI FIRS. In Reference 206, Section 5, the applicant stated that ACS SASSI (ACS SASSI by Ghiocel Predictive Technologies Inc. is a program that performs seismic soil-structure interaction (SSI) analysis) is used to perform 25 simulations with the incoherency function using the same methodology described in AP1000 DCD Appendix 3I, which, consistent with the staff guidance in ISG-1, uses the 2007 Abrahamson Hard-Rock coherency model. Additionally, the staff notes that Reference 206 Appendix A provides comparisons of WLS site-specific ISRS using both coherent and incoherent input motions. The staff noted that, while these comparisons identify the impacted frequency ranges due to incoherency and show that the incoherent response is generally lower than the coherent response, these comparisons did not explicitly indicate the percentage reduction to the coherent motion. As such, to assist the staff in its review of the incoherency function's impact on the demands, in RAI 120, Question 03.07.02-3, the staff requested that the applicant quantify the range of reductions to the coherent motion for both the site-specific evaluation and to compare it to the evaluation performed during the AP1000 certification. In an August 7, 2014, response, the applicant

provided plots of reductions factors versus frequency for all the locations in Reference 206, Appendix A and for the AP1000 HRHF and the site-specific evaluations. The staff reviewed the applicant's response and noted the maximum levels of site-specific reduction to the coherent motions are consistent with the AP1000 HRHF evaluation. Therefore, based on the similar ISRS reductions of the WLS site-specific evaluation using the three-dimensional incoherent SSI analysis and the AP1000 HRHF calculations, the staff finds the applicant's reduction to coherent motion acceptable and, therefore, considers RAI 120, Question 03.07.02-3 resolved.

WLS COL FSAR Figures 3.7-209a through 3.7-211c compare the ISRS (at the AP1000 six key locations) corresponding to the AP1000 CSDRS, AP1000 HRHF (incoherent response), and the site-specific NI-FIRS (incoherent response). Furthermore, Reference 206, Figures 5.4-1 through 5.4-16 show the ISRS comparisons at additional locations consistent with the locations in the AP1000 DCD Appendix 3I evaluation. The staff reviewed these comparisons and noted that the WLS site-specific ISRS are largely enveloped by either the AP1000 CSDRS or HRHF FRS, except for a few exceedances generally in the high frequency range. As discussed in WLS COL FSAR Section 3.7.2.1.5, additional evaluations are performed to address the effect of site-specific ISRS exceedances. To assess the significance of the exceedances at the ISRS level on the NI structures, the applicant evaluated and compared the loads obtained from the site-specific NI FIRS and those obtained from the AP1000 CSDRS. These evaluations were performed for representative portions of the building structures selected by screening as being potentially sensitive to high frequency input. Moreover, as stated in Reference 206, Section 6.1, the selection of these representative portions of the building structures is based on areas that can experience high seismic demands during a seismic event. These representative portions of the building structures, consistent with AP1000 DCD Appendix 3I, include three locations in the Auxiliary Building, eight locations in the Shield Building, and three areas in the Containment Internal Structures (CIS). Reference 206, Figures 6.1-2 through 6.1-6 and Tables 6.1-1 through 6.1-6 show the locations for the screened representative portion of building structures and the member force comparisons, respectively. The staff reviewed Reference 206, Tables 6.1-1 through 6.1-6 and noted that the member forces resulting from the AP1000 CSDRS are greater than those resulting from the WLS NI FIRS for all the screened representative portions of building structures. On this basis, the staff finds that the member forces resulting from the AP1000 CSDRS envelope those resulting from the WLS NI FIRS and, therefore, the design of the WLS NI structures using the AP1000 CSDRS input is acceptable.

The staff notes that the WLS COL FSAR supplemented information from the AP1000 DCD Appendix 3I. Specifically, the applicant identified WLS DEP 2.0-1 and added information to AP1000 DCD Sections 3I.1, 3I.2, 3I.3, 3I.6, 3I.6.1, 3I.6.2, 3I.6.3, 3I.6.4, and 3I.7. This added information describes the applicant's site-specific analysis supporting WLS DEP 2.0-1. In relation to the applicant's assessment of structures, the staff noted that the additional information in AP1000 DCD Appendix 3I is consistent with the supplemental information provided in WLS COL FSAR Section 3.7 and, as such, it is addressed by the review and conclusions in Section 3.7 of this report. The staff reviewed the site-specific SSI analyses performed by the applicant to evaluate the exceedances between the WLS NI FIRS and the CSDRS and the HRHF spectra. The staff concludes that the WLS site-specific SSI analyses demonstrate that the AP1000 standard plant structural demands are adequate to use for the design of the NI SSCs at the WLS site. On this basis, the staff finds the WLS SUP 3.7-5 and the associated portions of WLS DEP 2.0-1 acceptable.

- WLS SUP 3.7-6

WLS SUP 3.7-6 addressed the development of time histories for use in site-specific analyses. The earthquake record (CHICHI/ILA031) from the 1999 Chi-Chi earthquake was selected from NUREG/CR-6728 (Magnitude>7, Distance=50-100 km, WUS Rock bin) as the seed time history record for the site-specific analyses. The time histories in this seed record (i.e., two horizontal and one vertical time histories) are modified so as to match the site-specific NI FIRS. As stated in WLS COL FSAR Section 3.7.2.12, the time step interval for the modified time histories is no more than 0.005 seconds and the total duration is no less than 30 seconds. (WLS COL FSAR Figures 3.7-203a to 3.7-203c show a total duration of about 90 seconds.) Furthermore, WLS COL FSAR Table 3.7-201 indicates strong motion duration greater than 6 seconds and cross correlation coefficient lower than 0.16 for the 3 time history components. During the May 2014 audit, the staff reviewed the development of the time histories for use in site-specific analyses including response spectra matching and power spectral density (PSD) calculations. The staff confirmed that the development of the time histories was performed in accordance with SRP Section 3.7.1, Option 1 - Approach 2. The staff finds that the developed time histories provide an acceptable representation of the WLS NI FIRS and, as such, acceptable for use in WLS site-specific analyses. Accordingly, WLS SUP 3.7-6 and the associated portions of WLS DEP 2.0-1 are acceptable.

The following portion of this technical evaluation section is reproduced from Section 3.7.2.4 of the VEGP SER:

> *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 of 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 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*

The staff notes that Part 10 of the WLS application, Proposed License Conditions (including ITAAC), includes License Condition 14 and ITAAC Table 3.3-10. The staff's review determined that this license condition and ITAAC are not needed because the information sought is adequately addressed in the application. As such, License Condition 14 and the Seismic Category II ITAAC are not addressed here and should be removed from the next revision of the WLS COL FSAR. This issue is being tracked as Confirmatory Item 3.7-1.

Resolution of Confirmatory Item 3.7-1

Confirmatory Item 3.7-1 is an applicant commitment to revise Part 10 of the WLS application to remove License Condition 14 and the Seismic Category II ITAAC. The staff verified that Part 10 of the WLS application was appropriately revised. As a result, Confirmatory Item 3.7-1 is now closed.

The license condition language in this section has been clarified from previously considered language. In a letter dated March 22, 2016 (ADAMS Accession No. ML16084A099), the applicant did not identify any concerns with the clarified license condition language. The changes do not affect the staff's above analysis of the conditions, and therefore, for the reasons discussed in the technical evaluation section above, the staff finds the following license conditions acceptable:

- License Condition (3-2) – Before initial fuel load, the licensee shall update the seismic interaction analysis in AP1000 DCD, Rev. 19, Section 3.7.5.3 to reflect as-built information, which must be based on as-procured data, as well as the as-constructed condition.

- License Condition (3-3) – Before initial fuel load, the licensee shall reconcile the seismic analyses described in Section 3.7.2 of the AP1000 DCD, Rev. 19, to account for detailed design changes, including, but not limited to, those due to as-procured or as-built changes in component mass, center of gravity, and support configuration based on as-procured equipment information.

3.7.2.6 *Conclusion*

The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of 10 CFR Part 50, Appendix A, Appendix S, and other relevant staff guidance.

- WLS DEP 2.0-1 is acceptable because the applicant's site-specific analysis demonstrated that the AP1000 DCD design is adequate for use at the WLS site and this analysis addressed the relevant information that meets the guidance in NUREG-0800, Section 3.7.2 and ISG-1. In conclusion, the applicant has provided sufficient information

to satisfy the requirements in 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23.

- WLS COL 3.7-1 is acceptable because the applicant addressed the relevant information that meets the guidance in NUREG-0800, Section 3.7.2. In conclusion, the applicant has provided sufficient information to satisfy the requirements in 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23

- WLS SUP 3.7-4 is acceptable because the applicant addressed the relevant information and performed adequate analyses that meet the guidance in NUREG-0800, Section 3.7.2. In conclusion, the applicant has provided sufficient information to satisfy the requirements in 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23.

- WLS SUP 3.7-5 is acceptable because the applicant addressed the relevant information and performed adequate analyses that meet the guidance in NUREG-0800, Section 3.7.2 and ISG-1. In conclusion, the applicant has provided sufficient information to satisfy the requirements in 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23.

- WLS SUP 3.7-6 is acceptable because the applicant addressed the relevant information and performed adequate analyses that meet the guidance in NUREG-0800, Section 3.7.1. In conclusion, the applicant has provided sufficient information to satisfy the requirements in 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23.

