3.0 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

3.1 Conformance with NRC General Design Criteria

Section 3.1 of the Levy Nuclear Plant (LNP) combined license (COL) Final Safety Analysis Report (FSAR), Revision 9, 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 LNP COL FSAR, the applicant provided the following:

Departure

- LNP DEP 6.4-1

The applicant provided additional information about LNP 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 LNP 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 reviewed the application and checked the referenced DCD to ensure that 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 LNP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements. Section 21.2 of this report evaluates the departure from the DCD provided in LNP DEP 6.4-1.

3.2 Classification of Structures, Components, and Systems

3.2.1 Seismic Classification

3.2.1.1 *Introduction*

Nuclear power plant structures, systems, and components (SSCs) important to safety are to be designed to withstand the effects of earthquakes without loss of capability to perform their safety functions. Important to safety SSCs are defined in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities, "Appendix A, "General Design Criteria for Nuclear Power Plants," as those SSCs that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. Important to safety SSCs include safety-related SSCs that perform safety-related functions to ensure: (1) the integrity of the reactor coolant pressure boundary (RCPB); (2) the capability to shut down the reactor and maintain it in a safe-shutdown condition; and (3) the capability to prevent or mitigate the consequences of accidents that could result in potential

[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).

offsite exposures. The earthquake for which these safety-related plant features are designed is defined as the safe shutdown earthquake (SSE). The SSE is based on an evaluation of the maximum earthquake potential for the site and is an earthquake that produces the maximum vibratory ground motion for which SSCs are designed to remain functional. The regulatory treatment of nonsafety systems (RTNSS) process is applied to define seismic requirements for SSCs that are nonsafety-related but perform risk-significant functions.

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

3.2.1.2 *Summary of Application*

Section 3.2 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.2 of the AP1000 DCD, Revision 19. Section 3.2 of the DCD includes Section 3.2.1.

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

Departures

- LNP DEP 3.2-1

The applicant provided additional information about LNP 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 LNP DEP 3.2-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.1 of the SER.

Supplemental Information

- LNP Supplement (SUP) 3.2-1

The applicant provided supplemental information by adding text to the end of DCD Section 3.2.1, "Seismic Classification," stating that there are no safety-related SSCs at LNP Units 1 and 2 outside the scope of the DCD, except for roller compacted concrete (RCC), which is classified as a seismic Category I, safety-related structure. The applicant also states that the nonsafety-related SSCs outside the scope of the DCD are classified as NS.

- LNP SUP 3.2-2

The applicant provided supplemental information by adding text to the end of AP1000 DCD Section 3.2.1.3, "Classification of Building Structures," stating that the seismic classification of the makeup water pump house, Unit 1 freshwater raw water pump house, Unit 2 freshwater raw

water pump house, Unit 1 potable water pump house, and Unit 2 potable water pump house are provided in LNP COL FSAR Table 3.2-201.

3.2.1.3 *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 the Commission regulations for the seismic classification are given in Section 3.2.1 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants ([light-water reactor] LWR Edition)."

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

3.2.1.4 *Technical Evaluation*

The NRC staff reviewed Section 3.2 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to seismic classification. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this safety evaluation report (SER) provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DCD and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (Vogtle Electric Generating Plant [VEGP] Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5, to the LNP COL FSAR. In performing this comparison, the staff considered changes made to the LNP COL FSAR (and other parts of the 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.

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

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

in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER 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 information in the LNP COL FSAR:

Supplemental Information

- LNP SUP 3.2-1

The NRC staff reviewed LNP SUP 3.2-1, related to the seismic classification of safety-related SSCs included under Section 3.2.1 of the LNP COL FSAR, which states that there are no safety-related SSCs outside the scope of the DCD, except for roller compacted concrete (RCC), which is classified as a seismic Category I, safety-related structure at LNP Units 1 and 2. Therefore, the seismic classification is acceptable.

- LNP SUP 3.2-2

The NRC staff reviewed LNP SUP 3.2-2 included in LNP COL FSAR Section 3.2.1.3, related to the seismic classification of the makeup water pump house, Unit 1 freshwater raw water pump house, Unit 2 freshwater raw water pump house, Unit 1 potable water pump house, and Unit 2 potable water pump house, which are classified as NS and are provided in LNP COL FSAR Table 3.2-201. Therefore, the seismic classification is acceptable.

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

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

Seismic Classification of Other Site-Specific SSCs

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

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

Quality Assurance for Seismic Category II SSCs

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

Consistency with RG 1.29, Revision 4

Section 3.2.1 of the BLN COL FSAR does not identify any departures relative to seismic classification identified in the DCD and BLN COL FSAR, Appendix 1AA identifies conformance with RG 1.29, Revision 3 as stated in the DCD rather than

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

3.2.1.5 *Post Combined License Activities*

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

3.2.1.6 *Conclusion*

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

In addition, the staff concludes that the relevant information presented in the LNP 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:

- LNP 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.

- LNP SUP 3.2-1 is acceptable because the LNP COL FSAR states that there are no safety-related SSCs outside the scope of the AP1000 DCD, except for RCC, which is classified as a seismic Category I, safety-related structure. The LNP COL FSAR also states that the nonsafety-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.

- LNP SUP 3.2-2 is acceptable because the seismic classification of the makeup water pump house, Unit 1 freshwater raw water pump house, Unit 2 freshwater raw water pump house, Unit 1 potable water pump house, and Unit 2 potable water pump house, which are classified as NS are provided in LNP COL FSAR Table 3.2-201. Therefore, the requirements of 10 CFR Part 50, Appendix A, GDC 2, the acceptance criteria in NUREG-0800, Section 3.2.1, and the guidelines in RG 1.29 are satisfied.

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

3.2.2.1 *Introduction*

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

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

3.2.2.2 *Summary of Application*

Section 3.2 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.2 of the AP1000 DCD, Revision 19. Section 3.2 of the DCD includes Section 3.2.2.

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

Supplemental Information

- LNP SUP 3.2-1

The applicant provided supplemental information by adding text stating that there are no safety-related SSCs at LNP Units 1 and 2 outside the scope of the DCD, except for roller compacted concrete (RCC), which is classified as a seismic Category I, safety-related structure.

3.2.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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

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

3.2.2.4 *Technical Evaluation*

The NRC staff reviewed Section 3.2 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the system quality group classification. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DCD and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the LNP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER 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 LNP COL FSAR:

Supplemental Information

- LNP SUP 3.2-1

The NRC staff reviewed LNP SUP 3.2-1 related to the seismic classification of safety-related SSCs included under Section 3.2.2 of the LNP COL FSAR, which states that there are no safety-related SSCs outside the scope of the DCD at LNP Units 1 and 2, except for RCC, which is classified as a seismic Category I, safety-related structure.

The NRC staff reviewed LNP SUP 3.2-1 related to quality group classification of systems included under Section 3.2.2 of the LNP COL FSAR. LNP SUP 3.2-1 identifies that there are no safety-related structures, systems, or components outside the scope of the DCD, except for RCC which is classified as a seismic Category I, safety-related structure. Quality Group addressed in RG 1.26 is limited to pressure-retaining systems and their supports and does not apply to structures. Structures are specifically excluded from the scope of the NUREG-0800 Section 3.2.2 review. As discussed below, there are no site-specific nonsafety-related SSCs outside the scope of the AP1000 DCD that are important to safety so there are no changes to the quality group classifications listed in LNP COL FSAR Section 3.2.

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

> *Special Treatment for Risk-Significant SSCs*
>
> *GDC 1 identifies, in part, that SSCs important to safety shall be designed, fabricated, erected and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. Supplemental quality standards and QA programs applicable to passive SSCs used in non-safety-related regulatory treatment of non-safety systems that may be important to safety are not clearly defined in the BLN COL FSAR for site-specific SSCs.*
>
> *In RAI 3.2.2-2, the applicant was requested to clarify what supplemental quality standards are applied to non-safety-related site-specific SSCs that are important to safety to ensure that all SSCs important to safety are designed, fabricated, erected, and tested to quality standards commensurate with the safety function to be performed. Any site-specific SSCs that are considered important to safety may also require special treatment, but the response to RAI 3.2.1-1 identified that there are no site-specific non-safety-related SSCs outside the scope of the DCD that are important to safety. Therefore, this concern is closed.*

Codes and Standards

The Staff Requirements Memorandum (SRM), dated July 21, 1993, concerning SECY-93-087 identified that the staff will review passive plant design applications using the newest codes and standards endorsed by the NRC and unapproved revisions to the codes will be reviewed on a case by case basis. Editions of various codes and standards referenced in DCD Section 3.2.6 are not current and newer codes and standards are not referenced in BLN COL FSAR Sections 3.2 or 1.8. In RAI 3.2.2-3, the applicant was requested to clarify if any different or current codes and standards are applied to the design and procurement of site-specific SSCs, other than those identified in the DCD. The RAI response identified that the applicant intends to implement the DCD identified codes and standards and that the codes and standards applied to the design and procurement of non-safety-related site-specific SSCs are those identified in various sections of the BLN COL FSAR. Although codes and standards for site-specific SSCs would be expected to be identified and reviewed in the COL application rather than the DCD, the response to RAI 3.2.1-1 identified that there are no site-specific non-safety-related SSCs outside the scope of the DCD that are important to safety. Therefore, this concern is closed.

Consistency with RG 1.26, Revision 4

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

3.2.2.5 *Post Combined License Activities*

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

3.2.2.6 *Conclusion*

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

In addition, the staff concludes that the relevant information presented in the LNP 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:

- LNP SUP 3.2-1 is acceptable with regard to quality group classifications because no change was made to the quality group classifications in Section 3.2 and there are no site-specific nonsafety-related SSCs outside the scope of the AP1000 DCD. Quality Group does not apply to the site-specific RCC that is classified as a seismic Category I, safety-related structure. Therefore, 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, as required by GDC 2 in Appendix A to 10 CFR Part 50. This states that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures shall reflect the appropriate consideration of the most severe of the natural phenomena that have been historically reported in the area of the plant, with sufficient margin to account for limited accuracy, quantity, and period of time for collection of data.

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

3.3.1 Wind Loadings

3.3.1.1 *Introduction*

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

3.3.1.2 *Summary of Application*

Section 3.3 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.3 of the AP1000 DCD, Revision 19. Section 3.3 of the DCD includes Section 3.3.1.

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

AP1000 COL Information Items

- LNP COL 3.3-1

The applicant provided additional information in LNP COL 3.3-1 to address COL Information Item 3.3-1 (COL Action Item 3.3.2.2-1) by stating that the wind velocity characteristics for the LNP site are given in LNP COL FSAR Section 2.3.1.2.2. The applicant states that these values are bounded by the design wind velocities specified in AP1000 DCD Section 3.3.1.1 for the standard AP1000 plant design. In addition, the applicant states that the effects of wind on the safety-related SSCs due to failures in an adjacent AP1000 plant are bounded by the evaluation of the buildings and structures in a single unit. The portion of LNP COL 3.3-1 relating to design tornado site characteristics and the effects of wind on the safety-related SSCs due to failures in an adjacent AP1000 plant is reviewed in SER Section 3.3.2.

- LNP COL 3.5-1

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

3.3.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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

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

3.3.1.4 *Technical Evaluation*

The NRC staff reviewed Section 3.3 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff’s review confirmed that the information in the application and incorporated by reference addresses the required information relating to wind loadings. The results of the NRC staff’s evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the LNP COL FSAR:

AP1000 COL Information Item

- LNP COL 3.3-1

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

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

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

The applicant states in LNP COL 3.3-1 that the wind velocity characteristics for LNP Units 1 and 2, are given in LNP COL FSAR Section 2.3.1.2.2. The applicant states that these values are bounded by the DCD design wind velocity values for the standard AP1000 plant.

For consistency, the NRC staff reviewed the resolution to the site specific information item LNP COL 3.3-1 on the site related parameters with those contained in COL FSAR Section 2.3.1.2.2. ASCE 7-05 was used by the staff to validate wind design information in relation to the LNP site. The applicant has presented consideration to ASCE 7-05 in Table 2.0.201, "Comparison of AP1000 DCD Site Parameters and LNP Site Characteristics." In this Table, the applicant stated that the AP1000 Design Wind Speed of 145 mph envelopes the LNP Maximum 50-year and 100-year return 3-second gust wind speeds based on Table C6-7 of ASCE 7-05. However, historic records show at least two hurricanes that exceed the wind speed for the AP1000 Design. For this, the staff issued RAI 2.3.1-8.

In its April 1, 2009, response to RAI 2.3.1-8, the applicant stated that the 3-second gust wind speed will be increased from 139 mph to 185 mph. Exceeding the 145 mph design wind speed for the AP1000 Design will require site specific calculations to convert winds in pressure loads over safety related structures, following ASCE 7-05. Also, the site specific wind pressure load shall be considered for the structural analysis done in Section 3.8. This analysis of the site specific wind pressure load was not included with the applicant's response to RAI 2.3.1-8. For this, staff issued RAI 3.3.1-1.

The applicant's August 24, 2009, response to RAI 3.3.1-1 stated that the 50-year and 100-year wind speeds for the Levy Site were 120 mph and 128 mph, respectively. Also, the applicant indicated that the most severe historically reported wind speed for the site is 144 mph, which is enveloped by the AP1000 Design wind speed of 145 mph. Given that this historically recorded wind speed was just 1 mph less than the AP1000 design wind speed, the staff issued RAI 3.3.1-2 to understand how historic wind speed was considered, with sufficient margin, as required by 10 CFR 50 Appendix A, GDC 2. In its January 10, 2010, response to RAI 3.3.1-2, the applicant provided additional wind speed data which places the 144 mph recorded wind speed outside the Levy County site.

The exceeding wind speeds are part of the site-specific meteorological evaluation of FSAR Chapter 2.3. The staff verified the applicant's site-specific meteorological information, provided in the revised RAI response for RAI 2.3.1-8, to confirm that the different wind speeds exceeding

the AP1000 design wind were outside of the 100 nautical mile radius described in NUREG-0800 Section 2.3. Also, the staff concluded that the applicant's approach to determine the site specific wind speeds, and method of informing severe weather conditions around the vicinity of the site, was acceptable because it is consistent with guidance in Section 2.3.1 of NUREG-0800. RAIs 2.3.1-8, 3.3.1-1, and 3.3.1-2 are resolved. Additional information regarding the analysis and adequacy of site specific wind speeds is included in Section 2.3 of this SER.

Based on the above review, the staff finds that the information supplied to close Action Item 3.3-1 for site interface criteria for wind by the applicant is adequate in meeting the NRC regulatory requirements.

3.3.1.5 *Post Combined License Activities*

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

3.3.1.6 *Conclusion*

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

In addition, the staff concludes that the relevant information presented in the LNP COL FSAR is acceptable and meets the requirements of GDC 2. The staff based its conclusion on the following:

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

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

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

Similar considerations to hurricanes in coastal and tropical regions, per RG 1.221 "Design Basis Hurricanes and Hurricane Missiles for Nuclear Power Plants," include:

- the hurricane wind speeds
- the spectrum of hurricane-generated missiles

3.3.2.2 *Summary of Application*

Section 3.3 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.3 of the AP1000 DCD, Revision 19. Section 3.3 of the DCD includes Section 3.3.2.

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

AP1000 COL Information Items

- LNP COL 3.3-1

The applicant provided additional information in LNP COL 3.3-1 to resolve COL Information Item 3.3-1 (COL Action Item 3.3.2.2-1). In LNP COL 3.3-1, the applicant states that tornado characteristics for LNP Units 1 and 2, given in Section 2.3.1.2.2 of the LNP COL FSAR 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 states that the effects of wind and tornado on the safety-related SSCs due to failures in an adjacent AP1000 plant are bounded by the evaluation of the buildings and structures in a single unit. The portion of LNP COL 3.3-1 relating to design wind velocity characteristics is reviewed in SER Section 3.3.1.