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 of the WLS COL FSAR, Revision 11, incorporates by reference, Section 3.7.3, "Seismic Subsystem Analysis," of Revision 19 of the AP1000 DCD. In addition, in WLS COL FSAR Section 3.7, the applicant provided the following:

Departures

- WLS DEP 6.4-2

The applicant provided additional information in Table 3.7-207 of the WLS COL FSAR about WLS DEP 6.4-2 related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance. This information, as well as related WLS DEP 6.4-2 information appearing in other chapters of the FSAR, is reviewed in Section 21.3 of this SER.

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 WLS 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 a comparison with RG 1.12, "Nuclear Power Plant Instrumentation for Earthquakes," Revision 2, the location and description of instrumentation, control room operator notifications, comparison of measured and predicted responses, and tests and inspections.

3.7.4.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.7 incorporates by reference AP1000 DCD, Section 3.7. The applicant provided the following information in WLS COL FSAR Section 3.7.4:

AP1000 COL Information Item

- STD COL 3.7-2

The applicant provided information for STD COL 3.7-2 in WLS COL FSAR Section 3.7.4.4 to resolve COL Information Item 3.7-2 on post-earthquake procedures to compare measured and predicted ground motions. In STD COL 3.7-2, the applicant stated that post-earthquake operating procedures utilize the guidance of Electric Power Research Institute (EPRI) Reports NP-5930, "A Criterion for Determining Exceedance of the Operating Basis Earthquake";

TR-100082, “Seismic Instrumentation in Nuclear Power Plants for Response to OBE Exceedance: Guideline for Implementation”; and NP-6695, “Guidelines for Nuclear Plant Response to an Earthquake” as modified and endorsed by the NRC in 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.” A response spectrum check up to 10 Hz 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. In addition, in WLS COL FSAR Section 3.7.4.4 addresses measurement of 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.

- STD COL 3.7-5

The applicant provided information in STD COL 3.7-5 in WLS COL FSAR Section 3.7.4.2.1, “Tri-axial Acceleration Sensors,” to resolve COL Information Item 3.7-5. In STD COL 3.7-5, the applicant stated that a free-field sensor will be located and installed to record the ground surface motion representative of the site. It will be located such that the effects associated with surface features, buildings, and components on the recorded ground motion will be insignificant. The “trigger value” is also described.

Supplemental Information

- STD SUP 3.7-1

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

- STD SUP 3.7-2

The applicant provided supplemental information in WLS COL FSAR Section 3.7.4.4 to address the test and inspection requirements for the acceleration sensors. In this section, the applicant stated that installation and acceptance testing of the tri-axial acceleration sensors described in AP1000 DCD Section 3.7.4.2.1 is completed prior to initial startup. Installation and acceptance testing of the time-history analyzer described in AP1000 DCD Section 3.7.4.2.2 is completed prior to initial startup.

Interface Requirements

AP1000 DCD Table 1.8-1, “Summary of AP1000 Plant Interfaces with Remainder of Plant,” Items 3.3, “Site seismic sensor location and ‘trigger’ value,” and 3.12, “Earthquake response procedures,” refer to interfaces associated with AP1000 DCD Section 3.7.4. The interface requirements for staff review (associated with AP1000 DCD Section 3.7.4.2) include an onsite implementation of the site seismic sensor locations and trigger values, and development of procedures by the COL applicant for earthquake responses from the seismic instrumentation.

3.7.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for seismic instrumentation are given in NUREG-0800, Section 3.7.4.

The regulatory requirements and guidance documents for STD COLs 3.7-2 and 3.7-5 and STD SUP 3.7-1 and STD SUP 3.7-2 are 10 CFR Part 50, Appendix S, RG 1.166, RG 1.167, and RG 1.12, which provide for installation of free field tri-axial acceleration sensors and establishment of post-earthquake procedures for comparing measured and predicted responses.

3.7.4.4 *Technical Evaluation*

The staff reviewed this application section and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic. The staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the seismic instrumentation. The staff's evaluation of the information incorporated by reference in the WLS application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content for the Reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the WLS COL FSAR.

- The staff verified that site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content is directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (i.e., VEGP) contains evaluation material from the SER for the BLN, Units 3 and 4 COL application. The one notable difference between the VEGP and WLS applications for these COL items is the specification in VEGP COL 3.7-5 that the free-field sensor is located on the ground surface of the engineering backfill. In the WLS COL FSAR, the exact location of the tri-axial ground surface acceleration free-field sensor is not specified, but will be installed using NRC-approved methodology, and will use the same trigger value, and the staff concludes that this minor difference does not negatively affect the conclusion reached previously by the staff. The staff reviewed the following information in the WLS COL FSAR:

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.7.4.4:

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.

Resolution of Confirmatory Item 3.7-2

Confirmatory Item 3.7-2 is an applicant commitment to revise its FSAR to adjust the left margin annotations related to STD COL 3.7-2. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.7-2 is now closed.

- *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. 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.

<u>Supplemental information</u>

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

In addition, the staff concludes that the relevant information presented in the WLS COL application is acceptable and meets the requirements of 10 CFR Part 50, Appendix S and complies with the guidance provided in RG 1.166, RG 1.167, and RG 1.12. The staff based its conclusions on the following:

- STD COL 3.7-2 is acceptable because the applicant is committed to use the procedures endorsed by RG 1.166 and RG 1.167 and because the applicant provided sufficient

information to satisfy the requirements 10 CFR Part 50, Appendix S 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.

- STD COL 3.7-5 is acceptable because the applicant provided sufficient information to satisfy the requirement 10 CFR Part 50, Appendix S 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 to keep the maximum number of instruments in service during plant operation and shutdown.

- STD SUP 3.7-2 is acceptable because the applicant provided sufficient information to satisfy the requirement of 10 CFR Part 50, Appendix S 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 WLS 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
- In-service testing (IST) and inspection requirements

Section 3.8 of the WLS COL FSAR, Revision 11, incorporates by reference Section 3.8.2, “Steel Containment,” of Revision 19 of the AP1000 DCD. In addition, in the WLS COL FSAR, the applicant provided the following:

Departures

- WLS DEP 6.3-1 and WLS DEP 3.2-1

The applicant provided additional information about WLS DEP 6.3-1 and WLS DEP 3.2-1 in Section 3.8.2 of the FSAR related to design modifications to the condensate return portion of the Passive Core Cooling System and quantifying the duration that the passive residual heat removal heat exchanger can maintain safe shutdown conditions, respectively. This information,

as well as related WLS DEP 3.2-1 and WLS DEP 6.3-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.1 of this report.

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 WLS COL application are documented in NUREG-1793 and its supplements. Section 21.1 of this report evaluates the departures from the DCD provided in WLS DEP 6.3-1 and WLS DEP 3.2-1.

3.8.3 Concrete and Steel Internal Structures of Steel Containment

Structures inside the containment support the reactor coolant system components and related piping systems and equipment inside the containment and provide radiation shielding. These 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, and are not part of the containment pressure boundary.

The containment internal structures are constructed of 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 (modular construction). These steel form modules (liners) consist of two 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 inside of the steel plates where surface attachments to the plate transfer loads into the concrete. Where these surface attachments are Seismic Category I, the portion of the steel module transferring the load into the concrete is classified as Seismic Category I.

WLS COL FSAR, Revision 11, Section 3.8, incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19, Section 3.8.3, "Concrete and Steel Internal Structures of Steel Containment." The staff reviewed the application and checked the referenced DCD to ensure that no issues relating to this section remained for review.[1] The staff's review confirmed that there are no outstanding issues related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

AP1000 COL Information Item

- STD COL 3.8-5

In an April 25, 2011, letter, the WLS COL applicant endorsed an October 1, 2010, letter from the VEGP applicant, proposing STD COL 3.8-5 and adding new WLS COL FSAR Sections 3.8.3.7, 3.8.4.7, and 3.8.5.7. The applicant provided information in STD COL 3.8-5 addressing the construction inspection program related to Seismic Category I and II structures. The staff's evaluation of STD COL 3.8-5 is included in Section 3.8.5 of this report.

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, the auxiliary building, the containment air baffle, Seismic Category I cable tray supports, and Seismic Category I HVAC supports.

The criteria for other Category I structures include the following:

- Description of the structures
- Applicable codes, standards, and specifications
- Loads and load combinations
- Design and analysis procedures
- Structural acceptance criteria
- Materials, quality control, and special construction techniques
- In-service testing (IST) and inspection requirements
- Construction inspection

3.8.4.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.8, incorporates by reference Section 3.8.4, "Other Category I Structures," of the AP1000 DCD, Revision 19. In addition, in WLS COL FSAR Section 3.8.4, the applicant provided the following:

Departures

- WLS DEP 3.8-1

The applicant provided a description summary of the site-specific lateral earth pressure on the nuclear island below-grade wall departure from the AP1000 DCD. This departure affects WLS COL FSAR Section 3.8.4.4.4 and WLS COL FSAR Figures 3.8-201a, -202a, -203, and -204.

AP1000 COL Information Item

- STD COL 3.8-5

The applicant provided information in its application regarding STD COL 3.8-5 addressing the construction inspection program related to Seismic Category I and II structures. In an April 25, 2011, letter, the applicant endorsed the October 1, 2010, letter from the VEGP applicant proposing STD COL 3.8-5 and adding new Sections 3.8.3.7, 3.8.4.7, and 3.8.5.7 to the WLS COL FSAR. The staff's evaluation of STD COL 3.8-5 is included in Section 3.8.5.4 of this report.

Supplemental Information

- STD SUP 3.8-1

The applicant provided a supplement to the existing AP1000 DCD Section 3.8.4.4.4, "Below Grade Exterior Walls," under the sub-heading, "Load Combinations." The supplement provides

information supporting the WLS DEP 3.8-1 related to the departure of the WLS site-specific lateral earth pressure from the AP1000 DCD.

3.8.4.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations are given in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 3.8.4.

3.8.4.4 *Technical Evaluation*

The staff reviewed this application and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The 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 staff's evaluation of the information incorporated by reference in the WLS COL application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review evaluate subsequent COL applications. To ensure that the staff's findings on standard content for the Reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the COL FSAR.

- The staff verified that site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content to be directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double indented formatting.

Departures

- WLS DEP 3.8-1

The staff's evaluation of WLS DEP 3.8-1 is accomplished through the evaluation of the supplemental information section STD SUP 3.8-1. This supplemental information is evaluated below.

Supplemental Information

- STD SUP 3.8-1

STD SUP 3.8-1 addresses WLS DEP 3.8-1 related to the departure of the WLS site-specific lateral earth pressure from the AP1000 DCD. WLS COL FSAR Section 2.5.4.10.3, "Lateral Pressures," provides a description of the WSL site-specific lateral earth pressures. The departure is the use of a site-specific passive pressure on the below-grade NI walls that is less than the full passive pressure assumed in the analysis of the standard plant. The reason for the departure is that the conservative use of full site-specific passive earth pressure results in an earth pressure exceeding the value used in the standard design. The focus of the staff's review is the adequacy of the applicant's justification for the use of partial passive earth pressure and the validity of the approach used to calculate that pressure. WLS COL FSAR Section 2.5.4.10.3, "Lateral Pressures," provides a description of the WSL site-specific lateral earth pressures. The applicant stated that lateral earth pressures are developed against the below-grade nuclear island walls because of the placement and compaction of granular backfill material and that lateral earth pressures are calculated for active, at-rest, and passive pressure conditions. The applicant further stated that "Westinghouse has evaluated the Lee Nuclear Station site-specific lateral earth pressures and has determined that they are bounded by the standard AP1000 design pressures."

In RAI 112, Question 02.05.04-20, the staff requested that the applicant provide additional information to confirm that the site-specific lateral earth pressures are bounded by the AP1000 standard design. In an April 10, 2014, response to RAI 112, Question 02.05.04-20, the applicant provided tables that show the comparison of the WLS site-specific lateral earth pressure on the NI's below grade walls with corresponding pressures that were used in the AP1000 standard design for all the load combinations. The applicant stated that the site-specific lateral pressures on the NI exterior walls below grade are bounded by the AP1000 design pressures for Load Combinations 1 through 6, 8, and 9 in both the east-west (E-W) and north-south (N-S) directions. The applicant noted that the site-specific lateral pressure in Load Combination 7 (LC7), which includes the summation of the full passive lateral earth pressure, the static and dynamic lateral surcharges, and the water pressure for the well-graded gravel (GW) backfill material slightly exceeds the AP1000 LC7 lateral pressure. The applicant stated that the difference in the Load Combination 7 for WLS site compared to the AP1000 generic site is attributed to the site-specific groundwater level, which is 2.4 m (8 ft) below ground surface as compared to the AP1000 groundwater level of 0.6 m (2 ft) below ground surface; a difference of 1.8 m (6 ft) of non-buoyant (heavier) soil resulting in a higher passive earth pressure.

The applicant calculated analytical estimates of the fraction of the full WLS site-specific passive earth pressure that might be mobilized in the GW backfill using a given displacement of the nuclear island assumed as 05 cm (0.2 in.) The applicant included WLS COL FSAR Table 3.8-201 that summarizes the mobilized fraction of the full WLS passive lateral earth pressure for the assumed 0.5 cm (0.2 in) displacement for the range of water-table depths at the WLS site and for the range of values used for the soil modulus and Poisson's ratio.

AP1000 DCD Section 3.8.5.5.5, "Seismic Stability Analysis," states that the maximum lateral displacement at the base of the nuclear island when subjected to the CSDRS is expected to be 0.31 cm (0.12 in.) neglecting buoyancy of the nuclear island and 0.48 cm (0.19 in.) considering buoyancy effects. These values are without considering passive resistance from the backfill; therefore, the applicant's assumed 0.5 cm (0.2 in.) displacement in the analytical estimate is

considered conservative. The applicant stated that development of the full passive pressure requires more displacement than the nuclear islands will experience during a seismic event and small lateral displacements such as these are not capable of developing the full passive earth pressure. Therefore, the site-specific nuclear island below-grade wall pressures resulting from the NI FIRS will be less than those used in the standard AP1000 design for this load combination.

The staff reviewed the applicant's April 10, 2014, response to RAI 112, Question 02.05.04-20, and noted that WLS COL FSAR Figures 3.8-203, "William S. Lee Nuclear Station - Mobilized Wall Pressures vs. AP1000 Design Load (E-W)," and 3.8-204, "William S. Lee Nuclear Station - Mobilized Wall Pressures vs. AP1000 Design Load (N-S)," illustrate that the WLS passive pressure in LC7 will not be fully developed and that the pressures on the below-grade walls for the AP1000 standard design continue to bound the pressures that will actually occur at the WLS site. During a May 2014 structural audit, the staff reviewed the, "Lateral Pressure on Nuclear Island Foundation Walls," calculation and found the applicant's approach for estimating the earth pressures to be consistent with the methodology described in its responses to RAI 112, Question RAI 02.05.04-20. For the reasons stated above, the staff finds the applicant's responses to RAI 112, Question RAI 02.05.04-20 acceptable. Therefore, the staff considers STD SUP 3.8-1 and WLS DEP 3.8-1 acceptable because the applicant demonstrated that the passive pressure developed by site-specific conservative maximum displacements is bounded by the AP1000 passive pressure. Accordingly, the staff considers RAI 112, Question 02.05.04-20 resolved.

3.8.4.5 *Post Combined License Activities*

There are no post COL activities related to this section.

3.8.4.6 *Conclusion*

The staff reviewed the application and checked the referenced DCD. The staff's review confirmed that the applicant addressed the required information relating to other Seismic Category I structures. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of GDC 1, 2, 4, and 5 in 10 CFR Part 50, Appendix A.

- WLS DEP 3.8-1 is acceptable because the applicant adequately address the relevant information that meets the guidance in NUREG-0800, Section 3.8.4. In conclusion, the applicant has provided sufficient information to satisfy 10 CFR Part 50, Appendix A, GDC 1, GDC 2, GDC 4, and GDC 5.

- STD SUP 3.8-1 is acceptable because the applicant adequately addressed the relevant information that meets the guidance in NUREG-0800, Section 3.8.4. In conclusion, the applicant has provided sufficient information to satisfy the requirements in10 CFR Part 50, Appendix A, GDC 1, GDC 2, GDC 4, and GDC 5.

3.8.5 Foundations

3.8.5.1 *Introduction*

The NI structures consist of the Containment Building, the Shield Building, and the Auxiliary buildings located on a common 1.8 m (6 ft) thick, cast-in-place, reinforced concrete basemat foundation. Adjoining buildings, such as the Radwaste Building, Turbine Building, and Annex Building, are structurally separated from the NI structures by a 5 cm (2 in.) gap at and below grade. A 10 cm (4 in.) minimum gap is provided above grade. This provides space to prevent interaction between the NI structures and the adjacent structures during a seismic event. This space provides the required factor of safety to accommodate lateral movement under the most stringent loading conditions.

The criteria for the design of foundations include the following:

- Description of the foundations
- Applicable codes, standards, and specifications
- Loads and load combinations
- Design and analysis procedures
- Standard acceptance criteria
- Materials, quality control, and special construction techniques
- In-service testing (IST) and inspection requirements
- Construction inspection

3.8.5.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.8 incorporates by reference AP1000 DCD, Revision 19, Section 3.8. AP1000 DCD Section 3.8 includes Section 3.8.5. In addition, in WLS COL FSAR Section 3.8.5, the applicant provided the following:

AP1000 COL Information Items

- WLS COL 2.5-17

The applicant proposed information in WLS COL FSAR Section 3.8.4.7 addressing the type of waterproofing system to be used for the below-grade exterior walls exposed to flood and to groundwater under Seismic Category I structures. In WLS COL FSAR, Section 3.8.4.1, "Description of the Foundations," the applicant also stated that the site-specific waterproofing approach has not been selected and the applicant will notify the NRC of its selection of system and the qualification testing thereof, on a set schedule.

- STD COL 3.8-5

In an April 25, 2011, letter, the applicant endorsed the August 17, 2010, letter from the VEGP applicant, which proposed STD COL 3.8-5,to replace AP1000 DCD Sections 3.8.3.7, 3.8.4.7, 3.8.5.7, 3.8.6.5. The applicant also provided new WLS COL FSAR sections and revised WLS COL FSAR Section 17.6. The applicant provided information in STD COL 3.8-5 addressing the construction inspection program related to Seismic Category I and II structures.

- STD COL 3.8-6

In an April 25, 2011, letter, the applicant endorsed the October 1, 2010, letter from the VEGP applicant that proposed STD COL 3.8-6 that added a new Section 3.8.6.6 to the WLS COL FSAR. The applicant provided information in STD COL 3.8-6 addressing the construction procedure program related to safety-related Seismic Category I structures. The construction procedures program addresses the pre- and post-concrete placement, and use of construction mock-ups for the steel-concrete composite shield building modules.