- LNP COL 3.5-1

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

- STD COL 3.3-1

The information provided in LNP COL FSAR Section 3.3.2.3 to address Standard (STD) COL 3.3-1 is identical to the information provided in LNP COL FSAR Section 3.3.2.3 to address LNP COL 3.5-1. As noted above, the portion of LNP COL 3.5-1 included in LNP COL FSAR Section 3.3.2 is addressed by the staff in its evaluation of LNP COL 3.3-1 in this SER section. Therefore, STD COL 3.3-1 will not be addressed further in this SER.

3.3.2.3 *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 the Commission regulations for tornado loading are given in Section 3.3.2 of NUREG-0800.

Acceptance of the information addressing LNP 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 using acceptable procedures must meet the requirements of 10 CFR Part 50, Appendix A, GDC 2, which states that SSCs important to safety shall be designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

3.3.2.4 *Technical Evaluation*

The NRC staff reviewed Section 3.3.2 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to tornado loading. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the LNP COL FSAR:

AP1000 COL Information Item

- LNP COL 3.3-1

The NRC staff reviewed LNP COL 3.3-1 included under Sections 3.3.2 and 3.5.1 of the LNP COL FSAR. Specific information provided by the applicant to address COL Action Item 3.3.2.2-1 includes development of site-specific parameters and verification of bounding conditions, site arrangement and building construction. This information is provided to satisfy the commitment documented in Appendix F of NUREG-1793, which states:

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

In LNP COL 3.3-1, the applicant states that the tornado characteristics for LNP Units 1 and 2, given in Section 2.3.1.2.2 of the LNP COL FSAR, 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 states that the effects of wind and tornado on the safety-related SSCs due to failures in an adjacent AP1000 plant are bounded by the evaluation of the buildings and structures in a single unit.

In Section 2.3.1 of this SER, 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 LNP site are in compliance with GDC 2.

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

In order to assure the failure of structures or components not designed for wind or tornado loadings does not affect the capability of safety-related SSCs to perform their intended safety functions, the COL applicants were offered three options in Section 3.3.2.3 of the AP1000 DCD:

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

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

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

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

RG 1.221 provides new guidance that the NRC staff considers acceptable for use in selecting the design-basis hurricane wind speed and hurricane-generated missiles that a new nuclear power plant should be designed to withstand to prevent undue risk to public health and safety. As described in Section 2.3 of this SER, the staff compared the information provided in FSAR 2.3 regarding hurricane winds against the information in RG 1.221. In response to RAI 2.03.01-20, with regards to hurricane wind and hurricane missile effects on safety-related structures, the applicant provided a comparison between DCD Tier 1 tornado generated missiles and those in RG 1.221. The evaluation of the three missiles (1-in diameter steel sphere, 6-in diameter pipe, and 4,000 lb automobile) compared velocities generated from both hurricane and tornado events. For the 1-in diameter steel sphere, both horizontal and vertical velocities were bounded by the tornado event. For the 6-in diameter pipe, the applicant performed a local analysis calculation to confirm that the wall thicknesses of the NI structures are sufficient to prevent penetration and scabbing generated by the pipe’s impact. This calculation was verified by the staff to be acceptable, based on a staff confirmatory analysis. Impact energy was also evaluated by the applicant; however the staff was more concerned with the impact analysis for the automobile, due to its higher impact kinetic energy relative to the other analyzed missiles. The applicant mentioned that a confirmatory calculation were to be provided separately from the RAI response.

On February 9, 2012, the staff performed an audit of the applicant's calculation (# LNG-1000-S3R-001) related to the impact analysis of the automobile missile. Five different wall samples were used to estimate the shear stresses, impact energy, loads, and ductility. The applicant identified assumptions such as, not using Dynamic Impact Factor and corner impact to reduce shear perimeter, which the staff found to be conservative. Design codes and subject matter references including ACI-349 "Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary," and a Bechtel Topical Report (R. B. Linderman, et al., "Design of Structures for Missile Impact," BC-TOP-9-A, Revision 2, 1974), were used to demonstrate that shear stresses and ductility are still within code acceptable limits. The staff determined that the applicant's approach for estimating structural global response is acceptable because the applicant's approach is consistent with standard engineering practices. Additionally, the staff performed a confirmatory calculation to verify the adequacy of the LNP NI structures against the hurricane generated automobile missile. Based on the staff's confirmatory analysis, the applicant's evaluation of the hurricane generated missile effects on the NI structures for the LNP site was found to be acceptable.

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

3.3.2.5 *Post Combined License Activities*

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

3.3.2.6 *Conclusion*

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

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

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

LNP COL 3.3-1, as it relates to design hurricane loads, is acceptable based on the design hurricane wind and hurricane missile site characteristics, reviewed in Section 2.3 of this SER, matching the RG 1.221 site characteristics and, therefore, complies with GDC 2.

LNP COL 3.5-1, as it relates to hurricane missiles that are more energetic than the tornado missiles in the AP1000 DCD, is acceptable based on the evaluation of hurricane missile effects

on the LNP safety-related structures in response to RAI 2.03.01-20, and therefore, complies with GDC 2.

3.4 Water Level (Flood) Design

3.4.1 Flood Protection

3.4.1.1 *Introduction*

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

3.4.1.2 *Summary of Application*

Section 3.4 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.4 of the AP1000 DCD, Revision 19. Section 3.4 of the DCD includes Section 3.4.1.

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

AP1000 COL Information Item

- LNP COL 3.4-1

The applicant provided additional information in LNP COL 3.4-1 to resolve COL Information Item 3.4-1 (COL Action Item 3.4.1.1-1), which addresses plant-specific information on site-specific flooding hazards protective measures. LNP COL 3.4-1, in LNP COL FSAR Section 3.4.1.3, "Permanent Dewatering System," states that no permanent dewatering system is required because site groundwater levels are 2 feet (ft) or more below site grade level as described in LNP COL FSAR Section 2.4.12.5.

LNP COL 3.4-1, in LNP COL FSAR Section 3.4.3, "Combined License Information," states that the site-specific water levels given in LNP COL FSAR Section 2.4 satisfy the interface requirements identified in AP1000 DCD Section 2.4.

3.4.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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

Further, the acceptance criteria associated with the relevant requirements of the Commission regulations for the identification of floods and flood design considerations are given in Section 3.4.1.II of NUREG-0800.

3.4.1.4 *Technical Evaluation*

The NRC staff reviewed Section 3.4 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to flood protection measures. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the LNP COL FSAR:

AP1000 COL Information Item

- LNP COL 3.4-1

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

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

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

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

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

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

- LNP COL 3.4-1, in LNP COL FSAR Section 3.4.1.3, "Permanent Dewatering System," states that no permanent dewatering system is required because site groundwater levels are 2 ft or more below site grade level as described in LNP COL FSAR Section 2.4.12.5.

- LNP COL 3.4-1, in LNP COL FSAR Section 3.4.3, "Combined License Information," states that the site-specific water levels given in LNP COL FSAR Section 2.4 satisfy the interface requirements identified in AP1000 DCD Section 2.4.

In Section 2.4.12 of this SER, the staff accepted the LNP applicant's position that no permanent dewatering system is required and that the site-specific groundwater characteristics for the LNP

site fall within the Tier 1 and Tier 2 DCD parameter values. Therefore, the staff concludes that the site-specific information in LNP COL 3.4-1 is acceptable.

3.4.1.5 *Post Combined License Activities*

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

3.4.1.6 *Conclusion*

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to appropriate consideration of flood causing mechanisms and flood protection measures as described in section 2.4.2 and 2.4.10 of the FSAR. The NRC staff has determined that there is no outstanding information expected to be addressed in the LNP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

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

- LNP COL 3.4-1, is acceptable based on 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 SER regarding the adequacy of the site-specific groundwater levels.

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

Analysis methods and procedures are described for the design of AP1000 standard plants to assess the maximum water levels due to internal flooding caused by equipment failure or external flooding caused by natural phenomena and make sure that they do not jeopardize the safety of the plant or the ability to achieve and maintain safe shutdown conditions.

Section 3.4 of the LNP COL FSAR, Revision 9, incorporates by reference, with no departures or supplements, Section 3.4.2, "Analytical and Test Procedures," of Revision 19 of the AP1000 DCD. Section 3.4.2 of the AP1000 DCD states that the analytical approach for external and internal flooding events is described in DCD Section 3.4.1.2, "Evaluation of Flooding Events." The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

3.5 Missile Protection

Seismic Category I structures are analyzed and designed to be protected from a wide spectrum of missiles (e.g., missiles from rotating and pressurized equipment, gravitational missiles, and

missiles generated from tornado winds). Once a potential missile is identified, its statistical significance is determined (a significant missile is one which could cause unacceptable consequences or violate the guidelines of 10 CFR Part 100, "Reactor site criteria").

3.5.1 Missile Selection and Description

3.5.1.1 *Introduction*

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

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

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

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

3.5.1.2 *Summary of Application*

Section 3.5 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.5 of the AP1000 DCD, Revision 19. Section 3.5 of the DCD includes Section 3.5.1.

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

AP1000 COL Information Item

- LNP COL 3.3-1 and LNP COL 3.5-1

The applicant provided additional information in LNP COL 3.3-1 to resolve COL Information Item 3.3-1 (COL Action Item 3.3.2.2-1) and LNP COL 3.5-1 to resolve COL Information Item 3.5-1 (COL Action Item 3.5.1.5-1). LNP COL 3.3-1 and LNP COL 3.5-1, in LNP COL FSAR Section 3.5.1.5, "Missiles Generated by Events Near the Site," states that the buildings and structures at the LNP site are common structures that are located at a nuclear power plant. They are of similar design and construction to those that are typical at nuclear power plants.

Therefore, any missiles resulting from a tornado-initiated failure are not more energetic than tornado missiles postulated for design of the AP1000. Also, LNP COL 3.5-1 states that the missiles generated by events near the site are evaluated in accordance with FSAR Section 2.2.3, and concludes effects of these events on Units 1 and 2 safety-related components are insignificant.

The applicant provided additional information under LNP COL 3.5-1 related to hurricane missile parameters. This information was provided under Section 3.5.2 of the FSAR and is reviewed under Section 3.5.2 of this report.

Supplemental Information

- STD SUP 3.5-1

The applicant provided supplemental information by adding text to the end of AP1000 DCD Section 3.5.1.3. This supplemental information states that the potential for a turbine missile from another AP1000 plant in close proximity has been considered for LNP Units 1 and 2 in accordance with RG 1.115, "Protection Against Low-Trajectory Turbine Missiles," Revision 1.

- STD SUP 3.5-2

The applicant provided supplemental information by stating that the turbine system maintenance and inspection program is discussed in AP1000 DCD 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 and its supplements.

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

The regulatory basis for acceptance of LNP COL 3.5-1 is based on the development of site-specific parameters and verification of bounding conditions compared to the DCD interface criteria for missile generation, site arrangement, and building construction. The design of AP1000 safety-related structures for protection against missiles using acceptable procedures must meet the requirements of 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases." 10 CFR 100.21(e), "Non-seismic site criteria," provides regulatory requirements for potential hazards associated with nearby transportation routes, industrial and military facilities.

Additional regulatory guidance related to the review of the issues in this SER section are given in RG 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," Revision 1; and RG 1.115, "Protection Against Low-Trajectory Turbine Missiles."

3.5.1.4 *Technical Evaluation*

The NRC staff reviewed Section 3.5 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to missile protection of safety-related SSCs. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the LNP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER 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 LNP COL FSAR:

AP1000 COL Information Items

- LNP COL 3.3-1 and LNP COL 3.5-1

The NRC staff reviewed the COL information item LNP COL 3.5-1 and LNP COL 3.3-1 related to missiles generated by events near the site included under Section 3.5.1.5 of the LNP COL FSAR. 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 NRC staff confirmed that no pressure criteria were exceeded, 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.

COL Information Item LNP COL 3.5-1 in LNP COL FSAR Section 3.5.1.6, "Aircraft Hazards," states that based on the discussion in LNP COL FSAR Section 2.2.2.7, the applicant concludes that the calculated total aircraft crash hazard probability is 7.011×10^{-6} per year, which results in a core damage frequency (CDF) of 4.10×10^{-11} per year. This is not considered a safety concern since the resultant CDF when combined with other risk factors is less than the acceptable CDF for the AP1000 of 1.0×10^{-8} per year. Therefore, the applicant concludes the aircraft hazards pose no undue risk to the health and safety of the public. The staff's review of CDF calculations is presented as part of Probabilistic Risk Assessment (PRA) in Section 19.2 of this SER.

The applicant evaluated potential aircraft hazards 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 whether aircraft accidents resulting in radiological consequences would exceed the 10 CFR Part 100 radiological dose requirements was determined by the applicant based on the following:

Revision 0 of LNP FSAR did not list any flight paths passing within 2 miles of the LNP site. The NRC staff noted two flight paths within 2 miles and issued RAI 2.2.1-2.2.2-2 requesting evaluation of the flight paths. In LNP's response to the RAI, LNP stated that: "The outer boundaries of five airways are routed within two miles of the LNP site: V7-521, VR 1006, J119, Q110-116-118 and Q112 (as shown on LNP FSAR Figure 2.2.1-204)," and revised FSAR Section 3.5.1.6 to include a risk analysis for aircraft crashes.

The applicant calculated the total probability of small aircraft crash into the plant to be on the order of 7.011×10^{-6} per year. This crash probability results in a core damage frequency of 4.10×10^{-11} per year which is less than current plant (AP1000) acceptance criteria of 1.0×10^{-8} per year. The probability of large aircraft crashing on a seismic category 1 structure is calculated as 3.093×10^{-8} per year. This meets the acceptance criteria of 1.0×10^{-7} per year in Subsection 19.58.2.3.1 of the DCD. The NRC staff reviewed and confirmed the acceptability of the applicant's methodology and conclusions using NUREG-0800, Section 3.5.1.6. Therefore, RAI 2.2.1-2.2.2-2 is closed.

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 LNP units within two miles of the noted flight paths 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). This conclusion is based on the staff's independent verification of the applicant's assessment of aircraft hazards at the site that resulted in a probability less than an 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 Section 3.5.1.4 of the VEGP SER:

Supplemental Information

- *STD SUP 3.5-1*

The NRC staff reviewed the standard supplementary information (STD SUP 3.5-1) on the probability of turbine missiles from another AP1000 plant in close proximity affecting SSCs. The applicant proposes to add to the AP1000 DCD, Section 3.5.1.3, a statement that the potential for a turbine missile from another AP1000 plant in close proximity is less than $1x10^{-5}$ per year, and that the shield building and auxiliary building walls, roofs, and floors satisfies the guidance of RG 1.115 for two AP1000 plants side-by-side.

It should be noted that AP1000 DCD, Section 1.2.2 refers to Figure 1.2 2 of the AP1000 DCD for the building structure orientation with respect to the turbine building and the nuclear island. Figure 1.2 2 illustrates the AP1000 plant as a single unit. Section 1.2.1.3.1 of the AP1000 DCD also states that the turbine orientation minimizes potential interaction between turbine missiles and safety-related structures and components. In addition, Section 3.5.1.3 of the AP1000 DCD states that the turbine generator is located north of the nuclear island with its shaft oriented north-south so that safety-related systems are located outside the high-velocity, low trajectory missile strike zone. With this information, the AP1000 design is considered to favorably orient the turbine building with respect to safety-related SSCs as defined in RG 1.115. However, since BLN Units 3 and 4 will be side-by-side, the staff notes that each turbine generator may not be oriented favorably with respect to the other plant's safety-related SSCs (i.e., BLN Unit 3 turbine generator not favorably orientated to BLN Unit 4 safety-related SSCs, and vice versa).

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

- *STD SUP 3.5-2*

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

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

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

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

3.5.1.5 *Post Combined License Activities*

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

3.5.1.6 *Conclusion*

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

In addition, the staff concludes that the relevant information presented in the LNP COL FSAR is acceptable and meets the regulatory guidance in Sections 3.5.1.1 through 3.5.1.6 of NUREG-0800. The staff based its conclusion on the following:

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

- STD SUP 3.5-1 is acceptable because the turbine missile evaluation for collocated 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 the turbine maintenance and inspection program is included in Section 10.2 of this SER.

3.5.2 Protection from Externally Generated Missiles

3.5.2.1 *Introduction*

Systems required for safe shutdown are protected from the effects of missiles. Protection from external missiles, including those generated by natural phenomena, is provided by the external walls and roof of the seismic Category I nuclear island structures. The structural design requirements for the shield building and auxiliary building are outlined in AP1000 DCD Section 3.8.4. The external walls and roofs are reinforced concrete. Openings through these walls are evaluated on a case-by-case basis to provide confidence that a missile passing through the opening would not prevent safe shutdown and would not result in an offsite release exceeding the limits defined in 10 CFR Part 100.

3.5.2.2 *Summary of Application*

Section 3.5.2 of the FSAR, Revision 9, incorporates by reference Section 3.5.2 "Protection from Externally Generated Missiles," of the AP1000 DCD, Revision 19.

In addition, in FSAR Section 3.5.2, the applicant provided the following:

AP1000 COL Information Item

- LNP COL 3.5-1

The applicant provided additional information in FSAR Section 3.5.1.4 and 3.5.2 to resolve LNP COL 3.5-1. FSAR Section 3.5.2 identifies the horizontal and vertical velocities of design-basis missiles generated by site-specific hurricane winds.

Supplemental Information

- LNP SUP 3.5-3

The applicant provided supplemental information by adding Table 3.5-202 to AP1000 DCD Section 3.5. This supplemental information provides a summary of the site-specific

hurricane-generated missile parameters and compares them to AP1000 DCD Tier 1 Table 5.0-1 tornado-generated missile parameters.

3.5.2.3 *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 the Commission regulations for protection from externally generated missiles are given in Sections 3.5.1.4 and 3.5.2 of NUREG-0800.

The regulatory basis for acceptance of LNP COL 3.5-1 is based on the development of site-specific parameters compared to the DCD missile parameters. The design of AP1000 safety-related structures for protection against missiles using acceptable procedures must meet the requirements of 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena," and GDC 4, "Environmental and Dynamic Effects Design Bases."

Additional regulatory guidance related to the review of the issues in this SER section are given in RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," Revision 1."

3.5.2.4 *Technical Evaluation*

The NRC staff reviewed Section 3.5 of the FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to missile protection of safety-related SSCs. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

COL Information Items and Supplements

- LNP COL 3.5-1 and LNP SUP 3.5-3

LNP COL 3.5-1 requests COL applicants to evaluate whether the site characteristics for wind and tornadoes satisfy the AP1000 site parameters for wind and tornado conditions. If there are exceedances they must be discussed and shown acceptable. In Section 3.5.2 of the FSAR, the applicant provided additional information to address this COL information item.

The staff reviewed the information contained in the FSAR Section 3.5.2. The review evaluated the applicant's assessment of possible hazards attributed to missiles generated by extreme winds (such as hurricanes and tornados) identified in FSAR section 3.5.

RG 1.221 provides new guidance that the NRC staff considers acceptable for use in selecting the design-basis hurricane wind speed and hurricane-generated missiles that a new nuclear power plant should be designed to withstand to prevent undue risk to public health and safety.

In response to RAI 2.03.01-20, the applicant addressed hurricane-generated missiles in LNP COL 3.5-1 and provided hurricane missile spectra and associated velocities based on RG 1.221, and a discussion on whether the individual missiles are bounded by the AP1000 DCD.

The applicant concludes in LNP COL FSAR Section 3.5.2 that the AP1000 DCD design-basis tornado missile horizontal and vertical velocities of the 8 inch (275 lbs) artillery shell and the 1 inch steel sphere bound similar missiles subject to the site-specific hurricane wind of 195 mph. However, the site-specific hurricane-generated automobile missile results in a horizontal velocity of 120 mph which exceeds the AP1000 DCD automobile tornado missile velocity of 105 mph. As a result, the applicant evaluated the impact of the site-specific hurricane-generated automobile missile on the exterior walls of the nuclear island and concluded the LNP nuclear island is adequately protected against the hurricane-generated automobile missile impact. The staff's evaluation of the wind and missile loading and structural engineering aspects of RAI 2.3.1-20 is in Section 3.3.2.4 of this SER.

In addition, the applicant provided LNP SUP 3.5-3, Table 3.5-202, which compares the site-specific hurricane generated missile spectra and associated velocities to AP1000 DCD Tier 1 Table 5.0-1 tornado-generated missile parameters.

The staff reviewed the additional and supplemental information provided by the applicant and verified that the methodologies used to calculate the site-specific hurricane missile spectra and associated velocities are consistent with Figure 2, Table 1, and Table 2 of RG 1.221. On the basis of its review, the staff concludes that the information in FSAR Section 3.5.2 associated with LNP COL 3.5-1 and LNP SUP 3.5-3 adequately addresses COL information item 3.5-1 and is acceptable because the site-specific hurricane missile parameters conform to the guidance of RG 1.221.

3.5.2.5 *Post Combined License Activities*

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

3.5.2.6 *Conclusion*

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

In addition, the staff concludes that the relevant information presented in the FSAR is acceptable and meets the requirements of GDC 2 and GDC 4 with respect to missiles and environmental effects. The staff based its conclusion on the following:

- LNP COL 3.5-1 and STD SUP 3.5-3 are acceptable because they meet the acceptance criteria provided in Sections 3.5.1.4 and 3.5.2 of NUREG-0800, and conform to RG 1.221.

3.5.3 Barrier Design Procedures

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

Section 3.5 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.5.3, "Barrier Design Procedures," of the AP1000 DCD, Revision 19 without any departures or supplements. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

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

3.6.1 Introduction

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

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

3.6.2 Summary of Application

Section 3.6 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.6 of the AP1000 DCD, Revision 19. Section 3.6 of the DCD includes Section 3.6.4.

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

AP1000 COL Information Items

- LNP COL 3.6-1

The applicant provided additional information in LNP COL 3.6-1 replacing 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. This evaluation will be based on a completed piping layout and will be completed to support the COL. The evaluations will be provided prior to fabrication and installation of the piping and connected parts. In a letter dated July 22, 2011, the applicant committed to remove this additional information because the standard content provided in Revision 2 of the FSAR provides all the necessary information for resolving STD COL 3.6-1.

- STD COL 3.6-1

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

- STD COL 3.6-4

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

License Condition

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

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

Inspections, Tests, Analyses and Acceptance Criteria (ITAAC)

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

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

3.6.4 Technical Evaluation

The NRC staff reviewed Section 3.6 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the piping design against pipe break, pipe break locations and characteristics in safety-related piping, and LBB evaluation procedures. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the LNP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER 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 one confirmatory item in the standard content material retains the number assigned in the VEGP SER.

AP1000 COL Information Items

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

- *STD COL 3.6-1*

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

Based on the review of the information included in the BLN COL FSAR, it is unclear to the staff when the as-designed pipe rupture hazard analysis report will be completed by the applicant. As identified in 10 CFR 52.79(d)(3), the applicant should supply the NRC with a schedule for completion of detailed engineering information, in this case, the as-designed pipe rupture hazard analysis report. The applicant is requested to revise the implementation milestone for the License Condition to address the as-designed pipe rupture hazard analysis report (as opposed to as-built reconciliation) to allow coordination of activities with the NRC construction inspection program following the issuance of the COL such that the analysis would be made available to verify the design was completed in accordance with the regulations and DCD prior to fabrication and installation of the piping and connected components. In RAI 3.6.2-1, the staff requested the applicant provide a description pertaining to the closure milestone of the as-designed pipe rupture hazard analysis activities.

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

- *STD COL 3.6-4*

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

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

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

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

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

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

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

The staff notes that in a final rule to amend 10 CFR 50.55a (73 FR [Federal Register] 52730) issued on September 10, 2008, a new requirement was added for licensees to augment their ISI program to use ASME Code Case N-722 for ISI

of Alloy 600/182/82 materials to address PWSCC concerns. The applicant stated that there will be no Alloy 600/182/82 material used for new reactor construction of AP1000 plants. The staff notes that the final rule did not impose any additional requirements for augmented ISI of Alloy 690/152/52 materials. Based on the applicant's response discussed above and its commitment to evaluate and implement ASME Code cases that are developed and approved for augmented inspections of Alloy 690/152/52 material to address PWSCC concerns, the staff concludes the applicant's changes to COL Information Item 3.6-4 is consistent with current industry practice and NRC regulations as amended in 10 CFR 50.55a and is thus, acceptable.

Resolution of Standard Content Open Item 3.6-1

To address Open Item 3.6-1 in the BLN SER with open items, the VEGP applicant proposed in its letter dated April 23, 2010, an ITAAC for as-designed pipe rupture hazards analysis in ITAAC Table 3.8-# [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 14.3.3.# [where # is the next sequential number] related to pipe rupture hazards analysis.

Specifically, the proposed ITAAC includes a post-COL requirement related to the completion of the as-designed pipe rupture hazards analysis report. The proposed VEGP COL FSAR Section 3.6.4.1 states that the completed as-designed pipe rupture hazards analysis will be in accordance with the criteria outlined in AP1000 DCD Sections 3.6.1.3.2 and 3.6.2.5. The applicant stated that the completed as-designed pipe rupture hazards analysis report will be completed prior to installation of the piping and connected components and will be made available to the NRC staff. The applicant's proposed license condition that will require completion of the as-designed pipe rupture hazards analysis report prior to installation of the piping and connected components in their final location is proposed License Condition 2, Item 3.6-1. In the proposed VEGP COL FSAR Section 14.3.3.# [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, [Section 14.3.3.4 for LNP] *to verify the incorporation of the as-designed pipe rupture hazard analysis and add an ITAAC (Table 3.8-1)* [Table 3.8-5 for LNP] *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)* [Table 3.8-5 for LNP] *were appropriately updated. As a result, Confirmatory Item 3.6-1 is now closed.*

- LNP COL 3.6-1

The NRC staff reviewed LNP COL 3.6-1 included under Section 3.6.4.1 of the LNP COL FSAR. 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. This evaluation will be based on a completed piping layout and will be completed to support the COL. The evaluations will be provided prior to fabrication and installation of the piping and connected parts. In a letter dated July 22, 2011, the applicant committed to remove this additional information because the standard content provided in Revision 2 of the FSAR 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 LNP 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 condition, 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 ITAAC in SER Table 3.6-1.

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

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

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

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

3.7 Seismic Design

Seismic design of the AP1000 seismic Categories I and II structures, systems, equipment, and components are based on the safe shutdown earthquake (SSE). The operating basis earthquake (OBE) has been eliminated as a design requirement for the AP1000. Low-level seismic effects are included in the design of certain equipment 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. For the purposes of the shutdown criteria OBE for shutdown is considered to be one-third of the SSE.

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

3.7.1 Seismic Design Parameters

3.7.1.1 *Introduction*

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

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

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

3.7.1.2 *Summary of Application*

Section 3.7 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.7, of the AP1000 DCD, Revision 19. Section 3.7 of the DCD includes Section 3.7.1.

To address recommendations of the Fukushima Near-Term Task Force described in SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," and evaluate potential seismic hazards at the LNP site in light of these recommendations, the applicant performed sensitivity studies using the Central and Eastern United States Seismic Source Characterization model (NUREG-2115) to evaluate potential seismic hazards (e.g., changes to the GMRS) at the LNP site. The sensitivity studies indicated that the LNP site-specific soil-structure interaction analysis results remain conservatively bounded by the standard plant analysis results, and the staff conclusions regarding the adequacy of the site-specific soil-structure interaction analysis results remain unchanged. SER Section 20.1 presents the staff's evaluation of the sensitivity studies.

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

Supplemental Information

- LNP SUP 3.7-3

The applicant provided supplemental information in LNP SUP 3.7-3 by adding Section 3.7.1.1.1 to the LNP COL FSAR, which addresses site-specific GMRS. In LNP SUP 3.7-3, the applicant states that the horizontal and vertical site-specific GMRS were developed as the Truncated Soil Column Surface Response (TSCSR) on the uppermost in-situ competent material at elevation 11 m (36 ft) and were compared to the AP1000 certified seismic design response spectra (CSDRS). Additionally, the applicant has developed performance based surface horizontal and

vertical response spectra (PBSRS) at the design grade elevation of 15.5 m (51 ft). These PBSRS incorporate a scaling of the motion that is sufficient to achieve at least 0.1g horizontal peak ground acceleration at the foundation level of the NI. The PBSRS are also compared to the AP1000 CSDRS and shows that the CSDRS envelopes the scaled PBSRS.

In addition to the PBSRS, the applicant provided finished grade soil-structure interaction (SSI) analysis input surface spectra. These spectra were developed from the three soil columns (best estimate (BE), lower bound (LB), and the upper bound (UB) properties) using the soil column outcrop response spectra (SCOR) FIRS developed for elevation -7.3 m (-24 ft.), corresponding to the base elevation of planned excavation beneath the NI. Both horizontal and vertical SSI input response spectra were developed. The applicant states that the SSI input spectra from the UB, BE, and LB soil columns (Figures 3.7-202, 203, and 204) along with the corresponding acceleration time histories and corresponding UB, BE, and LB soil column profiles (Tables 2.5.2-228, 229, and 230) would be used for NI SSI analysis, if required. The envelope of the SSI input spectra from the UB, LB, and BE envelopes the PBSRS as required by DC/COL-ISG-017.

A comparison of the AP1000 CSDRS with the SSI input response spectra from the UB, BE, and LB soil columns for the horizontal ground motions for the North-South (H1) and the East-West (H2) directions is presented in Figures 3.7-202 and 203. The applicant states that, since the CSDRS envelops the SSI input response spectra from the three soil columns, site specific SSI analysis for horizontal ground motions is not required. The applicant states that for vertical ground motions in Figure 3.7-204, the CSDRS does not envelop the finished grade surface SSI input response spectra from the three soil columns in the high frequency range (greater than approximately 30 Hz). However, the applicant states that the CSDRS-based vertical in-structure response spectra envelopes the corresponding site-specific FIRS-based vertical in-structure response spectra.

The applicant also provided additional information in LNP SUP 3.7-3 by adding Section 3.7.1.1.2 to the LNP COL FSAR, which addresses foundation input response spectra (FIRS). The NI is supported on 10.7 meters (35 ft) of RCC over rock formations at the site as described in LNP COL FSAR Section 2.5.4.5. The seismic Category II Annex Building, Turbine Building, and Radwaste Building are supported on drilled shafts. The applicant compares foundation input response spectra (FIRS) for the NI at the base of the planned excavation beneath the NI and at the AP1000 foundation elevation in Figures 3.7-201 and 3.7-205, respectively. The applicant further states that the PBSRS are used to compute the maximum relative displacements of the drilled shaft foundations for the Annex Building, Turbine Building, and Radwaste Building with respect to the NI. These displacements are used to evaluate site-specific aspects of the seismic interaction of these buildings with the NI.

3.7.1.3 *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 the Commission regulations (GDC 2 of Appendix A to 10 CFR Part 50; Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants” to 10 CFR Part 50; and 10 CFR 100.23, “Geologic and

seismic siting criteria") for the seismic design parameters are given in Section 3.7.1 of NUREG-0800.

3.7.1.4 *Technical Evaluation*

The NRC staff reviewed Section 3.7 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to seismic design parameters. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the LNP COL FSAR:

Supplemental Information

- LNP SUP 3.7-3

LNP SUP 3.7-3 provides additional information on the design GMRS at LNP Units 1 and 2 to address COL Information Item 3.7-3. The NRC staff reviewed the resolution of the seismic input included under Section 3.7.1.1.1 of the LNP COL FSAR. The applicant compares the horizontal and vertical GMRS that were developed at the uppermost in-situ competent material at elevation 11 m (36 ft) to the CSDRS. Additionally, the applicant has developed performance based surface horizontal and vertical response spectra (PBSRS) at the design grade elevation 15.5 m (51 ft). These PBSRS incorporate a scaling of the motion that is sufficient to achieve at least 0.1 g horizontal peak ground acceleration at the foundation level of the NI. The PBSRS are also compared to the CSDRS and the applicant shows that the CSDRS envelops the scaled PBSRS.