Supplemental Information

- STD SUP 3.8-1

The applicant provided supplemental information by adding additional text which states that the depth of overburden and depth of embedment are given in WLS COL FSAR Section 2.5.4.

License Condition

- Part 10, License Condition 6, "Operational Program Readiness," Item 6.i

The applicant proposed to add "Item 6.i" to proposed License Condition 6 that addresses the availability to of the schedule for the implementation of operational programs, such as construction and inspection procedures, and procedures for concrete placement, use of construction mock-ups, and inspection of module concrete for concrete-filled steel plate modules to the NRC.

ITAAC

The licensee shall satisfy the non-system ITAAC described in WLS COL, Part 10, Appendix B, as new Table 3.3-9, "Waterproof Membrane Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 1 of 1)," requiring a report that documents the as-built waterproofing membrane system beneath the NI basemat has a coefficient of friction to resist sliding of ≥ 0.55, through material qualification testing.

3.8.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations (GDC 1, GDC 2, GDC 4, and GDC 5 in 10 CFR Part 50, Appendix A; 10 CFR 50.55(a), and 10 CFR Part 50, Appendix B) for the foundations are given in NUREG-0800, Section 3.8.5.

3.8.5.4 *Technical Evaluation*

The staff reviewed this application section and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic. The staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the foundations. The staff's evaluation of the information incorporated by reference in the WLS application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each

"standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content for the Reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the WLS COL FSAR.

- The staff verified that site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content is directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double indented formatting. The staff reviewed the following information in the WLS COL FSAR.

AP1000 COL Information Items

- *WLS COL 2.5-17*

SRP Section 3.8.5 requires confirmation that the nuclear island remains stable under design-basis demands. AP1000 DCD Section 3.4.1.1.1.1, "Waterproofing," states that (1) the waterproof membrane between the mudmat must provide adequate shear strength to transfer horizontal shear caused by seismic loading and (2) the function of the membrane is Seismic Category I. In this regard, AP1000 DCD Section 3.4.1.1.1 provides a requirement for the COL applicant to identify a waterproofing system and to demonstrate a friction coefficient greater than or equal to 0.55 with all horizontal concrete surfaces.

The staff reviewed the WLS COL FSAR and noticed that although there is a proposed ITAAC in WLS COL Part 10, Appendix B, Table 3.3-9, to address the coefficient of friction, there is no description of the selected waterproofing-membrane design. The staff notes that the regulations in 10 CFR 52.79, "Contents of applications; technical information in final safety analysis report," require the FSAR to contain information relative to materials of construction, arrangement, and dimensions sufficient to provide reasonable assurance that the design will conform to the design bases with adequate margin for safety. Therefore, in RAI 102, Question 03.08.05-6, the staff requested that the applicant describe, in an update to WLS COL FSAR Section 3.8.5.1, the proposed waterproofing approach and demonstrate compliance with the AP1000 DCD provisions. In a January 17, 2012, response to RAI 102, Question 03.08.05-6, the applicant stated that the nuclear island mudmat waterproofing system for the WLS nuclear station has not been chosen. However, the applicant confirmed that the waterproofing system selected will be chosen from one of the acceptable alternatives described in AP1000 DCD Section 3.4.1.1.1.1 and will be demonstrated to produce a friction coefficient of 0.55 or greater with the mudmat's horizontal concrete surface.

The staff reviewed the applicant's January 17, 2012, response to RAI 102, Question 03.08.05-6, and noted that the applicant committed to (1) use one of the three waterproofing membrane

systems identified in the standard AP1000 design, and (2) demonstrate that the waterproofing membrane meets the waterproofing and friction requirements of greater than or equal to 0.55 as specified in the AP1000 DCD Section 3.4.1.1.1.1. For the reasons stated above, the staff finds the applicant's response to RAI 102, Question 03.08.05-6 acceptable. Accordingly, the staff considers RAI 102, Question 03.08.05-6 resolved.

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.8.5.4:

- *STD COL 3.8-5*

In a letter dated August 17, 2010, the applicant proposed STD COL 3.8-5, adding a new Section 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.

Resolution of Standard Content Confirmatory Item 3.8-2

Confirmatory Item 3.8-2 is an applicant commitment to revise its FSAR Table 1.8-202, Table 1.9-201, Appendix 1AA, Section 3.8.3.7, Section 3.8.4.7, Section 3.8.5.7, Section 3.8.6.5, and Section 17.6 to address STD COL 3.8-5. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.8-2 is now closed.

- *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.

Resolution of Standard Content Confirmatory Item 3.8-3

Confirmatory Item 3.8-3 is an applicant commitment to revise its FSAR Table 1.8-202 and Section 3.8.6.6 to address STD COL 3.8-6. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.8-3 is now closed.

Supplemental Information

- STD SUP 3.8-1

In WLS COL FSAR Section 3.8.5.1, "Description of the Foundations," the applicant cited Section 2.5.4, "Stability of Subsurface Materials and Foundations," which describes the depth of overburden and embedment of the WLS foundation. A foundation is a structural element that connects the superstructure and the supporting medium, such as soils or rocks. The purpose of the foundation is to hold the superstructure in place and to transmit all the loads from the superstructure to the underlying soils or rocks. The NI foundation basemat will be supported by the existing concrete foundation of Cherokee Nuclear Station Unit 1, which is underlain by continuous rock or by fill concrete supported on continuous rock; rock that is fresh to moderately weathered as determined by visual inspection, and is expected to have a Rock Quality Designation (RQD) of at least 65 percent based on the site exploration boring logs.

Sliding and Overturning

WLS COL FSAR Section 2.5.4.5.3.1, "Nuclear Island Foundation Materials," provides a description of the overturning and sliding stability evaluation of the Seismic Category I and II structures. The applicant stated that the foundation quality rock and fill concrete provide adequate safety margins against bearing-capacity failure for both static and seismic loading of the NI and that only nominal settlement will occur. In its review of WLS COL FSAR Section 2.5.4.5.3.1, the staff noted that the applicant did not provide sufficient information concerning the factor of safety for sliding and overturning for the Seismic Category I structures.

During the May 2014 structural audit held in Cranberry Township, PA, the staff discussed with the applicant the limited information in the WLS COL FSAR related to the factor of safety for sliding and overturning for the WLS NI structures. The staff requested that the applicant provide the sliding and overturning evaluation of the NI structures subject to dynamic loads. The applicant presented the seismic analysis of the WLS NI, including the resultant shear and moment. The sliding and overturning results were conservative when compared to the AP1000 DCD minimum factor of safety values of 1.1 and 1.5 for sliding and overturning, respectively. However, to better understand as well as document the aspects and the results of the stability analysis, the staff issued post-audit RAI 121, Question 03.08.05-7, requesting that the applicant provide additional information that shows a comparison of the WLS NI maximum basemat forces and moments to the AP1000 CSDRS design-basis forces and moments.

In response to RAI 121, Question 03.08.05-7, the applicant provided WLS COL FSAR Table 2-1, "Comparison of Nuclear Island Maximum Absolute Forces and Moments: Lee vs. CSDRS," which summarized the seismic analysis results. The table shows the maximum reaction forces and moments at the center of gravity of the WLS NI. The applicant stated that the comparison of the WLS and the AP1000 CSDRS maximum NI basement forces and moments was performed based on time-history seismic analyses using the latest NI20u ANSYS model with contact elements at the basemat interface with the rock. The results of the comparison showed that the site-specific WLS sliding and overturning forces and moments are all less than the AP1000 design-basis forces and moments.

In reviewing the applicant's response, the staff noted that results of the comparison of the AP1000 CSDRS forces and moments enveloped the WLS forces and moments with significant margin. The comparison of the maximum forces and moments in the table shows that the factors of safety for resultant shear and moments are 2.06 and 3.68, respectively. These

factors of safety are greater than the corresponding AP1000 minimum factors of safety of 1.1 for sliding and 1.5 for overturning. Moreover, the sliding and overturning analysis performed by the applicant was carried out by models and using methods acceptable to the staff. Based on the information presented above, the staff considers the applicant's response acceptable because the applicant was able to demonstrate that the WLS NI sliding and overturning factors of safety are adequate. Accordingly, the staff considers RAI 121, Question 03.08.05-7 resolved.

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.8.5.4:

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 the proposed License Condition 6 acceptable.

3.8.5.5 *Post Combined License Activities*

The license condition language in this section has been clarified from previously considered language. In a letter dated March 22, 2016 (ADAMS Accession No. ML16084A099), the applicant did not identify any concerns with the clarified license condition language. The changes do not affect the staff's above analysis of the conditions, and therefore, for the reasons discussed in the technical evaluation section above, the staff finds the following ITAAC and license condition acceptable:

- The licensee shall perform and satisfy the non-system ITAAC described in WLS Combined License Application (COLA), Part 10, Appendix B, Table 3.3-9, "Waterproof Membrane Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 1 of 1)."

- License Condition (3-4) – No later than 12 months after issuance of the COL, the licensee shall submit to the Director of NRO, or the Director's designee, a schedule for implementation of the construction and inspection procedures for steel concrete composite (SC) construction activities for seismic Category I nuclear island modules. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until each this license condition has been fully

implemented. The schedule shall identify the completion of or implementation of the construction and inspection procedures for steel concrete composite (SC) construction activities for seismic Category I nuclear island modules (including shield building SC modules) described in AP1000 DCD Rev. 19, Section 3.8.4.8.