In its review of the site-specific supplemental information in LNP COL FSAR Section 3.7.1.1.1 and Section 3.7.1.1.2, the staff indicated in RAI 03.07.01-1 that, since the FIRS and CSDRS are defined at different elevations, comparison of these spectra is inappropriate. The comparison that is needed is the AP1000 CSDRS to envelope the spectra generated at the ground surface for each of the three SSI profiles (BE, UB, and LB site profiles).

As part of its review, the NRC staff performed the following confirmatory analyses to evaluate the adequacy of the applicant's PBSRS and Soil Column Outcrop Response spectra (SCOR) FIRS.

NRC PBSRS Site Response Confirmatory Analysis

The applicant developed site amplification functions for the calculation of the PBSRS and associated FIRS following Subsection 5.2.1 of the Interim Staff Guidance DC/COL-ISG-017. The process used by the applicant to develop the PBSRS and FIRS similarly follows the process for the GMRS as described in Section 2.5.2 of this SER. The primary difference is that the PBSRS is developed for the plant finished grade and includes the effects of engineered fill,

while the GMRS in Section 2.5.2 represents the ground motions at the overall LNP Units 1 and 2 sites and does not characterize building- or fill-specific ground motions.

To determine the adequacy of the applicant's PBSRS site response calculations at the elevation of 15.5 m (51 ft) NAVD88, the staff performed confirmatory site response analysis. As input, the staff used the static and dynamic soil properties provided in FSAR Table 2.5.2-222 for LNP Unit 1 and FSAR Table 2.5.2-223 for LNP Unit 2 sites. With hard rock located at the depth of 1,325 m (4,350 ft), the overlying static and dynamic soil property profiles consist of 29 layers that reach the elevation of +11 m (+36 ft) NAVD88 with an additional layer of 4.5 m (15 ft) of engineered fill. The average fill V_S is 259 m/s (850 ft/s) with a variation from 154 to 308 m/s (500 to 1000 ft/s). To model the nonlinear properties of the engineered fill, the staff used shear modulus reduction and damping relationships for the engineered fill material developed by Menq (2003).

The staff performed the site response calculations using the program STRATA (Kottke and Rathje, 2008). The staff calculated six site amplification functions, one for each of the three fill layer's V_S (154, 259, and 308 m/s (500, 850 and 1000 ft/s)) for both LNP1 and LNP2 sites. In each calculation of the site amplification function the staff used 60 randomized V_S profiles. Secondly, the staff used the following averaging scheme proposed by the applicant to calculate weighted average site amplification functions separately for the LNP Unit 1 and Unit 2 sites: 154 m/s (0.185), 259 m/s (0.63), and 308 m/s (0.185). Third, the staff took the maximum of the LNP1 and LNP2 site amplifications by enveloping the two weighted site amplification functions, and multiplied the uniform hazard response spectrum (UHRS) by the envelope function to calculate the PBSRS.

The staff's calculated PBSRS is enveloped by the applicant's. Therefore, the staff concludes that in the frequency range significant to a reactor's structures, systems, and components, there are no significant differences between the staff's and the applicant's calculated amplification functions and the PBSRS for the 10^{-4} and 10^{-5} hazard levels.

The two soil column outcropping response (SCOR) FIRS were developed by the applicant for the purpose of checking the requirement of the minimum level of ground motion specified in 10 CFR Part 50, Appendix S. The applicant developed the first SCOR FIRS for the elevation -7 m (-24 ft) NAVD88 since the site is to be excavated to this elevation. In addition, a second SCOR FIRS was developed at the reactor foundation elevation of +3.3 m (+11 ft) NAVD88 corresponding to the reactor placed on approximately 10.7 m (35 ft) of concrete backfill.

The staff performed confirmatory calculations for both FIRS using the same approach as described above for the PBSRS. For the V_S profiles for the FIRS at the elevation of -7 m (-24 ft), the staff used profiles shown in FSAR Tables 2.5.2-222 and 2.5.2-223. Modifications to these V_S profiles were made by removing the layers in the upper 15 m (50 ft). Figure 3.7.1-1 compares the staff's calculation of the FIRS with the CSDRS and FSAR (Fig.3.7-201).

The set of site amplification functions for the FIRS at the elevation of +3.3 m (+11 ft) was calculated using 10.7 m (35 ft) of concrete with V_S of 1066 m/s (3500 ft/s) (FSAR Table 2.5.4.5-201) on the top of profile used for the FIRS at the elevation of -7 m (-24 ft). Figure 3.7.1-1 compares the staff's calculation of FIRS with CSDRS and the applicant's from the LNP Unit 1 and 2 FSAR (Figure 3.7-205).

The staff's calculation of the FIRS at both elevations of -7 m (-24 ft) and +3.3 m (+11 ft) are enveloped by the applicant's FIRS and by the CSRDS. Therefore, the staff concludes that in the frequency range significant to a reactor's structures, systems, and components, there are no significant differences between the staff's and the applicant's calculated amplification functions and FIRS for the 10^{-4} and 10^{-5} hazard levels.

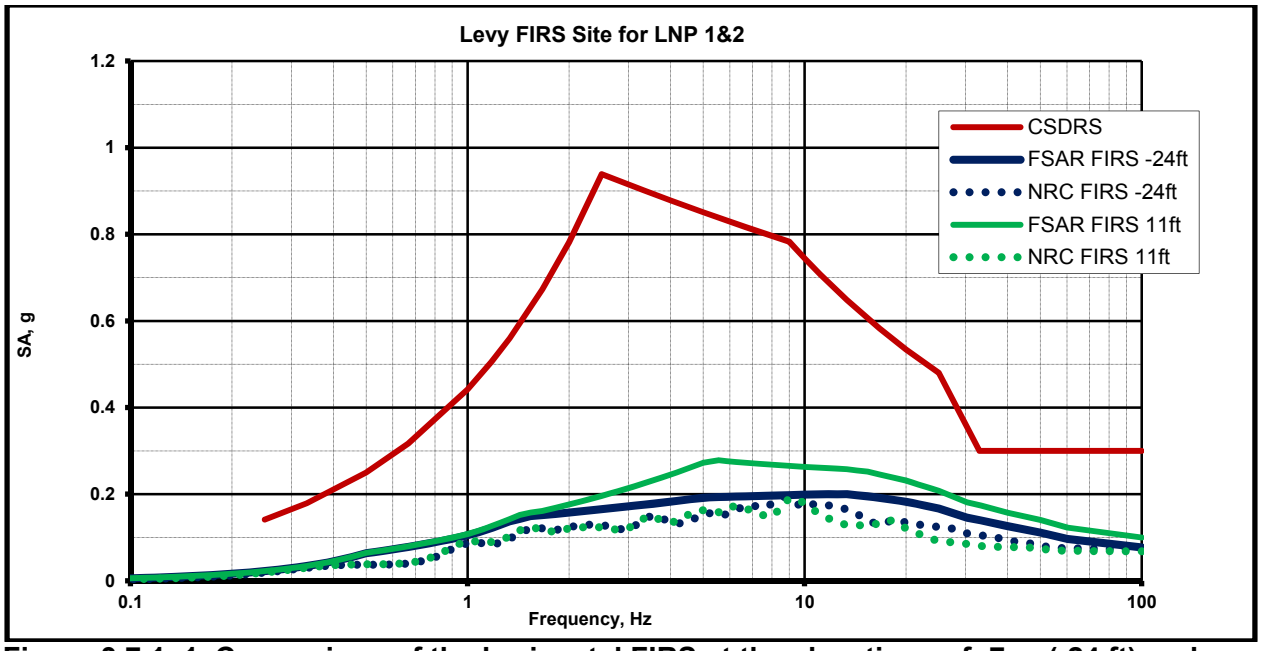

Figure 3.7.1–1. Comparison of the horizontal FIRS at the elevations of -7 m (-24 ft) and +3.3 m (+11 ft) calculated by the NRC staff, the horizontal FIRS at the same elevations calculated by the applicant, and the Westinghouse CSDRS.

In addition, the staff identified that discreet shear wave velocities as measured by the P-S logger (Figures 2.5.2-247 and -248) are quite variable, ranging by wide margins from the average value within the zone of influence of the foundation. The staff questioned whether the variability of shear wave velocities across the footprint of the NI was consistent with the assumptions in the AP1000 DCD SSI calculations and whether the impact of the variability on SSI response had been adequately addressed.

The staff also questioned whether the design of the NI structures, which are based on the intrinsic assumption that the properties of the soils to the side of the structure are the same as under the foundation, and whether the seismic gap between the NI and adjacent facilities is adequate to account for the relative displacements anticipated for the plant. In RAI 03.07.01-1, the staff requested that the applicant provide justification for the assumed uniformity of site soil layers structure for SSI response evaluations.

In RAI 03.07.01-1, the staff requested that the applicant justify the design of the drilled shafts supporting the structures adjacent to the NI to assure that the behavior of the adjacent

structures under seismic loading had been adequately addressed and that the potential impact of loss of support of side soils on the drilled shaft design be included in the justification.

The staff generated RAI 03.07.01-2 based on the applicant's response to RAI 03.07.01-1, which requested the applicant to provide information regarding the extent of the planned excavation and the placement of engineered backfill as well an assessment of whether these changes are sufficiently extensive such that the surface ground motion would be modified. As part of this additional RAI, the staff requested the applicant to summarize the planned construction sequence of removal of near surface soils, placement of engineered fill, drilled shaft installation for adjacent structures, construction of the diaphragm wall, and excavation of soil material beneath the NI structures as it relates to potentially changing the ground motion as is inferred by incorporating the engineered fill in the SSI soil columns.

The applicant provided responses to the staff's information requests in their response to RAI 03.07.01-2, dated July 19, 2010. The applicant stated that the backfill to design grade was included in the free field response analysis as specified in DC/COL-ISG-017 and in the SSI analysis since the plant NI footprint (approximately 0.8 acres for each unit) is small compared to the approximately 347 acres where fill will be placed to raise the existing grade level. In addition the PBSRS is higher than the GMRS for the LNP site.

The applicant also provided a description of the basis for the extent of placement of controlled engineered fill. The applicant states that the backfill provides lateral support to drilled shafts that support the Turbine Building, Annex Building , and Radwaste Building. The applicant further stated that seismic II/I interaction evaluations show that for drilled shafts up to 6 ft. in diameter, the lateral stiffness of the drilled shafts is primarily dependent on the soil property of the top 4.9 m (16 ft) of soil. The ~9.1 m (~30 ft) lateral extent of the controlled engineered fill corresponds to the lateral extent of an assumed passive wedge extending through the engineered fill having a friction angle of 34 degrees as specified in Table 2.5.4.5-201.

The applicant developed an SSI model to calculate the ISRS for the Levy site-specific soil profile and foundation geometry. The SSI model incorporated the effects of the roller compacted concrete bridging mat beneath the NI and in-situ and disturbed soil properties. For the SSI analysis of the NI, the BE, LB, and UB soil profiles were considered and the potential degradation of soil due to foundation installation was considered by adding an additional Lower LB case (LLB). The applicant demonstrated that the ISRS considering the Levy site-specific soil profile, foundation geometry, and site specific ground motion is enveloped by the AP1000 DCD ISRS.

In RAI 03.08.05-3, the staff requested additional information related to the drilled shaft design. In a response dated June 8, 2010, the applicant provided a description of the drilled shaft conceptual design, key installation practices, and industry codes that will be specified for installation. The applicant stated that the lateral stiffness of the drilled shafts is primarily governed by soil properties in the top 10 ft for the drilled shaft up to 4 ft diameter and 16 ft for 6 ft diameter drilled shafts. A description of the civil construction sequence construction practices was also provided. Also, the applicant provided proposed ITAAC in FSAR Table 3.8-4 to ensure that the as built design of the drilled shafts provide adequate bearing capacity to safely sustain the vertical design load of the drilled shafts and required lateral stiffness of the drilled shaft to minimize seismic interactions with adjacent structures to NI. In a letter dated January

25, 2011, the applicant revised portions of its June 8, 2010 response letter to address the design of the drill shaft. The staff reviewed the applicant's revised response and found it to be acceptable. A full discussion of the contents of RAI 03.08.05-3 can be found in Section 3.8.5.4 of this SER.

The staff reviewed the applicant's responses to RAIs 03.07.01-1, 03.07.01-2, and 03.08.05-3, including the calculations and reports attached to the responses and concluded that the supplemental information provided is adequate to demonstrate that the Levy site specific demand is enveloped by the AP1000 CSDRS. The staff considers RAIs 03.07.01-1, 03.07.01-2, and 03.08.05-3 to be resolved pending the incorporation of changes in a future revision to the LNP COL FSAR. This 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 the LNP COL in several locations as it pertains to RAIs 03.07.01-1, 03.07.01-2, and 03.08.05-3. The staff verified that the changes proposed in the responses dated July 19, 2010, June 8, 2010, and January 25, 2011, were incorporated into Revision 4 of the LNP COL FSAR. As a result, Confirmatory Item 3.7-1 is now closed.

3.7.1.5 *Post Combined License Activities*

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

3.7.1.6 *Conclusion*

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

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

> LNP SUP3.7-3 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 3.7.1 of NUREG-0800. In conclusion, the applicant has provided sufficient information for satisfying 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*

Seismic analysis methods and acceptance criteria for all seismic Category I SSCs are described. The review includes a review of basic assumptions, procedures for modeling,

seismic analysis methods, development of ISRS envelopes, consideration of torsional effects, evaluation of overturning and sliding of seismic Category I structures, and determination of composite damping. The effects of SSI on the seismic responses of the NI structures are included in the review scope because the LNP site is considered a soil site (e.g., shear wave velocity is greater than 1000 ft/s at foundation level). The review also covered design criteria and procedures for evaluating the interaction of NS Category I structures with seismic Category I structures and the effects of parameter variations on floor response spectra (FRS).

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

- Seismic analysis methods
- Natural frequencies and response loads
- Procedures used for analytical modeling
- SSI
- Development of FRS
- Three components of earthquake motion
- Combination of modal responses
- Interaction of NS Category II structures with seismic Category I SSCs
- Effects of parameter variations on FRS
- Use of constant vertical static factors
- Method used to account for torsional effects
- Methods for seismic analysis of dams
- Determination of seismic Category I structures overturning moments
- Analysis procedure for damping

3.7.2.2 *Summary of Application*

Section 3.7 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.7 of the AP1000 DCD, Revision 19. Section 3.7 of the DCD includes Section 3.7.2. In addition, in LNP COL FSAR Section 3.7.2, the applicant provided the following:

Supplemental Information

- LNP SUP 3.7-5

The applicant added supplemental information to the end of AP1000 DCD Sections 3.7.2.8.1, 3.7.2.8.2, and 3.7.2.8.3 regarding the Annex Building, the Radwaste Building, and the Turbine Building, respectively.

Departure

- LNP DEP 3.7-1

The applicant submitted a letter dated August 27, 2013, proposing a departure from the AP1000 certified design (DCD Revision 19) related to the maximum seismic loads for the drilled shaft foundations underlying the Annex Building and Turbine Building.

AP1000 COL Information Items

- LNP COL 3.7-1

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

- STD COL 3.7-3

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

- STD COL 3.7-4

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

License Conditions

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

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

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

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

3.7.2.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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

3.7.2.4 *Technical Evaluation*

The NRC staff reviewed Section 3.7 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to seismic system analysis. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Unit 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

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

The staff reviewed the information in the LNP COL FSAR and noted that the AP1000 DCD (Revision 19) Section 2.5.2.3 addresses site-specific seismic evaluation that should be performed by the Combined License applicant if the site-specific design response spectra exceed the CSDRS or if site soil conditions are outside the range evaluated for AP1000 design certification. According to the applicant's response to RAI Question 03.07.01-1, dated November 16, 2010, the site-specific surface design response spectra exceed the CSDRS in vertical motion at the LNP site. Although the applicant views that the CSDRS-based in-structure response spectra would envelop the corresponding site-specific FIRS-based in-structure response spectra, no quantitative evaluation was provided to justify the assumption. As for site soil conditions, no subsurface profile considered in the AP1000 DCD is similar to that of the LNP site which is characterized by stiff material (3500 psi minimum) immediately under the NI basemat with soft material to the sides (controlled low strength material). In addition, the design and analysis of AP1000 is based on subsurface conditions with uniform properties within horizontal layers, and the applicant response to RAI 03.07.01-1 does not fully justify this assumption of lateral uniformity of subsurface conditions.

In RAI 03.07.02-02, the staff requested that the applicant provide detailed site-specific seismic evaluation of the NI structures and the surrounding structures that may impact the safety function of NI structures. The staff requested that the evaluation fully incorporate the effects of soil-structure interaction and meet the Acceptance Criteria 4 of SRP Section 3.7.2.

In its supplement response to RAI 03.07.02-02, dated May 27, 2011, the applicant addressed the seismic evaluation of the NI and the surrounding structures by performing site-specific SSI analyses of the NI. The results of these analyses are also documented in applicant's response. The staff reviewed the LNP specific SSI analyses that utilize both three-dimensional (3D) and two-dimensional (2D) models and the SASSI Subtraction and Direct methods for computing in-structure floor response spectra. The 3D design basis model consists of a 5-Layer, 75-foot embedded Finite Element Model (FEM) developed for the BE soil case using the SASSI Direct method of analysis. This FEM was used to demonstrate that for the LNP site-specific SSI analysis, the use of the SASSI Subtraction Method results in computed responses that are comparable with the responses computed using the SASSI Direct Method.

The evaluation of the potential error that may be associated with the use of the Subtraction Method is made by comparing response spectra at six key NI locations (Figures A-1 through A-18 of the supplement response to RAI 03.07.02-02, dated May 27, 2011). The staff has reviewed the response spectra contained in these figures to assess the potential that the Subtraction Method used for the site-specific configuration predicts responses that are lower than those predicted by the Direct Method. Where the demand computed using the Subtraction Method is lower than that predicted by the Direct Method, the staff has assessed the significance of the non-conservatism as it relates to the comparison to the certified design. A summary of the review is as follows.

At most frequencies the Subtraction Method yields responses that are the same as the Direct Method. At some locations, over limited frequency ranges, the Subtraction Method results exceed the Direct Method results and are therefore conservative. The frequencies where the Subtraction Method results exceed the results for the Direct Method are at higher frequencies (greater than 20 Hz). For both methods in this higher frequency region, adequate design margin exists relative to the standard plant.

In a few locations, over a limited frequency range(less than 15 Hz), the site-specific response spectra computed using the Subtraction Method are lower than the spectra computed using the Direct Method. The frequency range at which this occurs is in the spectral frequency regions where the site-specific spectra are very much lower than the certified design spectra, and an adequate margin exists relative to the seismic demands to which the standard plant design is certified. In addition, these under-predictions generally fall in regions where broadening of the spectra developed using the Subtraction Method would minimize the potential under-prediction of in-structure response.

The staff also reviewed the results that were computed for the 5-Layer model that was refined after the March 2011 audit. The refinements, described in LNG-1000-S2R-804, Revision 4, Section 4.1, resulted in improving a number of the approximations in the analyses model, specifically increasing the number of frequencies of analyses. The effect of improving the model was to significantly reduce the computed peaks in the high frequency regions of the

response spectra as seen by comparing the results shown in Figures 6.2-1 through 6.2-18 to those shown in Figures A-1 through A-18. Therefore, the staff concludes that the comparisons used to evaluate the effect of the Subtraction Method on the computed in-structure response described above and shown in Figures A-1 through A-18 under-state the available margin between the site-specific seismic demand and the seismic demand used in the certified design. The lower response computed using the refined model demonstrates that the actual demand will be lower than that used in the comparisons described in the previous paragraphs.

In a letter dated October 4, 2011 the applicant informed the NRC that an error in the calculations presented in the May 27, 2011 letter had been identified. The applicant corrected the error and resubmitted the results of the calculations to the staff. The staff found the corrected information to be acceptable.

An 8-Layer, 75-foot embedded 3D FEM was developed for sensitivity analysis of the LNP BE, UB, LB and LLB site soil cases utilizing the SASSI Subtraction Method. The results of analyses using the 8-layer model demonstrate that the BE case is the controlling case. Two 2D models, which use the Direct Method, were developed to address mesh size modeling, potential frequency filtering due to the model layering and to evaluate the lower boundary SASSI SITE profile depth. The results of the 2D SSI analyses determine the frequency-dependent ratio of Fine-to-Coarse response spectra (≥1.0), (i.e., Bump Factor), which was subsequently applied to the controlling 3D BE Design-Basis FRS for comparison to the AP1000 generic and HRHF FRS envelopes. The applicant demonstrated that the LNP FRS are enveloped by the AP1000 generic FRS at all of the six NI key nodes with sufficient margin.

In RAI 03.08.05-7, the staff requested additional information related to the drilled shafts for structures adjacent to the NI. In its response dated January 25, 2011, the applicant provided supplemental seismic analyses of the drilled shaft supported adjacent structures (Turbine, Annex, and Radwaste Buildings). The analyses results shows that the maximum relative displacement at foundation mat between NI and the adjacent structures for PBSRS was 1.96 cm (0.77 in) and for 10^{-5} UHRS 1.14 cm (0.45 in). These relative displacements are less than the 50 mm (2.0 in) gap per AP1000 DCD. A discussion of the full contents of RAI 03.08.05-7 can be found in Section 3.8.5.4 of this SER.

The staff concluded that the 5 Layer model analysis using the SASSI Direct Method is the design bases analysis based on the review described above and that the use of the Subtraction Method was adequate to determine the governing soil condition and the impact of the model refinement on the predicted responses by the Direct Method. The information provided by the applicant is sufficient to demonstrate that the ISRS are enveloped by the AP1000 ISRS and that the seismic gaps are adequate to prevent interaction between the NI and the adjacent structures.

Because the applicant has provided the details requested in response to RAI 03.07.02-2 the staff considers the RAI to be resolved, pending the incorporation of changes in a future revision to the LNP COL FSAR. This is being tracked as **Confirmatory Item 3.7-2.**

Resolution of Confirmatory Item 3.7-2

Confirmatory Item 3.7-2 was an applicant commitment to revise the LNP COL FSAR. The staff verified that the proposed changes to Chapters 2 and 3 of the LNP COL FSAR, and Revision 5 of the SSI Report, LNG-100-S2R-804, (ML113130557) were made as described in the applicant's letters dated January 25, May 27, and October 4, 2011. As a result Confirmatory Item 3.7-2 is now closed.

The staff reviewed the information in the LNP COL FSAR:

Supplemental Information

- LNP SUP 3.7-5

The NRC staff reviewed LNP SUP 3.7-5 related to adding information to the end of AP1000 DCD Sections 3.7.2.8.1, 3.7.2.8.2, and 3.7.2.8.3 regarding the Annex Building, Radwaste Building, and Turbine Building, respectively.

The staff noted that LNP FSAR Figure 2.5.4.5-201 B indicates that a cementitious fill will be placed adjacent to the NI structures and fills the region between the NI structures and the diaphragm wall. FSAR Section 3.7.2.8 indicates that structure-to-structure interaction will not occur since the gap between the NI and adjacent structures is larger than the expected movement based on the maximum displacement seen in the GMRS. Since the construction details provided in Figure 2.5.4.5- 201 B indicate that the adjacent buildings rest on the diaphragm wall it appeared that there was no gap between the diaphragm wall and NI, and thus the construction detail does not provide a gap as required by the AP1000 DCD. In RAI 03-07-02-1, the staff requested the applicant to clarify the detail to either demonstrate that the required seismic gap would be achieved or that the connectivity between the NI and the adjacent buildings had been properly considered.

Additionally, the staff noted that the GMRS is a ground motion that was developed based on a UHRS motion modified by a scale factor to account for the fragility inherent in the structural system. However, the level of relative displacement that is expected to occur at the ground surface is the displacement that is associated with the UHRS at the performance goal level without the scale factor included. The staff requested that the applicant provide the basis for the use of the GMRS associated displacement in lieu of that associated with the performance goal level UHRS.

The applicant responded to RAI 03.07.02-01 with letters dated July 23, 2010 and November 10, 2010. In a letter dated January 25, 2011, the applicant responded to RAI 03.08.05-7. In those three response letters, the applicant provided information related to seismic gap and the relative displacements between the NI and adjacent structures. This information included details about the drilled shaft to drilled shaft interaction effects, the soil column displacement, the maximum NI displacements at design grade elevation, the probable maximum relative displacements between the NI and the adjacent structures, and the median relative displacements between the NI and the adjacent structures. The applicant also provided figures showing the conceptual design for the interface between the NI and the drilled shaft foundation. The staff reviewed the responses provided by the applicant and concluded that the

responses are sufficient to demonstrate that the seismic separation between buildings is adequate to prevent interaction with the seismic Category I NI structures as stated in this SER Section 3.7.2.4. The staff considers RAIs 03.07.02-1, and 03.08.05-7 to be resolved pending the incorporation of changes in a future revision to the LNP COL FSAR. This is being tracked as **Confirmatory Item 3.7-3.**

Resolution of Confirmatory Item 3.7-3

Confirmatory Item 3.7-3 is an applicant commitment to update the LNP COL FSAR in various sections of Chapter 2 and Chapter 3 as discussed in the responses cited above. The staff verified the proposed changes were made to the LNP COL FSAR. As a result, Confirmatory Item 3.7-3 is now closed.

Departure

- LNP DEP 3.7-1

On August 27, 2013, LNP submitted letter number NPD-NRC-2013-037 to address the drilled shaft foundation design criteria for the Annex and Turbine Buildings. The submittal included a departure from the AP1000 DCD Tier 2 information in Sections 3.7.2.8.1 and 3.7.2.8.3, LNP DEP 3.7-1, which addresses the use of site-specific seismic hazard for the lateral design of the drilled shafts supporting the seismic Category II portions of the Annex and Turbine Buildings. In the applicant's submittal, the applicant stated that the drilled shafts supporting the portions of the buildings adjacent to the NI do not conform to any of the six soil profiles described in Subsection 3.7.1.4 of the AP1000 DCD. The applicant further stated that in the conceptual design of the drilled shafts, the vertical seismic demands are consistent with the AP1000 CSDRS which exceed the site-specific vertical seismic demands at the LNP site. However, instead of the AP1000 CSDRS, the applicant used site-specific demands (e.g., PBSRS, RG 1.60 minimum FIRS, and scaled site-specific FIRS) to compute the maximum relative horizontal displacements of the Turbine, Annex, and Radwaste Buildings drilled shaft foundations with respect to the NI. The applicant concluded that the drilled shafts are designed for the AP1000 certified design vertical seismic loads and the site-specific horizontal seismic loads to ensure that the maximum relative displacement of the foundation of these buildings and the NI remains within the DCD limit.

The staff reviewed the applicant's departure, to use site-specific horizontal seismic response spectra for the design of the drilled shafts that support the seismic Category II portions of the Annex and Turbine Buildings. The staff's review focused on the impact of the departure as it relates to the potential seismic interaction between the NI and the adjacent structures. The staff's review found that the applicant used the site-specific horizontal seismic demands (e.g., PBSRS, RG 1.60 minimum FIRS, scaled site-specific FIRS) for the conceptual lateral design of the drilled shafts. The development and use of the site-specific horizontal demands as a representation for the seismic demands at the Levy site was reviewed and found acceptable by the staff in Sections 3.7.1 and 20.1.4.6.5 of this SER. Using the site-specific horizontal demands, the applicant computed a maximum relative displacement in Table 3.7-206 between the NI and the adjacent structures of 0.77 inches. This relative displacement is less than the minimum 2-inch gap at and below grade, and the 4-inch gap above grade as specified in the AP1000 DCD between the NI and the adjacent structures. The design method for the

drilled shafts was reviewed and found acceptable in SER Section 3.8.5. Based on the adequacy of the site-specific seismic hazard development, the limited relative displacement as compared to the available gap between the NI and the adjacent structures under those seismic demands, and the adequate design method for the drilled shafts, the staff finds that there is reasonable assurance that the drilled shaft design under the horizontal site-specific seismic demands will be adequate to support the adjacent structures to the NI so as to preclude seismic interaction under the LNP site-specific seismic demands. Accordingly, proposed departure LNP DEP 3.7-1 is acceptable. The staff concludes that the relevant information presented by the applicant is acceptable and satisfies the guidance in Section 3.7.2 of NUREG-0800 and the requirements in 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23. The staff verified that the applicant has appropriately updated Sections 3.7.2.8.1 and 3.7.2.8.3 in Revision 7 of the LNP COL FSAR.

AP1000 COL Information Item

- LNP COL 3.7-1

The NRC staff reviewed the resolution to the COL information item related to the evaluation of existing and new dams included under Section 3.7.2.12 of the LNP COL FSAR. LNP 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 LNP COL FSAR Section 2.4.4 for the details of the evaluation. The applicant states that the LNP site is not subject to flooding from dam failures. The staff's review of LNP COL FSAR Section 2.4.4 is in Section 2.4.4 of this SER, which found the information included therein to be acceptable. Therefore, the NRC staff finds the information added to the LNP COL FSAR by LNP COL 3.7-1 to be 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 performed by the licensee and will be complete prior to fuel load.

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

3.7.2.5 *Post Combined License Activities*

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

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

- LNP SUP 3.7-5 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 3.7.2 of NUREG-0800. In conclusion, the applicant

has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDC 2; 10 CFR Part 50, Appendix S; and 10 CFR 100.23.

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

- LNP COL 3.7-1 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 3.7.2 of NUREG-0800. In conclusion, the applicant has provided sufficient information for satisfying 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 LNP COL FSAR, Revision 9, incorporates by reference, Section 3.7.3, "Seismic Subsystem Analysis," of Revision 19 of the AP1000 DCD. In addition, in LNP COL FSAR Section 3.7, the applicant provided the following:

Departures

- LNP DEP 6.4-2

The applicant provided additional information in Table 3.7-207 of the LNP COL FSAR about LNP 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 LNP 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 LNP COL application are documented in NUREG-1793 and its supplements.

3.7.4 Seismic Instrumentation

3.7.4.1 *Introduction*

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

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

3.7.4.2 *Summary of Application*

Section 3.7 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.7 of the AP1000 DCD, Revision 19. Section 3.7 of the DCD includes Section 3.7.4.

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

AP1000 COL Information Items

- STD COL 3.7-2 and LNP COL 3.7-2

The applicant provided additional information in STD COL 3.7-2 and LNP COL 3.7-2 in Section 3.7.4.4 to resolve COL Information Item 3.7-2 (COL Action Item 3.7.5-2) on

post-earthquake procedures to compare measured and predicted ground motions. In LNP COL 3.7-2, the applicant also stated that post-earthquake operating procedures utilize the guidance of Electric Power Research Institute (EPRI) Reports NP-5930, TR-100082, and NP-6695, as modified and endorsed by the NRC in RG 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Postearthquake Actions" and RG 1.167, "Restart of a Nuclear Power Plant Shut Down by a Seismic Event." A response spectrum check up to 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 a letter dated October 15, 2010, the LNP applicant identified a change to STD COL 3.7-2 in Section 3.7.4.4 of the LNP COL FSAR to address the measurement of the post-seismic event gaps between the new fuel rack and walls of the new fuel storage pit, between the individual spent fuel racks, and from the spent fuel racks to the spent fuel pool walls.

- STD COL 3.7-5

The applicant provided additional information in STD COL 3.7-5 in Section 3.7.4.2.1 to resolve COL Information Item 3.7-5 (COL Action Item 3.7.5-4) on free field triaxial acceleration sensors. In STD COL 3.7-5, the applicant stated that a free-field sensor will be located and installed within the protected area to record the ground surface motion representative of the site. It will be located such that the effects associated with surface features, buildings, and components on the recorded ground motion will be insignificant.

Supplemental Information

- STD SUP 3.7-1

The applicant provided supplemental information in LNP 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 inservice during plant operation and shutdown.