3.8.5.6 *Conclusion*

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

In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of GDC 1, GDC 2, GDC 4, and GDC 5 in 10 CFR Part 50, Appendix A. The staff based its conclusion on the following:

- STD SUP 3.8-1 is acceptable because the applicant adequately provided the relevant information that meets the guidance in NUREG-0800, Section 3.8.5 and specifically addresses WLS COL 2.5-6; WLS COL 2.5-7; WLS COL 2.5-10; WLS COL 2.5-12; and the sliding and overturning evaluation of the Seismic Category I and II structures. In conclusion, the applicant provided sufficient information to satisfy 10 CFR Part 50, Appendix A, GDC 1 GDC 2, GDC 4, and GDC 5.

- WLS COL 2.5-17 is acceptable because the applicant committed to (1) use one of the three waterproofing-membrane systems identified in AP1000 DCD Section 3.4.1.1.1.1 standard design and that were reviewed and accepted by the staff; and (2) demonstrate that the waterproofing membrane meets the waterproofing and friction requirements of greater than or equal to 0.55 as specified in the AP1000 DCD, Section 3.4.1.1.1.1.

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 such 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 WLS COL FSAR 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.

WLS COL FSAR, Revision 11, Section 3.9 incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19, Section 3.9.1, "Special Topics for Mechanical Components." The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS 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.

WLS COL FSAR, Revision 11, Section 3.9, incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19, Section 3.9.2, "Dynamic Testing and Analysis of Systems, Structures and Components." The staff reviewed the WLS COL application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] Specific to departure WLS DEP 2.0-1, which was not referenced in Section 3.9.2 of the WLS COL FSAR but is addressed further in other sections in this chapter, FSAR Reference 206 shows that the reactor vessel and internals were chosen for evaluation as representative of major equipment. From the analyses performed, the CSDRS was found to have higher loads and stresses than those from the WLS site-specific seismic response. Hence, the WLS site-specific seismic response does not impact the structural integrity of the reactor vessel and internals. The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS 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.

3.9.3.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.9, incorporates by reference AP1000 DCD, Revision 19, Section 3.9. In addition, in WLS COL FSAR Section 3.9.3, the applicant provided the following:

Departures

- WLS DEP 6.4-2

The applicant provided additional information in Table 3.9-202 of the WLS COL FSAR about WLS DEP 6.4-2 related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance. This information, as well as related WLS DEP 6.4-2 information appearing in other chapters of the FSAR, is reviewed in Section 21.3 of this SER.

AP1000 COL Information Items

- STD COL 3.9-2

The applicant provided information in WLS COL FSAR Section 3.9.8.2, "Design Specifications and Reports," for STD COL 3.9-2 to address COL Information Item 3.9-2, which states that "Reconciliation of the as-built piping (verification of the thermal cycling and stratification loadings considered in the stress analysis discussed in [DCD] Section 3.9.3.1.2) is 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 report.

- STD COL 3.9-3

The applicant provided information in WLS COL FSAR Sections 3.9.3.4.4, "Inspection, Testing, Repair, and/or Replacement of Snubbers," and 3.9.8.3, "Snubber Operability Testing," for STD COL 3.9-3 to address COL Information Item 3.9-3, which describes snubber design and testing, snubber installation requirements, and snubber preservice and inservice examination and testing.

- STD COL 3.9-5

The applicant provided information in WLS COL FSAR Sections 3.9.3.1.2, "Loads for Class 1 Components, Core Support, and Component Supports," and 3.9.8.5, "Surge Line Thermal Monitoring," for STD COL 3.9-5 to address 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 report.

- STD COL 3.9-7

In a June 21, 2011, letter, the applicant endorsed the April 23, 2010, letter from the VEGP applicant that proposed to add STD COL 3.9-7 to the WLS COL FSAR. The applicant provided information in WLS COL FSAR Section 3.9.8.7, "As-Designed Piping Analysis," to address STD COL 3.9-7. This COL item provides additional information on the process to be used to complete the piping design and to complete the ITAAC added to verify the design. Evaluation of this particular COL information item is provided in Section 3.12 of this report.

3.9.3.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for the ASME Code Class 1, 2, and 3 components, component supports, and CS structures are given in NUREG-0800, Section 3.9.3.

3.9.3.4 *Technical Evaluation*

The staff reviewed this application section 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. The staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the ASME Code Class 1, 2, and 3 components, component supports, and core support structures. The staff's evaluation of the information incorporated by reference in the WLS application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content for the Reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews.

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the WLS COL FSAR.

- The staff verified that site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and found the evaluation performed for the standard content to be directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (VEGP) contains evaluation material from the SER for the BLN, Units 3 and 4 COL application.

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

AP1000 COL Information Items

- *STD COL 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.

<u>Clarification of BLN SER Standard Content</u>

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 staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants." The staff based its conclusion on the following:

- WLS DEP 6.4-2, related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance, is reviewed and found acceptable by the staff in Section 21.3 of this SER.

- STD COL 3.9-3 is acceptable because the applicant addressed the relevant information that meets the guidance in NUREG-0800, Section 3.9.3. In conclusion, the applicant provided sufficient information to satisfy the requirements in 10 CFR Part 50, Appendix A, GDC 1 and GDC 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. Since 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; GDC 2; GDC 14, "Reactor Coolant Pressure Boundary;" GDC 29 "Protection Against Anticipated Operational Occurrences;" and 10 CFR 50.55a.

WLS COL FSAR, Revision 11, Section 3.9, incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19, Section 3.9.4, "Control Rod Drive System (CRDS)." The staff reviewed the WLS COL application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference 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 protection, alignment and support for the core. Control rods and gray rods 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.

WLS COL FSAR, Revision 11, Section 3.9, incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19, Section 3.9.5, "Reactor Pressure Vessel Internals." The staff reviewed the WLS COL application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

3.9.6 Inservice Testing of Pumps and Valves

3.9.6.1 *Introduction*

In this section, the staff describes its review of the functional design, qualification, and inservice testing (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 WLS. 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 WLS 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 WLS.

3.9.6.2 *Summary of Application*

WLS COL FSAR, Revision 11, Section 3.9, incorporates by reference AP1000 DCD, Revision 19, Section 3.9. In addition, in WLS COL FSAR Section 3.9.6, the applicant provided the following

Departures

- WLS DEP 6.4-2

The applicant provided additional information in Table 3.9-203 of the WLS COL FSAR about WLS DEP 6.4-2 related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance. This information, as well as related WLS DEP 6.4-2 information appearing in other chapters of the FSAR, is reviewed in Section 21.3 of this SER.

AP1000 COL Information Item

- STD COL 3.9-4

The applicant provided information in several sections of WLS 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 WLS. For example, the WLS COL FSAR supplements the provisions in the AP1000 DCD with respect to the Edition and Addenda of the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code) applicable to the description of the IST program for WLS, 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.

The AP1000 DCD addresses the functional design and qualification of mechanical equipment to be used at an AP1000 nuclear power plant in several AP1000 DCD sections. For example, AP1000 DCD 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. AP1000 DCD 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 inservice inspections (ISIs), and periodic inservice operations to be performed in situ to verify the functional capability of the valves. AP1000 DCD 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. AP1000 DCD 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.” AP1000 DCD 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. AP1000 DCD Section 5.4.10, “Component Supports,” includes provisions for design, testing, and inspection of component supports in the reactor coolant system. The WLS 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. AP1000 DCD 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 WLS 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) 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." AP1000 DCD 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 AP1000 DCD Section 3.9.8.3, "Snubber Operability Testing." AP1000 DCD Section 3.9.8.3 states that COL applicants referencing the AP1000 design will develop a program to verify operability of essential snubbers. The WLS COL FSAR provides supplemental information for AP1000 DCD Section 3.9.3.4.4 regarding snubbers. For example, WLS 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 (BPV Code); the ASME OM Code; and ASME Standard QME-1-2007. WLS 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. WLS COL FSAR Table 3.9-201, "Safety Related Snubbers," provides a list of safety-related snubbers to be installed, 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. AP1000 DCD Table 3.9-16, "Valve Inservice Test Requirements," 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. WLS 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 WLS 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 WLS COL FSAR, the applicant described 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 indicated 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 WLS 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, "Operational Program Implementation," Items G.2 and G.5

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

- Part 10, License Condition 6, "Operational Program Readiness," Item 6.d

The applicant proposed a license condition to provide a schedule to support the NRC 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 NUREG-1793 and its supplements. The regulatory basis for the staff's review of the WLS 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 10 CFR Part 50, Appendix A 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. 10 CFR 52.79(a), Paragraph (11) 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. 10 CFR 52.79(a), Paragraph (29)(i) requires that a COL application provide plans for conduct of normal operations, including maintenance, surveillance, and periodic testing of SSCs. 10 CFR 52.79(a), Paragraph (37) 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 NRC regulations. For example, RG 1.206, Section C.IV.4 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, February 22, 2006.

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

3.9.6.4 *Technical Evaluation*

The staff reviewed WLS COL FSAR Section 3.9.6 and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The 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 staff's evaluation of the design-related information incorporated by reference in the WLS 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 section of the report.

Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (i.e., VEGP Units 3 and 4) were equally applicable to the WLS COL application, the staff undertook the following reviews.

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In performing this comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the COL application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were included in the WLS COL FSAR.

- The staff verified that site-specific differences did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content is directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double-indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (i.e., VEGP) contains evaluation material from the SER for the BLN, Units 3 and 4 COL application. The staff reviewed the following information in the WLS COL FSAR:

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.9.6.4:

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 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.

Resolution of Standard Content Confirmatory Item 3.9-1

Confirmatory Item 3.9-1 is an applicant commitment to revise its FSAR Table 1.9-201, Section 3.9.6.3, Section 3.9.6.2.2, and Section 3.9.9, to address IST of valves. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.9-1 is now closed.

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.

Resolution of Standard Content Confirmatory Item 3.9-2

Confirmatory Item 3.9-2 is an applicant commitment to revise its FSAR. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.9-2 is now closed.

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.

Resolution of Standard Content Confirmatory Item 3.9-3

Confirmatory Item 3.9-3 is an applicant commitment to revise its FSAR Section 3.9.6.2.2 to address MOV testing. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.9-3 is now closed.

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, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," 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.

Resolution of Standard Content Confirmatory Item 3.9-4

Confirmatory Item 3.9-4 is an applicant commitment to revise its FSAR Section 3.9.6.2.2, to address POV testing. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.9-4 is now closed.

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.

Resolution of Standard Content Confirmatory Item 3.9-5

Confirmatory Item 3.9-5 is an applicant commitment to revise its FSAR Section 3.9.6.2.2 to address squib valve testing. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.9-5 is now closed.

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.

Resolution of Standard Content Confirmatory Item 3.9-6

Confirmatory Item 3.9-6 is an applicant commitment to revise its FSAR Section 3.9.6.2.2 to address the ASME OM Code. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.9-6 is now closed.

License Conditions

- *Part 10, License Condition 3, Items G.2 and G.5*

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.

Squib Valves

During the uncontested hearing for the VEGP Units 3 and 4 COL application, the Commission discussed issues associated with the inservice testing and inspection program for squib valves to be used to perform safety functions at VEGP Units 3 and 4. Tier 1 of the AP1000 DCD requires squib valves to undergo tests or type tests to demonstrate their operational capability under design conditions. Additionally, the Commission asked the staff questions on this topic after the VEGP and V.C. Summer Nuclear Station (VCSNS) COL uncontested hearings. For these COL applications, the Commission concluded that, although it found that the staff's review of the squib valve issues was rigorous, it had a concern similar to that initially raised by the Advisory Committee on Reactor Safeguards (ACRS) regarding the status of the inservice testing and inspection program for this component. As such, the Commission imposed a license condition for each COL that directs the implementation of a surveillance program for squib valves at VEGP Units 3 and 4 and VCSNS Units 2 and 3, with the specific requirements described in the Commission orders authorizing issuance of the VEGP and VCSNS COLs.

The squib valves subject to the surveillance program license condition under the VEGP and VCSNS COLs are part of the AP1000 certified design, and the same squib valves are specified in the Levy COL application. Therefore, the staff determined that it was appropriate to apply the same surveillance program license condition to the WLS Units 1 and 2 squib valves.

The surveillance program is established to provide reasonable assurance that the WLS squib valves are operational and ready to perform their safety function. The staff-proposed license condition follows the precedent set in the VEGP and VCSNS COLs (ADAMS Accession Nos. ML113540620 and ML113420105) to require such a surveillance program.

3.9.6.5 *Post Combined License Activities*

The license condition language in this section has been clarified from previously considered language. In a letter dated March 22, 2016 (ADAMS Accession No. ML16084A099), the

applicant did not identify any concerns with the clarified license condition language. The changes do not affect the staff's above analysis of the conditions, and therefore, for the reasons discussed in the technical evaluation section above, the staff finds the following license conditions acceptable:

- License Condition (3-5) – Before initial fuel load, the licensee shall implement (1) the Preservice Testing Program and (2) the Motor-Operated Valve Testing Program.

- License Condition (3-6) – No later than 12 months after issuance of the COL, the licensee shall submit to the Director of NRO a schedule that supports planning for and conduct of NRC inspections of the IST program (including preservice and MOV testing). The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month 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.

- License Condition (3-7) – Before initial fuel load, the licensee shall implement a surveillance program for explosively actuated valves (squib valves) that includes the following provisions in addition to the requirements specified in the edition of the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code) as incorporated by reference in 10 CFR 50.55a.

  a. Preservice Testing

     All explosively actuated valves shall be preservice tested by verifying the operational readiness of the actuation logic and associated electrical circuits for each explosively actuated valve with its pyrotechnic charge removed from the valve. This must include confirmation that sufficient electrical parameters (voltage, current, resistance) are available at the explosively actuated valve from each circuit that is relied upon to actuate the valve. In addition, a sample of at least 20% of the pyrotechnic charges in all explosively actuated valves shall be tested in the valve or a qualified test fixture to confirm the capability of each sampled pyrotechnic charge to provide the necessary motive force to operate the valve to perform its intended function without damage to the valve body or connected piping. The sampling must select at least one explosively actuated valve from each redundant safety train. Corrective action shall be taken to resolve any deficiencies identified in the operational readiness of the actuation logic or associated electrical circuits, or the capability of a pyrotechnic charge. If a charge fails to fire or its capability is not confirmed, all charges with the same batch number shall be removed, discarded, and replaced with charges from a different batch number that has demonstrated successful 20% sampling of the charges.

  b. Operational Surveillance

     Explosively actuated valves shall be subject to the following surveillance activities after commencing plant operation:

     (1) At least once every 2 years, each explosively actuated valve shall undergo visual external examination and remote internal examination (including evaluation and removal of fluids or contaminants that may interfere with operation of the valve)

to verify the operational readiness of the valve and its actuator. This examination shall also verify the appropriate position of the internal actuating mechanism and proper operation of remote position indicators. Corrective action shall be taken to resolve any deficiencies identified during the examination with post-maintenance testing conducted that satisfies the preservice testing requirements.

(2) At least once every 10 years, each explosively actuated valve shall be disassembled for internal examination of the valve and actuator to verify the operational readiness of the valve assembly and the integrity of individual components and to remove any foreign material, fluid, or corrosion. The examination schedule shall provide for both of the two valve designs used for explosively actuated valves at the facility to be included among the explosively actuated valves to be disassembled and examined every 2 years. Corrective action shall be taken to resolve any deficiencies identified during the examination with post-maintenance testing conducted that satisfies the preservice testing requirements.

(3) For explosively actuated valves selected for test sampling every 2 years in accordance with the ASME OM Code, the operational readiness of the actuation logic and associated electrical circuits shall be verified for each sampled explosively actuated valve following removal of its charge. This must include confirmation that sufficient electrical parameters (voltage, current, resistance) are available for each valve actuation circuit. Corrective action shall be taken to resolve any deficiencies identified in the actuation logic or associated electrical circuits.

(4) For explosively actuated valves selected for test sampling every 2 years in accordance with the ASME OM Code, the sampling must select at least one explosively actuated valve from each redundant safety train. Each sampled pyrotechnic charge shall be tested in the valve or a qualified test fixture to confirm the capability of the charge to provide the necessary motive force to operate the valve to perform its intended function without damage to the valve body or connected piping. Corrective action shall be taken to resolve any deficiencies identified in the capability of a pyrotechnic charge in accordance with the preservice testing requirements.

This license condition shall expire upon (1) incorporation of the above surveillance provisions for explosively actuated valves into the facility's inservice testing program, or (2) incorporation of inservice testing requirements for explosively actuated valves in new reactors (i.e., plants receiving a construction permit, or combined license for construction and operation, after January 1, 2000) to be specified in a future edition of the ASME OM Code as incorporated by reference in 10 CFR 50.55a, including any conditions imposed by the NRC, into the facility's inservice testing program.

3.9.6.6 *Conclusion*

The staff reviewed the WLS COL application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the design-related

information incorporated by reference in the 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 section of the report. In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the guidance in NUREG-0800, Section 3.9.6 and in RG 1.206. The staff based its conclusion on the following:

- WLS DEP 6.4-2, related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance, is reviewed and found acceptable by the staff in Section 21.3 of this SER.

- 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.

WLS COL FSAR, Revision 11, Section 3.9, incorporates by reference, with no departures or supplements, AP1000 DCD, Revision 19 Section 3.9.7, "Integrated Head Package." The staff reviewed the WLS COL application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The staff's review confirmed that there is no outstanding issue related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS 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 Category I equipment includes the following types (1) safety-related active mechanical equipment that performs a mechanical motion while accomplishing a system safety-related function. Examples include pumps, valves, and valve operators, (2) 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 to fulfill its design safety-related function (3) 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. The equipment includes devices associated with systems essential to safe shutdown, containment isolation, reactor core cooling, containment and reactor

heat removal, or equipment otherwise essential to prevent significant release of radioactive material to the environment or in mitigating the consequences of accidents.

3.10.2 Summary of Application

WLS COL FSAR, Revision 11, Section 3.10, incorporates by reference AP1000 DCD, Revision 19, Section 3.10. This section of the WLS 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 NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for the seismic and dynamic qualification of mechanical and electrical equipment are given in NUREG-0800, Section 3.10.

3.10.4 Technical Evaluation

The staff reviewed this application and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The 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 staff's evaluation of the information incorporated by reference in the WLS COL application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the Reference COL application (i.e., VEGP Units 3 and 4) were equally applicable to the WLS Units 1 and 2 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the COL application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the WLS COL FSAR.