- STD SUP 3.7-2

The applicant provided supplemental information in LNP COL FSAR Section 3.7.4.5 to address the test and inspection requirements for the acceleration sensors. In this section, the applicant stated that installation and acceptance testing of the triaxial acceleration sensors described in 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, Items 3.3 and 3.12 refer to interfaces associated with DCD Section 3.7.4. The interface requirements for NRC review (associated with 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.

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

The regulatory guidance documents for STD COL 3.7-2 and STD COL 3.7-5 are RG 1.166, RG 1.167, and RG 1.12, and Appendix S to 10 CFR Part 50 that provide for installation of free field triaxial acceleration sensors and establishment of post earthquake procedures to comparing measured and predicted responses.

3.7.4.4 *Technical Evaluation*

The NRC staff reviewed Section 3.7.4 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information related to seismic instrumentation. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

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

The staff has compared STD COL 3.7-2 and STD COL 3.7-5 in the LNP COL FSAR to STD COL 3.7-2, VEGP COL 3.7-2 and VEGP COL 3.7-5 in the VEGP COL FSAR, respectively.

The staff concludes that the information added to the applications for these COL items are sufficiently similar so that the evaluations performed in VEGP SER Section 3.7.4 for VEGP COL 3.7-2 and VEGP COL 3.7-5 are directly applicable to STD COL 3.7-2 and STD COL 3.7-5, respectively. The one notable difference between the VEGP and LNP 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. Also, instead of endorsing the October 15, 2010, VEGP letter regarding post-seismic event gaps in STD COL 3.7-2, the LNP applicant provided this information in its October 15, 2010, letter. In the LNP COL FSAR, the ground surface location at the site of the free-field sensor is not specified, but will be installed using NRC-approved methodology, and the staff concludes that this minor difference does not affect the conclusions reached by the staff.

The following portion of this technical evaluation section is reproduced from Section 3.7.4.4 of the VEGP SER. The review of LNP COL 3.7-2 corresponds to the review of VEGP COL 3.7-2, and is included in the standard content review of STD COL 3.7-2, below:

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.

Supplemental information

- *STD SUP 3.7-1*

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

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

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

- *STD SUP 3.7-2*

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

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

The NRC staff reviewed the resolution to STD SUP 3.7-2, related to the timing of installation and acceptance testing of the triaxial acceleration sensors described

in DCD Section 3.7.4.2.1 for the VEGP site. Because of the equivalence of the proposed resolution of STD SUP 3.7-2 to the general operability guidance for seismic equipment addressed in RG 1.12, RG 1.166 and RG 1.167, the staff concludes the applicant adequately resolved STD SUP 3.7-2.

3.7.4.5 *Post Combined License Activities*

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

3.7.4.6 *Conclusion*

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

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

- STD COL 3.7-2 is acceptable because the applicant is committed to use the procedures endorsed by RGs 1.166 and 1.167 and because the applicant has provided sufficient information for satisfying the requirements Appendix S to 10 CFR Part 50 by committing to address the measurement of the post-seismic event gaps between the new fuel rack and walls of the fuel storage pit and to take appropriate corrective actions.

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

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

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

3.8 Design Of Category I Structures

3.8.1 Concrete Containment

This section is not applicable to the LNP 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 LNP COL FSAR, Revision 9, incorporates by reference Section 3.8.2, "Steel Containment," of Revision 19 of the AP1000 DCD. In addition, in the LNP COL FSAR, the applicant provided the following:

Departures

- LNP DEP 6.3-1 and LNP DEP 3.2-1

The applicant provided additional information about LNP DEP 6.3-1 and LNP 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 LNP DEP 3.2-1 and LNP 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 LNP COL application are documented in NUREG-1793 and its supplements. Section 21.1 of this report evaluates the departures from the DCD provided in LNP DEP 6.3-1 and LNP DEP 3.2-1.

3.8.3 Concrete and Steel Internal Structures of Steel or Concrete Containment

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

The containment internal structures are constructed of reinforced concrete and structural steel. At the lower elevations conventional concrete and reinforcing steel are used, except that

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

Section 3.8 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.8.3, "Concrete and Steel Internal Structures of Steel Containment," of Revision 19 of the AP1000 DCD. In addition, in the LNP COL FSAR Section 3.8.3.7, the applicant provided the following:

AP1000 COL Information Items

- STD COL 3.8-5

The applicant provided additional information related to in-service testing and inspection requirements. This information is reviewed in Section 3.8.5 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 LNP COL application are documented in NUREG-1793 and its supplements.

3.8.4 Other Seismic Category I Structures

The AP1000 DCD defines other seismic Category I structures as the shield building, the auxiliary building, the containment air baffle, Category I cable tray supports, and 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

Section 3.8 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.8.4, "Other Category I Structures," of Revision 19 of the AP1000 DCD. In addition, in the LNP COL FSAR Section 3.8.4.7, the applicant provided the following:

AP1000 COL Information Items

- STD COL 3.8-5

The applicant provided additional information related to testing and in-service inspection requirements. This information is reviewed in Section 3.8.5 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 evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

3.8.5 Foundations

3.8.5.1 *Introduction*

The NI structures consists of the containment building, the shield building, and the auxiliary building, on a common 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 2-inch gap at and below grade. A 4-inch 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*

Section 3.8 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.8 of the AP1000 DCD, Revision 19. Section 3.8 of the DCD includes Section 3.8.5.

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

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 Section 2.5.4.

AP1000 COL Information Items

- LNP COL 2.5-17

In a letter dated September 23, 2010, the applicant proposed identifying, as LNP COL 2.5-17, the information in Section 14.3.3.2 addressing the type of waterproofing system to be used for the below grade exterior walls exposed to flood, and groundwater under seismic Category I structures.

- STD COL 3.8-5

In a letter dated April 19, 2011, the applicant endorsed the August 17, 2010, letter from the VEGP applicant that proposed STD COL 3.8-5, adding new Section 3.8.3.7, 3.8.4.7, and 3.8.5.7 to the FSAR. 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 a letter dated April 19, 2011, the applicant endorsed the October 1, 2010, letter from the VEGP applicant that proposed STD COL 3.8-6, adding a new Section 3.8.6.6 to the FSAR. The applicant provided information in STD COL 3.8-6, addressing the construction procedure program related to safety-related Category I structures.

License Condition

- Part 10, License Condition 6

In its letter dated April 19, 2011 the applicant endorsed the October 1, 2010, letter from the VEGP applicant that 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.

- Part 10, License Condition 4

In its letter dated May 27, 2011, the applicant provided information regarding the Strength Verification and Constructability Testing in accordance with criteria outlined in FSAR Subsection 3.8.5.11.3.

ITAAC

In Part 10, Appendix B, of the LNP COL application, the applicant proposed ITAAC requiring that the 35 foot thick Roller Compacted Concrete (RCC) Bridging mat is seismic Category I and is designed and constructed to bridge over the design basis karst feature when subjected to design basis loads as specified in the Design Description in FSAR 2.5.4.5.4 without loss of structural integrity and the safety related functions. In a letter dated August 19, 2011, the applicant provided revisions to clarify the RCC ITAAC.

In Part 10, Appendix B, of the LNP COL application, the applicant proposed ITAAC requiring that the Drilled Shaft Foundations for the Turbine, Radwaste, and Annex Buildings will preclude movement in excess of the separation provided between the structural elements of the Turbine, Radwaste, and Annex Buildings and the NI structures. In a letter dated August 19, 2011, the applicant provided revisions to clarify the Drilled Shaft Foundation ITAAC.

In Part 10, Appendix B, of the LNP COL application, the applicant proposed ITAAC requiring that the mudmat-waterproofing-RCC interface beneath the NI basemat has a coefficient of friction to resist sliding of ≥ 0.55.

3.8.5.3 *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 the Commission regulations (GDC 1, GDC 2, GDC 4, and GDC 5, "Sharing of Structures, Systems, and Components" of Appendix A to 10 CFR Part 50; 10 CFR 50.55(a) and Appendix B, to 10 CFR Part 50) for the foundations are given in Section 3.8.5 of NUREG-0800.

3.8.5.4 *Technical Evaluation*

The NRC staff reviewed Section 3.8.5 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to foundations. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

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

The staff reviewed the information in the LNP COL FSAR:

Supplemental Information

- STD SUP 3.8-1

In LNP FSAR Section 3.8.5.1, "Description of the Foundations," the applicant referenced Subsection 2.5.4, "Stability of Subsurface Materials and Foundations," which presents the depth of overburden and depth of embedment of the LNP 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 loads of the superstructure to the underlying soils or rocks.

FSAR Section 2.5.4 stated that, below the NI basemat, a 10.7 m (35 ft) thick RCC bridging mat will be used to transmit the NI loads under static and dynamic conditions to the karst foundation.

In its review of the standard supplemental information in LNP COL FSAR Section 2.5.4, the staff determined that the applicant did not provide enough information for the design of the RCC bridging mat. As a result, the staff issued RAI 03.08.05-1, requesting that the applicant provide additional information that details the transfer of the NI loads to the karst foundation through the RCC bridging mat and justifies the use of the RCC bridging mat between the NI basemat and the karst foundation. In addition, the applicant was requested to provide a description of the material properties, installation, and compaction for the RCC bridging mat along with the analysis and design methods used for the bridging mat.

In its response to RAI 03.08.05-1 dated November 20, 2008, the applicant provided a brief description of the methods used to transmit the static and dynamic loads of the NI through the bridging mat and the use of the RCC bridging mat. The applicant stated that the RCC bridging mat is a block of mass concrete that transmits the static and dynamic NI loads to the underlying Avon Park Formation. The applicant also stated that the RCC bridging mat will be installed below the waterproofing membrane where the RCC bridging mat serves as the 'lower mud mat.' Additionally, the applicant provided a description of the material properties, installation, and compaction for the RCC bridging mat, along with the analysis and design methods for the bridging mat. The applicant provided additional information regarding the RCC mix design program. The staff's evaluation of the mix design program is discussed later in this section of this SER.

The staff reviewed the applicant response and concluded that additional information was needed related the design and construction of the RCC bridging mat. As a result, the staff issued RAI 03.08.05-2, requesting the applicant to describe the type of joints to be used at lift boundaries; identify methods to be used to determine tensile and shear strengths and stiffnesses at lift joints, together with their variability, number and types of tests to be used to verify properties; and identify the required shear strength at lift joints, the assumed shear strength at the lift joints and the technical basis for the assumed strength.

In its November 17, 2009, response to RAI 03.08.05-2, the applicant addressed the design and construction of the RCC bridging mat by stating that two types of lift joints may be formed at the bridging mat lift boundaries. The first type of lift joint is bonded with bedding material which acts as a bonding layer. The second type of lift joint that may be used does not include a layer of bedding mix. The applicant described the basis for the shear strength at lift joints, the expected seismic demand and the assumptions used in developing the design strength.

The applicant also stated that there are two testing programs associated with the RCC bridging mat: Production testing that will be conducted during placement of the RCC bridging mat; and an RCC test program that will be conducted prior to construction. The applicant provided a description of the tests that will be performed to assess shear strength for both the base material and for the lift joints including identification of the testing methods to be used. The staff's evaluation of these programs is discussed later in this section of this SER.

In addition, the applicant stated that for the assumed values recommended by the United States Army Core of Engineers (USACE) and ACI-318 for tensile and shear strength are based on empirical historical data, and have been used in the conceptual design phase. The allowable values for tensile and shear strength correspond to the recommended design values with an applied factor of safety. The applicant provided a number of quality control measures that assure that the RCC material is of good quality and to determine the compressive strength and density of the as-place material.

The staff reviewed the applicant's method for designing and constructing the RCC bridging mat and noted that the applicant did not adequately address the number of RCC tests to be performed and how the variability of RCC properties will be assessed; the desired level of performance of the bridging mat; and the transfer of shear or tension between the as-placed material and the bedding joints. As a result, the staff issued RAIs 03.08.05-4, 03.08.05-5, and 03.08.05-6 respectively.

In RAI 03.08.05-4, the staff requested that the applicant provide a detailed description as to how the proposed RCC construction for the Levy plant is similar to the construction for which the shear strength to compressive strength correlations provided by the USACE is appropriate and a detailed description about the methodology for testing of the production bridging mat. In addition, the staff also requested a detailed description as to how the RCC nominal strength capacities will be established and information about the test program that identifies the expected variability of material properties, methods used to quantify the variability, how this variability is incorporated into developing an appropriate factor of safety for design and how the tests that will be performed during production will ensure that the design strengths will be achieved.

In the May 27, 2011, supplemental response to RAI 03.08.05-4 the applicant addressed the shear strength to compressive strength correlation between the proposed RCC for the Levy plant and to similar construction provided by the USACE. The applicant stated that the RCC construction at the Levy plant will follow standard RCC guidance and construction practice, as described in the USACE Engineering Manual EM 1110-2-2006, "Roller-Compacted Concrete," with additional enhancements related to nuclear safety grade Quality Assurance; and that USACE correlations will be used for preliminary conceptual design. Furthermore, the applicant stated that laboratory testing would be used to verify that these relationships are appropriate. Additionally, the applicant intends to perform direct shear testing to evaluate the shear strength along lift surfaces.

The applicant also provided a description of the quality control and inspection plan that will be used during production that will ensure that the placement of production for the RCC is within project specifications. A report, "Post-COL Roller Compacted Concrete Test Plan," submitted by the applicant detailed the design, testing, and construction methods used for large commercial RCC construction projects and how the applicant intends to relate the experience gained on these projects to the Levy Nuclear Plant RCC Bridging Mat.

In the May 27, 2011, supplemental response to RAI 03.08.05-4 the applicant also addressed how the production mat will be sampled to provide assurance that the strength of 'as placed' material exceeds the design requirements. The applicant stated that confirmatory testing of the RCC production mat will be performed using Non-Destructive Testing Methods to ensure that the construction of the RCC and Bedding Joints is in accordance with the RCC construction specification. The applicant provided reports that detail the RCC Test Program. These documents discuss the tests that will be performed during the conceptual design phase and during construction to evaluate variability of material properties and ensure that design strengths will be achieved. Included in the test requirements are a number of direct shear tests that will be performed to verify that the design shear strength is achievable. As a result of the RCC testing program, the ITAAC entry in LNP COLA Part 10 Table 3.8-3 was revised to address the RCC to require consistency of the production LNP Bridging Mat placement and constituents with the design requirements. Additionally, the applicant provided details that describe how the RCC nominal strength capacities will be established. The applicant stated that the nominal capacities are established during the conceptual design phase using standard concrete codes equations, ACI 349-01 and ACI 318-99 and USACE Engineering Manual 1110-2-2006 guidance. These capacities include ACI 318-99 strength reduction factors and load factors of DCD Table 3.8.4-2, consistent with ACI 349-01. On this basis, the applicant concludes that the RCC failure probability is consistent with industry codes. A FEM of the RCC Bridging Mat was used to confirm that these capacities are adequate for the anticipated loading conditions.

Also, in RAI 03.08.05-4, the staff requested a written description of the applicant's expanded test program in order for the staff to complete its evaluation of the acceptability of the final test program. The staff requested that the test program identify the expected variability of material properties, methods used to quantify the variability, how this variability is incorporated into developing an appropriate factor of safety for design and how the tests that will be performed during production will ensure that the design strengths will be achieved.

In its May 27, 2011, supplemental response to RAI 03.08.05-4, the applicant addressed the variability of the RCC materials and stated that the variability of the RCC materials is accounted for in the mix design process. The applicant also stated that based on previous commercial RCC experience, the expected coefficient of variation on the compressive strength of the RCC is approximately 14 percent with the strict quality control measures that will be in place. Additionally, the applicant stated that the targeted RCC mix design strength accounts for forecasted variability.

The staff reviewed the applicant's responses along with associated reports, calculations, and applicable codes and standards provided by the applicant related to the design of the RCC bridging mat and concludes that the applicant's design methodology and results, construction methods, testing and inspection requirements are acceptable. The applicant design methodology and approach demonstrate that the stresses in the bridging mat will remain within concrete code allowable limits and is therefore assured of performing its required function. Because the applicant has complied with the regulatory requirements in 10 CFR 50.55(a) and GDC 1 by providing the details requested in response to RAI 03.08.05-4, the staff considers the RAI to be resolved. The incorporation of changes in a future revision to the LNP COL FSAR is being tracked as **Confirmatory Item 3.8-1**. The staff conclusion relies heavily on the successful placement of the large scale RCC test pad to be completed prior to the construction of the bridging mat. As a result, the staff has reviewed ITAAC 3.8.3, which is discussed later in this section of this SER.