- The staff verified that site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion,

The staff completed its review and concluded that the evaluation performed for the standard content is directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double-indented formatting.

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.10.4:

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 is complete.

On April 25, 2012, the staff issued RAI 105, Questions 01.05-1 through 01.05-4 on the NRC Fukushima NTTF Recommendation 2.1, Recommendation 9.3, spent fuel instrumentation, and mitigation strategies for beyond-design-basis events. The staff completed the review of the Duke Energy's January 30, 2014, response as supplemented by the February 28, 2014,

response to the questions in RAI 105. In the Duke Energy's January 30, 2014, response as supplemented by the February 28, 2014, the applicant stated that the only equipment potentially affected by the identified high frequency (HF) exceedance is tested to levels higher than those imposed by those equipment ISRS. In RAI 114, Question 03.10-1, the staff questioned how the exceedances for those affected equipment were resolved if the seismic qualification by analysis was used. In a June 5, 2014, response to RAI 114, Question 03.10-1, Duke Energy stated that AP1000 DCD Chapter 3, Appendix 3I identifies equipment that is potentially sensitive to HF excitation. No such HF sensitive equipment is qualified by analysis, and all such HF sensitive equipment is qualified by testing, thereby confirming that equipment is adequate for the site-specific demands. The staff finds the applicant's response acceptable and, therefore, considers RAI 114, Question 03.10-1 resolved.

In RAI 114, Question 03.10-2, the staff requested that the applicant provide technical explanation for the fact that the AP1000 combined CSDRS & HRHF equipment Required Response Spectra (RRS) exceed the WLS RRS, even though both the horizontal and vertical design ground motion response spectra for WLS-CEUS spectra exceed the AP1000 CSDRS and AP1000 HRHF ground spectra (RRS) for some equipment. In a June 5, 2014, response to RAI 114, Question 03.10-2, the applicant stated that the differences in determining ISRS are discussed in WLG-GW-GLR-815, Section 5.3 and the ISRS differences are predominately attributed to (1) model refinements and (2) rock profile differences between the AP1000 generic hard rock profile and the site-specific WLS concrete/rock profiles (i.e., lower shear wave velocity (Vs) in the 15 m (50 ft) directly below basemat. The staff finds the applicant's response acceptable and, therefore, considers RAI 114, Question 3.10-2 resolved.

In RAI 114, Question 03.10-3, the staff requested that the applicant provide the source of test data for protection and monitoring systems, nuclear instrumentation source- and intermediate-range systems, and main control room/remote shutdown panels, shown on the Duke Energy January 20, 2014, submittal (WLG-GW-GLR-815, Letter WLG 2014.01-02) Enclosure 4, Figures 6.4-1 through 6.4-8. In a June 5, 2014, response to RAI 114, Question 03.10-3, the applicant stated that Westinghouse calculation WLG-1000-SC2-702 documents the source of AP1000 TRS/RRS testing references and the site-specific Lee RRS plots in WLG-GW-GLR-815, Figures 6.4-1 through 6.4-8 for some equipment cited in WLG-GW-GLR-815, specifically, Westinghouse calculations, APP-PMS-VPR-006, APP-PMS-VPR-004, and APP-JW03-VBR-001. The staff reviewed those calculations and verified the source of the TRS shown in WLG-GW-GLR-815, Figures 6.4-1 through 6.4-8. The staff finds the applicant's response acceptable and, therefore, considers RAI 114, Question 03.10-3 resolved.

3.10.5 Post Combined License Activities

There are no post COL activities related to this section.

3.10.6 Conclusion

The staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. The staff compared the information in the

application to relevant NRC regulations, the acceptance criteria in NUREG-0800, Section 3.10. The staff's review confirmed that the applicant has adequately addressed the COL information relating to the seismic qualification of equipment in accordance with the requirements of GDC 2, GDC 4, and GDC 14.

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. This specifies the replacement frequencies of affected safety-related equipment in harsh environments, and non-safety-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 of this report. 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 stating 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 WLS COL application with its incorporation by reference of the AP1000 DCD and supplemental information to fully describe the EQ program and other related operational programs.

3.11.2 Summary of Application

WLS COL FSAR, Revision 11, Section 3.11 incorporates by reference AP1000 DCD, Revision 19, Section 3.11. AP1000 DCD Section 3.11 describes the EQ Program for electrical and mechanical equipment to be used in the AP1000 certified design.

Departures

- WLS DEP 3.11-1

In WLS COL FSAR Table 3.11-201 (Sheet 14 of 51), "Environmentally Qualified Electrical and Mechanical Equipment," the applicant added three spent fuel pool level instruments related to the Fukushima Lessons Learned report. The staff addressed the departure in the technical evaluation section below.

- WLS DEP 6.4-2

The applicant provided additional information in Tables 3.11-202, 3I-201, and 3I-202 and in Figure 3D-201 of the WLS COL FSAR about WLS DEP 6.4-2 related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance. This information, as well as related WLS DEP 6.4-2 information appearing in other chapters of the FSAR, is reviewed in Section 21.3 of this SER.

AP1000 COL Information Item

- STD COL 3.11-1

In WLS COL FSAR Section 3.11.5, "Combined License Information Item For Equipment Qualification File," the applicant provided information to address COL Information Item 3.11-1 regarding administrative control and milestones for implementation of the EQ Program for WLS.

License Conditions

- Part 10, License Condition 3, "Operational Program Implementation," Item G.1

The applicant proposed a license condition requiring the submittal of a schedule to the NRC to aid in the planning for and conduct NRC inspections of operational programs including 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 NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for the environmental qualification of mechanical and electrical equipment are given in NUREG-0800, Section 3.11.

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, RG 1.206, Section C.IV.4 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 of

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 February 22, 2006, SRM for SECY-05-0197.

3.11.4 Technical Evaluation

Mechanical and electrical equipment (including instrumentation and controls), its supports (classified as Seismic Category I) must demonstrate that it is capable of performing its 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 equipment otherwise essential in preventing significant release of radioactive material to the environment or in mitigating the consequences of accidents.

The staff reviewed this application section and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic. The staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the environmental qualification of mechanical and electrical equipment. The staff's evaluation of the information incorporated by reference in the WLS application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content for the Reference COL application FSAR (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews.

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the COL FSAR.

- The staff verified that site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

The staff completed its review and concluded that the evaluation performed for the standard content to be directly applicable to the WLS COL application. This standard content material is identified in this report by use of italicized, double indented formatting. Section 1.2.3 of this report provides an explanation of why the standard content material from the SER for the Reference COL application (i.e., VEGP) contains evaluation material from the SER for the BLN, Units 3 and 4 COL application.

Departures

- WLS DEP 3.11-1

In WLS COL FSAR Table 3.11-201, the applicant included a departure of "Environmental Zone" for three spent fuel pool level instruments (SFS-JE-LT 019A, SFS-JE-LT 019B, and SFS-JE-LT 019C) from AP1000 DCD Table 3.11-1, "Environmentally Qualified Electrical and Mechanical Equipment," (Sheet 14 of 51) to correct the location of those instruments. This change updates DCD Table 3.11-1 and addresses the spent fuel pool level instruments concern related to the Fukushima Lessons Learned report. All the aforementioned instruments currently shown in an Environmental Zone (number) 11 will change (i.e., SFS-JE-LT 019A to Environmental Zone 6, SFS-JE-LT 019B to Environmental Zone 7, and SFS-JE-LT 019C to Environmental Zone 6) in the proposed DCD Table 3.11-1.

The staff reviewed the departure that corrects the location of three spent fuel pool level instruments (i.e., Environmental Zone from 11 to 6 and 7). The staff finds that the above corrections do not result in any changes in the environmental qualification requirements (i.e., environment, "Function," "Operating Time Required," and "Qualification Program." Thus, the staff concludes the departure is acceptable.

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

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 G.1*

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

The license condition language in this section has been clarified from previously considered language. In a letter dated March 22, 2016 (ADAMS Accession No. ML16084A099), the applicant did not identify any concerns with the clarified license condition language. The changes do not affect the staff's above analysis of the conditions, and therefore, for the reasons discussed in the technical evaluation section above, the staff finds the following license conditions acceptable:

- License Condition (3-8) – Before initial fuel load, the licensee shall implement the Environmental Qualification Program.

- License Condition (3-9) – No later than 12 months after issuance of the COL, the licensee shall submit to the Director of NRO a schedule that supports planning for and conduct of NRC inspections of the Environmental Qualification Program. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the Environmental Qualification Program has been fully implemented.

3.11.6 Conclusion

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

The staff compared the information in the application to relevant NRC regulations, the acceptance criteria in NUREG-0800, Section 3.11. The staff's review confirmed that the applicant has adequately addressed the COL information relating to the environmental qualification of equipment in accordance with the requirements of GDC 1, GDC 2, GDC 4, and GDC 23.

- WLS DEP 3.11-1, regarding a correction to the Environmental Zone designation for three level instruments for the spent fuel pool, is acceptable because the correction does

not result in any changes in the environmental qualification requirements applicable to the instruments.

- WLS DEP 6.4-2, related to design changes affecting how the temperature and humidity in the main control room are maintained within the limits for reliable human performance, is reviewed and found acceptable by the staff in Section 21.3 of this SER.

- STD COL 3.11-1, regarding the administrative control of the EQ program for WLS, 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

3.12.1 Introduction

This section covers the design of piping systems and supports for Seismic Category I and non-seismic systems. It also discusses the adequacy of the structural integrity, as well as the functional capability, of the safety-related piping systems, 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 Non-seismic 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

WLS COL FSAR, Revision 11, Chapter 3, incorporates by reference AP1000 DCD, Revision 19, Chapter 3. NUREG-0800, Sections 3.7 and 3.9 address Section 3.12, “ASME Code Class 1, 2, and 3 Piping Systems, Piping Components and their Associated Supports.” In addition, in WLS COL FSAR Sections 3.7 and 3.9, the applicant provided the following:

Departures

- WLS DEP 2.0-1

WLS DEP 2.0-1 provides updated seismic hazards and updated site-specific foundation response spectra (i.e., GMRS, FIRS, and NI FIRS (envelope of GMRS and FIRS)) for WLS that exceed the AP1000 CSDRS. These spectra consider the newly released model described in NUREG-2115, “Central and Eastern United States Seismic Source Characterization for Nuclear Facilities,” as well as local and regional refinements. This updated information affects the seismic inputs to the piping analysis, the methodology for which is described in the AP1000 DCD.

AP1000 COL Information Items

- STD COL 3.9-2

The applicant provided 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 staff review and that reconciliation of these documents is completed after construction and prior to fuel load.

- STD COL 3.9-5

The applicant provided 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 November 4, 2010, letter, the applicant endorsed the April 23, 2013, letter from the VEGP applicant, which proposed to add STD COL 3.9-7 to the 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, "COL Holder Items" Item 3.9-7

In a November 4, 2010, letter, the applicant endorsed an April 23, 2010, letter from the VEGP applicant, which proposed a license condition addressing the as-designed piping analysis reconciliation schedule.

ITAAC

In a November 4, 2010, letter, the applicant endorsed the April 23, 2010, letter from the VEGP applicant, proposing 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 NUREG-1793 and its supplements. The acceptance criteria associated with the relevant requirements of NRC regulations for the pipe and support analysis are given in NUREG-0800, Section 3.12.

3.12.4 Technical Evaluation

The staff reviewed WLS COL FSAR Section 3.9 and checked the referenced DCD to ensure that the combination of the DCD and the WLS COL application represents the complete scope of information relating to this review topic.[1] The 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 staff's evaluation of the information incorporated by reference in the WLS application is documented in NUREG-1793 and its supplements. Section 1.2.3 of this report provides a discussion of the strategy used by the staff to perform a technical review for each "standard issue" and use this review to evaluate subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the Reference

COL application (i.e., VEGP Units 3 and 4) were equally applicable to the WLS application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the WLS COL FSAR. In the comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the application, as applicable) resulting from responses to RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content evaluation were endorsed and that those changes were actualized in the COL FSAR.

- The staff verified that the site-specific differences, if any, did not adversely affect any previous relevant evaluation or conclusion.

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

Departures

- WLS DEP 2.0-1

The WLS COL Part 7, "Departures and Exemptions Requests," Revision 9, identifies in departure WLS DEP 2.0-1 that the WLS FIRS exceeds the AP1000 DCD CSDRS and HRHF spectra. The applicant's June 11, 2014, response to RAI 115, Question 03.12-1, shows that safety-related piping (ASME Class 1, Class 2, and Class 3) is designed for both CSDRS and HRHF spectra, as described in AP1000 DCD Appendix 3I. 10 CFR Part 50, Appendix A, GDC 2 and 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," state that SSCs important to safety shall be designed to withstand the effects of earthquakes. In the applicant's June 11, 2014, response to RAI 115, Question 03.12-1, Westinghouse, as documented in its report WLG-GW-GLR-815, which is cited as WLS COL FSAR Section 3.7, Reference 206, performed a detailed review of all WLS site-specific in-structure floor response spectra (FRS) X-, Y-, and Z-direction exceedances of both the AP1000 CSDRS design spectra and the HRHF design spectra. The applicant's response also stated that selected piping packages in Reference 206 showed that resulting pipe stresses due to WLS FRS are bounded by the CSDRS or HRHF design basis analysis results.

The staff reviewed Reference 206 for the effects of the WLS FIRS exceedances on piping. Forty ASME Class 1, 2 and 3 piping layout packages were reviewed. Reference 206, Figures 5.4-15 and 5.4-16, state that the horizontal WLS FRS for the hot legs and pressurizer bottom has exceedances at lower frequencies. On this basis, two piping packages inside containment were selected for analysis. These two packages are the automatic depressurization system (ADS) 4th stage east compartment and passive residual heat removal (RHR) supply and the pressurizer surge line. A third package, the spent fuel cooling system (SFS) from the auxiliary building steel containment vessel (SCV) to the auxiliary building SFS pumps was also selected for review because it is potentially sensitive to high frequency response. These three piping systems were analyzed using the PIPESTRESS computer program with seismic FRS input loadings from CSDRS, HRHF and WLS FIRS. The staff reviewed a comparison of moment stresses from the seismic analyses due to these seismic input loadings was performed. For all three piping systems, the WLS spectrum resulting

stresses were bounded either by the AP1000 DCD CSDRS or the AP1000 DCD HRHF spectra. The Reference 206 report also determined that piping support loads due to WLS FRS are enveloped by CSDRS loads. Furthermore, the applicant, in a revised January 13, 2015, response to RAI 116, Question 03.12-2, the applicant stated that when piping reanalysis is required to reconcile as-built piping, in addition to the AP1000 DCD CSDRS and HRHF spectra, the as-built piping system will also be qualified using the Lee site-specific spectra to confirm that configuration changes during construction have not affected the piping system qualification for site-specific demands. The staff also notes that the applicant revised the WLS COLA, Part 2, and WLS COL FSAR, Chapter 3, Appendix 3I to identify WLS DEP 2.0-1 and provide additional information to the end of AP1000 DCD Sections 3I.1, 3I.2, 3I.3, 3I.6, 3I.6.1, 3I.6.2, 3I.6.3, 3I.6.4, and 3I.7. Specifically, the revised Appendix 3I, Section 3I.6.3 describes the applicant's site-specific analyses for piping, supporting WLS DEP 2.0-1. The staff's concluded that the additional information in AP1000 Appendix 3I.6.3 regarding piping systems is consistent with the information provided in Reference 206.

Based on its review above, the staff finds that the applicant adequately evaluated the effects of the exceedances of the WLS site-specific spectra to the AP1000 DCD CSDRS and HRHF spectra on piping and has provided reasonable assurance that the WLS site-specific seismic exceedances will not adversely affect the structural integrity of the WLS AP1000 safety related piping.

The following portion of this technical evaluation section is reproduced from VEGP SER Section 3.12.4:

> *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.

Resolution of Standard Content Confirmatory Item 3.12-1

Confirmatory Item 3.12-1 is an applicant commitment to revise its FSAR Table 1.9-204 and Sections 3.9.3.1.2 and 3.9.8.5 for surge line monitoring testing. The

staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.12-1 is now closed.

- *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-# [where # is the next sequential number] 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.# [where # is the next sequential number] 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****.*

<u>Resolution of Standard Content Confirmatory Item 3.12-2</u>

Confirmatory Item 3.12-2 is an applicant commitment to revise its FSAR Table 1.8-202, Section 3.9.8.2, Section 3.9.8.7, and Section 14.3.3.3 for pipe analysis and add an ITAAC (Table 3.8-2) for verification of the ASME Code design reports. The staff verified that the VEGP COL FSAR and Part 10 of the application (ITAAC Table 3.8-2) were appropriately updated. As a result, Confirmatory Item 3.12-2 is now closed.

3.12.5 Post Combined License Activities

The license condition language in this section has been clarified from previously considered language. In a letter dated March 22, 2016 (ADAMS Accession No. ML16084A099), the applicant did not identify any concerns with the clarified license condition language. The changes do not affect the staff's above analysis of the conditions, and therefore, for the reasons discussed in the technical evaluation section above, the staff finds the following ITAAC and license condition acceptable:

- The licensee shall perform and satisfy the piping design analysis ITAAC in 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.

- License Condition (3-10) – Before commencing installation of individual piping segments identified in AP1000 DCD, Rev. 19, Section 3.9.8.7, and connected components in their final locations in the facility, the licensee shall complete the analysis of the as-designed individual piping segments and shall inform the Director of NRO, or the Director's designee, in writing, upon the completion of these analyses and the availability of the design reports for the selected piping packages.

3.12.6 Conclusion

The staff reviewed the application and checked the referenced DCD. The 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 WLS COL FSAR related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the WLS COL application is acceptable and meets NRC regulations.

- WLS DEP 2.0-1 is acceptable because the applicant provided sufficient information to satisfy the requirements of 10 CFR Part 50, Appendix A, GDC 2 of Appendix A and 10 CFR Part 50, Appendix S, "Earthquake engineering criteria for nuclear power plants."

- STD COL 3.9-2 is acceptable because it meets the general requirements of the ASME Code, as specified in 10 CFR 50.55a.

- STD COL 3.9-5 is acceptable because it is consistent with pressurizer surge line monitoring discussed in 10 CFR Part 52, Appendix D, "Design Certification Rule for the AP1000 Design."

- STD COL 3.9-7 is acceptable because it meets the general requirements of the ASME Code, as specified in 10 CFR 50.55a.

- WLS DEP 2.0-1 is acceptable because the applicant provided sufficient information to satisfy the requirements of 10 CFR Part 50, Appendix A, GDC 2 and 10 CFR Part 50, Appendix S, "Earthquake engineering criteria for nuclear power plants."