Resolution of Confirmatory Item 3.8-1

Confirmatory item 3.8-1 is an applicant commitment to revise the LNP COL FSAR to address RCC mat construction, testing, and associated ITAAC. The staff verified that the LNP COLA was appropriately revised. As a result, Confirmatory Item 3.8-1 is now closed.

In its August 18, 2010, response to RAI 03.08.05-5, the applicant addressed the desired level of performance of the RCC Bridging Mat. The applicant stated that the performance is assured by the method of analysis using the load factors and strength reduction factors from ACI 349-01 in conjunction with the equations and methodology for plain concrete from ACI 318. The applicant further stated that a FEM with solid elements under service loading conditions was used to evaluate the demand on the bridging mat and includes an evaluation of 10-foot diameter voids and a 10-foot wide strip cavity beneath the RCC Bridging Mat. The applicant states that the calculated shear stresses across the lift joint do not exceed the allowable shear stress.

The staff has reviewed the load factors and strength reduction factors for the design of the RCC bridging mat and concludes that the strength reduction factor to estimate a target factor of safety forms an adequate basis for assuring that the desired level of performance for the RCC mat supports the NI structure. Because the applicant has provided the details requested in response to RAI 03.08.05-5 the staff considers the RAI to be resolved. The incorporation of changes in a future revision to the LNP COL FSAR is being tracked as **Confirmatory Item 3.8-2.**

Resolution of Confirmatory Item 3.8-2

Confirmatory Item 3.8-2 is an applicant commitment to update the LNP COL FSAR to provide requested details regarding the assumptions made to justify the expected performance of the RCC mat. The staff verified that the LNP COL FSAR was appropriately revised. As a result, Confirmatory Item 3.8-2 is now closed.

In FSAR Section 2.5.4.8 the applicant presented the results of its liquefaction analysis. Because both the Avon Park limestone and the RCC bridging mat are not prone to liquefaction, the applicant stated that liquefaction cannot occur below the NI. The section further states that liquefaction will not affect the NI and that the drilled shafts will be designed in a manner that precludes soil liquefaction effects from having an impact on the surrounding structures such that they might unfavorably interact with the NI. In reviewing Section 2.5.4.8 of the LNP FSAR, the staff observed that liquefaction has not been considered in any of the seismic interaction analyses for the Annex, Radwaste, and Turbine Buildings. As a result, the staff issued RAI 03.08.05-3 requesting that the applicant provide an explanation of how the AP1000 DCD seismic interaction analysis for the Annex Building bounds the Levy site given that liquefaction was not considered in the DCD analysis.

In its January 25, 2011, revised response to RAI 03.08.05-3, the applicant stated that the Turbine, Annex, and Radwaste Building foundation mats displacements calculated in its response to RAI 03.08.05-3 were superseded by those calculated in the supplemental response to RAI 03.08.05-7. The applicant stated in the response to RAI 03.08.05-07 that remediation measures for pockets of potential liquefaction will be taken through installation of vertical and horizontal drains to prevent buildup of excess pore pressure that is required for liquefaction to occur. The staff has reviewed the response and associated calculations and concludes that the proposed remediation is adequate to mitigate the effects of potential liquefaction on the seismic interaction between adjacent structures. The staff's evaluation of the supplemental response is documented in Section 2.5.1.1.1 of this SER.

Additionally, in RAI 03.08.05-7, the staff requested that the applicant provide further clarification on how the estimate of relative displacements between adjacent structures was calculated for seismic loads. One displacement source that did not appear to be considered was displacement that may develop from deformation of the soils along the sides of the RCC mat, including the engineered fill. Second, the staff requested that the applicant describe the procedure(s) that will be used to assess the significance of the interaction effects between the drilled shafts in the final design. A third question by the staff was related to the ground motion used to assess liquefaction potential and global displacement of structures. The applicant computed displacements that were associated with the GMRS and the related PBSRS. The staff requested that the applicant clarify why displacement and liquefaction are not evaluated to the higher desired performance goal level (1×10^{-05}). The final question by the staff was related to the design and installation of the drilled shaft foundations for the seismic category II and nonsafety-related adjacent buildings (Turbine Building, Annex Building, and Radwaste Building).

In its response to RAI 03.08.05-07 the applicant addressed how the estimate of relative displacements between adjacent structures were calculated for seismic loads by stating that the displacements have been computed which consider the deformation of soil adjacent to the RCC

and drilled shaft-to-shaft interaction. In addition, the displacements associated with the performance goal level were evaluated.

The staff reviewed the applicants RAI responses and associated calculations and concludes that the seismically induced displacements are significantly smaller than the seismic gap provided in the DCD. As a result of the detailed information presented by the applicant, the ITAAC entry in LNP COLA Part 10 Table 3.8-4 was revised to address the drilled shaft foundations for the Turbine, Radwaste, and Annex Buildings to preclude movement so as not to exceed the separation provided between these buildings and the NI structures. The details of the conceptual drilled shaft design and installation procedure are described in Section 3.7.1 of this SER. Thus, the staff considers RAI 03.08.05-7 to be resolved. The incorporation of changes in a future revision to the LNP COL FSAR is being tracked as **Confirmatory Item 3.8-3.**

Resolution of Confirmatory Item 3.8-3

Confirmatory Item 3.8-3 is an applicant commitment to update its FSAR to include details regarding its calculation of displacements between adjacent structures for seismic loads. The staff verified that the FSAR was appropriately revised. As a result, Confirmatory Item 3.8-3 is now closed.

In the applicant response to RAI 03.08.05-2, the applicant described a number of quality control measures that will provide information needed to ensure that the RCC material is of good quality and to determine the compressive strength and density of the as-placed material. In reviewing the applicant response, the staff determined that none of the quality control measures appeared to address the capability of the as-placed material to transfer shear or tension across the as-constructed bedding joints. Thus, the staff issued RAI 03.08.05-6, requesting the applicant to provide additional information that describes the transfer of shear or tension between the as-placed material and the bedding joints.

In its revised response to RAI 03.08.05-6, the applicant stated that the revised response incorporates pre-COL RCC testing results and the revised post-COL RCC test as discussed at the April 27-28, 2011 meeting that the staff participated in with the applicant in Tucson, Arizona to witness the RCC Specialty Tests. As part of that meeting, the staff requested the following information be provided:

I. Summary report of commercial RCC experience and test data.

II. Description of materials, processes, and equipment types/sizes from commercial projects and a commitment that those used for LNP will be similar.

III. Identify the specific RCC mix design for the LNP project, and confirm the acceptability of this mix to provide the characteristics required for the foundation design.

IV. Submit the 90-day specialty test report verifying RCC strength characteristics.

V. Submit post-COL RCC Strength Verification and Constructability Testing plan.

VI. Add a new FSAR Subsection 3.8.5.11 summarizing information on commercial test results, RCC mix design, pre-COL 90-day testing, and commitments for the post-COL testing and the use of equipment and process validated by the post-COL testing in production construction of the RCC Bridging mat.

VII. Add a new License Condition for post-COL testing stating that the licensee will complete 180-days prior to construction, the 90-day test report for the Strength Verification and Constructability Testing in accordance with the criteria outlined in FSAR Section 3.8.5.11.3.

VIII. Revise COLA Part 10 "Table 3.8-3: LNP COLA RCC ITAAC"

The applicant stated that the LNP RCC construction will follow industry standard methods that have been successfully implemented on large commercial RCC projects. The applicant provided a detailed description of the methods that will be used. Additionally, the applicant summarized the RCC production and placement practices that were used for three large commercial RCC projects and concluded that the properties of the aggregates, cement, and fly ash planned for the LNP RCC bridging mat will meet or exceed the requirements used for these successful commercial projects. The applicant stated that the experience from the large-scale commercial RCC projects provides assurance that LNP RCC bridging mat can be successfully constructed and have the desired strength.

Additionally, the applicant provided a detailed test plan that describes the quality control and inspection to occur during production construction, and stated that the implementation of the plan will ensure that the mixing, placement, and compaction of production RCC complies with the LNP RCC construction specifications.

The applicant provided details that describe the RCC testing results from three large commercial RCC projects and concluded the following:

- The compressive strengths measured during production construction exceeded those that were measured during pre-construction mix design laboratory testing. Thus, laboratory testing during RCC mix design provides reasonable assurance that the desired RCC compressive strength will be achieved or exceeded during production construction.

- The measured modulus of elasticity from commercial testing correlates well with that computed using ACI 318-99 Section 8.5.1 method. Thus use of ACI 318-99 Section 8.5.1 for modulus of elasticity for RCC design is appropriate.

- The USACE EM 1110-2-2006 correlation of the direct tensile strength of RCC to approximately 75 percent of the split tensile strength trends close to the ACI 318-99 equation 22-2 for tensile strength. Thus the use of ACI 318-99 equation 22-2 for tensile strength in RCC design is appropriate.

- Shear tests performed on pre-cracked (at lift joints) block samples show that the friction angle when concrete bedding mix is used is greater than the 45 degrees design value

provided in the USACE EM 1110-2-2006. Thus, the use of 45 degrees friction angle for shear capacity in RCC design across lift joints is appropriate.

Furthermore, the applicant stated that testing of the production RCC mat will provide confirmation that the construction of the RCC and bedding joints is in accordance with the RCC construction specifications. The applicant described the testing that will occur during construction of the RCC bridging mat, including quality control testing. In addition, the applicant stated that Post-COL RCC and bedding mix strength verification and constructability testing (RCC Test Program Phase IV) will be performed on a large test pad. This testing will be performed post-COL but prior to construction of the LNP bridging mat for the following reasons:

- Due to the limitation on mixing and compaction equipment sizes that can be used in a laboratory setting, the required compaction cannot be achieved in a laboratory setting. A larger scale test pad in an open field setting is required.

- Because RCC design strength is specified as the 365-day strength, it is not practical to perform destructive testing on the RCC bridging mat during construction on cored or block cut test specimens. The post-COL RCC strength verification and constructability testing will be performed post-COL at the LNP site. The test pad construction will use mixing, placement, and compaction procedures and equipment comparable to those that will be used during LNP RCC bridging mat construction. The constitutive materials for the RCC mix will be comparable to that used in the RCC mix design program. The post-COL strength verification and constructability test report with 90-day test results will be completed at least 180-days prior to start of LNP RCC bridging mat construction.

The applicant stated that the RCC construction specifications, non-destructive testing and quality controls during construction together with implementing procedures and equipment comparable to those used on past successful RCC projects, pre-COL RCC mix design testing, the pre-COL RCC testing, and planned post-COL RCC testing using a large test pad provides sufficient assurance that the LNP design compressive and tensile strengths, and shear strengths across lift joints will be achieved during the RCC bridging mat construction using the RCC and bedding mix, mixing and placement procedures and equipment, and the compaction equipment specified for construction.

The applicant provided details of the mix design program for the RCC and bedding mix and stated that the program demonstrates that design workability and strength requirements can be achieved with the trial mixes and constituent materials procured for the program. The applicant described the preliminary testing on cored cylinders from the test panels indicated that the concrete in the test panels did not attain the desired compressive or tensile strengths and indicated that this low strength is believed to be due to the constructability issues related to construction of the laboratory-scale test panels that required the use of small mixing and compaction equipment.

The applicant states that conducting the “Roller Compacted Concrete Strength Verification and Constructability Testing,” post-COL but prior to production construction is acceptable because of the following reasons:

- RCC Mix Design testing shows that the specified compressive and split tensile strength can be achieved with the trial RCC mixes.

- Laboratory cast cylinders from both the mix design program and the RCC specialty test program using the LNP selected RCC design mix exceed the compression and tensile strengths required for the project.

- Biaxial shear test results on block samples from the RCC specialty test panel yielded shear strengths at least 1.67 times the maximum design demand shear across lift joints, despite the fact that the test panels did not achieve the desired compressive strength.

- Post-COL RCC Strength Verification and Constructability Testing (RCC Test Program Phase IV) as described in Attachment 2 of the applicant letter dated May, 27, 2011 "Post-COL Roller Compacted Concrete Test Plan," Revision 3, will be conducted prior to RCC bridging mat construction to verify that the design specified compressive strength, ACI 318-99 specified tensile strength, and USACE EM 1110-2-2006 specified shear strengths across lift joints can be achieved. For this post-COL test program, the test report with 90-day test results will be completed at least 180-days prior to start of RCC bridging mat construction. For these tests, constructability issues experienced during pre-COL specialty testing in a laboratory setting will be avoided by the use of production construction scale mixing, placement, and compaction equipment. The test pad for the pre-construction tests will be constructed using mixing and placement procedures similar to those that will be used for the LNP RCC bridging mat construction.

- The proposed License Condition for post-COL RCC testing states: "The licensee will complete 180-days prior to construction, the 90-day test report for the Strength Verification and Constructability Testing in accordance with the criteria outlined in FSAR Subsection 3.8.5.11.3 and make it available to the NRC."

- Two other seismic demands were evaluated based on the SSI analyses results. The applicant demonstrated that the maximum bearing pressure on the RCC bridging mat beneath the NI basemat is 20.29 ksf, less than the AP1000 maximum bearing pressure of 35 ksf. In addition, the maximum base shear on the RCC bridging mat corresponds to base shear to vertical load ratio of 0.12 for the NI which is less than the AP1000 maximum ratio of 0.55.

NRC staff reviewed the information provided by the applicant in response to the information requested during the April 27-28, 2011 audit and concludes that the information provided by the applicant adequately considered the quality requirements for the material and placement of the RCC bridging mat will ensure that the bridging mat as built will perform its intended function. The staff finds this information adequate because it meets the requirements of 10 CFR 50.55(a) and GDC 1. The staff agreed with the applicant's assessment that conducting the "Roller Compacted Concrete Strength Verification and Constructability Testing," post-COL but prior to production construction is acceptable. Thus, the staff considers RAI 03.08.05-6 to be resolved. The incorporation of changes in a future revision to the LNP COL FSAR is being tracked as **Confirmatory Item 3.8-4.**

Resolution of Confirmatory Item 3.8-4

Confirmatory Item 3.8-4 is an applicant commitment to provide details regarding the testing of the RCC. The required information was provided by the applicant as part of its response to RAI 03.08.05-4. The staff found the information in the applicant's response to RAI 03.08.05-4 to be acceptable. The staff verified that the FSAR was appropriately revised. As a result, confirmatory Item 3.8-4 is now closed.

AP1000 COL Information Items

- LNP COL 2.5-17

In a letter dated September 23, 2010, the LNP applicant proposed identifying, as LNP COL 2.5-17, the information in Section 3.8.5.1 addressing the type of waterproofing system to be used for the below grade exterior walls exposed to flood, and groundwater under seismic Category I structures. The applicant provided a waterproofing material to be used for the below grade, exterior walls exposed to flood and groundwater under seismic Category I structures. The applicant stated that a sheet type waterproofing membrane will be used for both the horizontal and vertical surfaces under Seismic Category I structures. The applicant further stated the waterproofing material will be qualified by test, with commercial grade dedication and lab testing to achieve a minimum coefficient of friction of 0.55. The performance requirements to be met by the COL applicant for the waterproofing material are described in Section 3.4.1.1.1.1 of the AP1000 DCD. Thus, the NRC staff considers LNP COL 2.5-17 to be resolved.

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

- *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 2.8.5.7, 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.

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

License Condition

- *Part 10, License Condition 6*

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

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

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

3.8.5.5 *Post Combined License Activities*

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 conditions acceptable:

- The licensee shall perform and satisfy the RCC ITAAC in SER Table 3.8-1.

- The licensee shall perform and satisfy the Drilled Shaft Foundation ITAAC in SER Table 3.8-2.

- The licensee shall perform and satisfy the Waterproof Membrane ITAAC in SER Table 3.8-3.

- 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.

- License Condition (3-5) – The licensee shall complete and make available to the NRC 180-days prior to construction the 90-day test report for the Strength Verification and Constructability Testing in accordance with the criteria outlined in FSAR Subsection 3.8.5.11.3.

3.8.5.6 *Conclusion*

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

In addition, the staff concludes that the relevant information presented in the LNP COL FSAR Section 3.8.5 forms an adequate basis for the design and construction of the RCC bridging mat at the LNP site, and meets the requirements of 10 CFR 50.55(a), GDC 1, 2, 4, and 5 to 10 CFR Part 50, Appendix A, and 10 CFR 50, Appendix B. The staff based its conclusion on the following:

- STD SUP 3.8-1 is acceptable because the applicant addressed the relevant information that meets the guidance in Section 3.8.5 of NUREG-0800. In conclusion, the applicant has provided sufficient information for satisfying 10 CFR Part 50, Appendix A, GDC 1, 2, 4, and 5.

- COL 2.5-17 In a letter dated September 23, 2010, the LNP applicant proposed identifying, as LNP COL 2.5-17, the information in Section 3.8.5.1 addressing the type of waterproofing system to be used for the below grade exterior walls exposed to flood, and groundwater under seismic category I structures.

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

Section 3.9 of the LNP COL FSAR, Revision 9, incorporates by reference, with no departures or supplements, Section 3.9.1, "Special Topics for Mechanical Components," of Revision 19 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

3.9.2 Dynamic Testing and Analysis of Systems, Structures and Components

The criteria, testing procedures, and dynamic analyses employed to ensure the structural and functional integrity of piping systems, mechanical equipment, reactor internals, and their supports (including supports for conduit and cable trays, and ventilation ducts) under vibratory loadings, are addressed in this section. The loadings include those due to fluid flow (and

especially loading caused by adverse flow conditions, such as flow instabilities over standoff pipes and branch lines in the steam system) and postulated seismic events.

Section 3.9 of the LNP COL FSAR, Revision 9, incorporates by reference, with no departures or supplements, Section 3.9.2, "Dynamic Testing and Analysis of Systems, Structures and Components," of Revision 19 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

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

3.9.3.1 *Introduction*

The structural integrity and functional capability of pressure-retaining components, their supports, and CS structures are ensured by designing them in accordance with ASME Code, Section III, or other industrial standards. The loading combinations and their respective stress limits, the design and installation of pressure-relief devices, and the design and structural integrity of ASME Code Class 1, 2, and 3 components and component supports are included.

The criteria for the SSC design include the following considerations:

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

3.9.3.2 *Summary of Application*

Section 3.9 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.9 of the AP1000 DCD, Revision 19. Section 3.9 of the DCD includes Section 3.9.3.

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

Departures

- LNP DEP 6.4-2

The applicant provided additional information in Table 3.9-202 of the LNP COL FSAR about LNP 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 LNP 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 additional information in 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] subsection 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 SER.

- STD COL 3.9-3

The applicant provided additional information in STD COL 3.9-3 to address COL Information Item 3.9-3 (COL Action Item 3.9.8-1), 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 additional information in STD COL 3.9-5 to address COL Information Item 3.9-5 (COL Action Item 3.12.5.10-1), which addresses pressurizer surge line monitoring. Evaluation of this particular COL information item is provided in Section 3.12 of this SER.

- STD COL 3.9-7

In its letter dated June 21, 2011, the applicant endorsed the letter dated April 23, 2010, from the VEGP applicant, that 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 to complete the ITAAC added to verify the design.

Supplemental Information

- STD SUP 3.9-3

The applicant provided supplemental information in STD SUP 3.9-3 to describe snubber design and testing and snubber installation requirements. In a letter dated June 21, 2011, the applicant stated that a correction will be made to the left margin annotation (LMA) in a future revision to the FSAR. The current version of the LNP COL FSAR has the LMA as STD COL 3.9-3 instead of STD SUP 3.9-3.

3.9.3.3 *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 the Commission regulations for the ASME Code Class 1, 2, and 3 components, component supports, and CS structures are given in Section 3.9.3 of NUREG-0800.

3.9.3.4 *Technical Evaluation*

The NRC staff reviewed Section 3.9.3 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the functional design of ASME Code Class 1, 2, and 3 components and component supports and CS structures. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the LNP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER 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 and STD SUP 3.9-3*
>
> *AP1000 DCD, Section 3.9.8.3, "Snubber Operability Testing," states that COL applicants referencing the AP1000 design will develop a program to verify operability of essential snubbers as outlined in Section 3.9.3.4.3, "Snubbers*

Used as Component and Piping Supports," and Section 3.9.3.4.4, "Inspection, Testing, Repair and/or Replacement of Snubbers." In the BLN COL FSAR, the applicant states in Section 3.9.8.3, "Snubber Operability Testing," that STD COL 3.9-3 is addressed in BLN COL FSAR Section 3.9.3.4.4, which incorporates by reference AP1000 DCD Section 3.9.3.4.4, with supplemental snubber information added to the end of the existing Section 3.9.3.4.4.

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

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

(1) For the purpose of STD COL 3.9-3, operability testing encompasses the preservice and inservice examinations and testing required by the ASME Code for Operation and Maintenance (OM) for Nuclear Power Plants (ASME OM Code), Subsection ISTD, "Preservice and Inservice Examination and Testing of Dynamic Restraints (Snubbers) in Light-Water Reactor Nuclear Power Plants" as described in BLN COL FSAR Section 3.9.3.4.4.c and Section 3.9.3.4.4.d (as revised in applicant's response to RAI 3.9.6-3).

(2) In order to provide a complete description of the snubber operability testing program, that is, the preservice and IST programs for snubbers, additional information was provided in BLN COL FSAR

Section 3.9.3.4.4 as indicated in the applicant's letter to the NRC in response to RAI 3.9.6-3. Previously, only snubber preservice examination and testing had been described in BLN COL FSAR Section 3.9.3.4.4.c.

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

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

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

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

The staff found that above responses provided by the applicant to be adequate in clarifying that the information for snubber operability testing originally provided in STD COL 3.9-3 was primarily intended for preservice and inservice examination and testing. The staff also found that the supplemental information provided under a new STD SUP 3.9-3, for snubber design and qualification testing, and the snubber installation requirements includes a better description for snubber design and qualification testing, and is more consistent with other industry COL

applications. The staff confirmed that Revision 1 has incorporated all the changes as required. RAI 3.9.3-1 is closed.

Clarification of BLN SER Standard Content

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

Resolution of Difference Between FSARs

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

Resolution of LMA

In a letter dated June 21, 2011, the applicant stated that a correction will be made to the LMA in a future revision to the FSAR. The current version of the LNP COL FSAR has the LMA as STD COL 3.9-3 instead of STD SUP 3.9-3. The incorporation of the planned changes to the LNP COL FSAR will be tracked as **Confirmatory Item 3.9-7.**

Resolution of Confirmatory Item 3.9-7

Confirmatory Item 3.9-7 is an applicant commitment to properly add LMA STD SUP 3.9-3 in FSAR Section 3.9.3.4.4. The staff verified that the desired change had been made. As a result, Confirmatory Item 3.9-7 is now closed.

3.9.3.5 *Post Combined License Activities*

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

3.9.3.6 *Conclusion*

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to ASME Code Class 1, 2, and 3 components, component supports and CS structures, and there is no outstanding information expected to be addressed in the LNP COL FSAR related to this section.

The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the LNP 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:

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

3.9.4 Control Rod Drive System

The control rod drive system (CRDS) consists of the control rods and the related mechanical components that provide the means for mechanical movement. As discussed in GDC 26, "Reactivity Control System Redundancy and Capability" and GDC 27, "Combined Reactivity Control Systems Capability," the CRDS provides one of the independent reactivity control systems. The rods and the drive mechanism are capable of reliably controlling reactivity changes either under conditions of anticipated operational occurrences, or under postulated accident conditions. A positive means for inserting the rods is always maintained to ensure appropriate margin for malfunction, such as stuck rods. Because the CRDS is a safety-related system and portions of the CRDS are a part of the RCPB, the system is designed, fabricated, and tested to quality standards commensurate with the safety-related functions to be performed. This provides an extremely high probability of accomplishing the safety-related functions either in the event of anticipated operational occurrences or in withstanding the effects of postulated accidents and natural phenomena such as earthquakes, as discussed in GDC 1; GDC 2; GDC 14, "Reactor Coolant Pressure Boundary"; GDC 29 "Protection Against Anticipated Operational Occurrences"; and 10 CFR 50.55a.

Section 3.9 of the LNP COL FSAR, Revision 9, incorporates by reference, with no departures or supplements, Section 3.9.4, "Control Rod Drive System (CRDS)," of Revision 19 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

3.9.5 Reactor Pressure Vessel Internals

AP1000 reactor internals consist of two major assemblies - the lower internals and the upper internals. The reactor internals provide 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.

Section 3.9 of the LNP COL FSAR, Revision 9, incorporates by reference, with no departures or supplements, Section 3.9.5, "Reactor Pressure Vessel Internals," of Revision 19 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

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

3.9.6.1 *Introduction*

In this section, the NRC staff describes its review of the functional design, qualification, and IST programs for pumps, valves, and dynamic restraints as required by the NRC regulations in 10 CFR Part 52 and 10 CFR 50.55a, "Conditions of construction permits, early site permits, combined licenses, and manufacturing licenses" for LNP Units 1 and 2. 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 LNP 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 LNP Units 1 and 2.

3.9.6.2 *Summary of Application*

Section 3.9 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.9 of the AP1000 DCD, Revision 19. Section 3.9 of the DCD includes Section 3.9.6.

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

Departures

- LNP DEP 6.4-2

The applicant provided additional information in Table 3.9-203 of the LNP COL FSAR about LNP 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 LNP 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 additional information in several sections of LNP 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 LNP Units 1 and 2. For example, the LNP COL FSAR supplements the provisions in the AP1000 DCD with respect to the Edition and Addenda of the ASME OM Code applicable to the description of the IST program for LNP Units 1 and 2, determination of the MOV testing frequency, operability testing of power-operated valves (POVs) other than MOVs, performance of check valve exercise tests, and plans to apply alternatives to the ASME OM Code. Under STD COL 3.9-3, the applicant supplemented the AP1000 DCD provisions for design, installation, preservice examination and testing, and inservice examination and testing of dynamic restraints (snubbers) in LNP COL FSAR Section 3.9.3.4.4, "Inspection, Testing, Repair, and/or Replacement of Snubbers."

The AP1000 DCD addresses the functional design and qualification of mechanical equipment to be used at an AP1000 nuclear power plant in several DCD sections. For example, Section 3.9.3.2, "Pump and Valve Operability Assurance," states that criteria are developed to assess the functional capability of required components to operate. Section 3.9.3.2.2, "Valve Operability," indicates that operational tests will be performed to verify that valves open and close prior to installation. This section also specifies cold hydro tests, hot functional tests, periodic ISIs, and periodic inservice operations to be performed in situ to verify the functional capability of the valves. Section 5.4.8, "Valves," includes provisions regarding design and qualification, and preoperational testing of valves within the scope of those systems, and refers to these activities for other safety-related valves. Section 5.4.8.3, "Design Evaluations," specifies that the requirements for qualification testing of power-operated active valves are based on ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants." Section 5.4.9, "Reactor Coolant System Pressure Relief Devices," includes provisions for design, testing, and inspection of relief devices in the reactor coolant system. Section 5.4.10, "Component Supports," includes provisions for design, testing, and inspection of component supports in the reactor coolant system. The LNP COL FSAR incorporates by reference these specific sections in the AP1000 DCD.

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

AP1000 DCD, Section 3.9.3.4.4, "Inspection, Testing, Repair, and/or Replacement of Snubbers," specifies that a program for inservice examination and testing of dynamic supports

(snubbers) to be used in the AP1000 reactor will be prepared in accordance with the requirements of the ASME OM Code, Subsection ISTD, “Preservice and Inservice Examination and Testing of Dynamic Restraints (Snubbers) in Light-Water Reactor Nuclear Power Plants.” Section 3.9.3.4.4 indicates that details of the snubber inservice examination and testing program, including test schedules and frequencies, will be reported in the ISI and testing plan included in the IST Program required by Section 3.9.8.3, “Snubber Operability Testing.” Section 3.9.8.3 states that COL applicants referencing the AP1000 design will develop a program to verify operability of essential snubbers. The LNP COL FSAR provides supplemental information for Section 3.9.3.4.4 regarding snubbers. For example, LNP COL FSAR Section 3.9.3.4.4 includes provisions for snubber design and testing with specifications that snubber qualification and production testing will satisfy the applicable sections of the ASME Boiler and Pressure Vessel Code (B&PV Code); the ASME OM Code; and ASME Standard QME-1-2007. LNP 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. LNP COL FSAR Table 3.9-201, “Safety Related Snubbers,” provides a list of safety-related snubbers to be installed at LNP, including the snubber identification number and the associated system or component.

AP1000 DCD, Section 3.9.6, “Inservice Testing of Pumps and Valves,” provides a general description of the IST Program to be developed for AP1000 reactors. Table 3.9-16, “Valve Inservice Test Requirements,” in AP1000 DCD, lists valves within the scope of the IST Program provided in support of the AP1000 DC, and indicates the valve tag number, valve and actuator type, safety-related missions, safety functions, ASME Code class and IST category, and IST type and frequency. LNP 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 LNP Units 1 and 2 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 LNP COL FSAR, the applicant describes the periodic testing program for POVs other than MOVs that incorporates lessons learned based on nuclear power plant operating experience and research programs for MOV performance. The applicant also indicates its plan to apply Revision 1 to ASME OM Code Case OMN-1, “Alternative Rules for the Preservice and Inservice Testing of Certain Electric Motor-Operated Valve Assemblies in Light Water Reactor Power Plants,” as an alternative to the quarterly MOV stroke-time testing provisions in the ASME OM Code, and to satisfy the supplemental requirements specified in 10 CFR 50.55a(b)(3)(ii) to ensure that MOVs continue to be capable of performing their design-basis safety functions. The LNP COL FSAR does not identify any additional plant-specific valves to be included in the IST Program beyond those listed in AP1000 DCD, Table 3.9-16.

License Conditions

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

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

- Part 10, License Condition 6

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

3.9.6.3 *Regulatory Basis*

The regulatory basis of the design related information incorporated by reference is addressed in NUREG-1793 and its supplements.

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

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

condition for operational program implementation milestones that are fully described or referenced in the FSAR as discussed in the SRM for SECY-05-0197, dated February 22, 2006.

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

3.9.6.4 *Technical Evaluation*

The NRC staff reviewed Section 3.9.6 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to functional design, qualification and IST programs for pumps, valves, and dynamic restraints. The results of the NRC staff's evaluation of the design-related information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements. The results of the staff's review of the material in the AP1000 DCD related to the IST operational program for pumps, valves, and dynamic restraints are in this SER section.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

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

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

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 G2 and G5*

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

- *Part 10, License Condition 6*

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

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

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 LNP Units 1 and 2 squib valves.

The surveillance program is established to provide reasonable assurance that the LNP 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 (3-6) – Before initial fuel load, the licensee shall implement (1) the Preservice Testing Program and (2) the Motor-Operated Valve Testing Program.

- License Condition (3-7) – 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.

- License Condition (3-8) – 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 NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the IST Program, and there is no outstanding information expected to be addressed in the LNP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the design-related information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements. The results of the staff's review of the material in the AP1000 DCD related to the IST operational program for pumps, valves, and dynamic restraints are in this SER section.

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

- LNP 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.

Section 3.9 of the LNP COL FSAR, Revision 9, incorporates by reference, with no departures or supplements, Section 3.9.7, "Integrated Head Package" of Revision 19 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

3.10.1 Introduction

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

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

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

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

Mechanical and electrical equipment (including instrumentation and controls), and where applicable, their supports classified as seismic Category I must demonstrate that they are capable of performing their intended safety-related functions under the full range of normal and accident (including seismic) loadings. This equipment includes devices associated with systems essential to safe shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or is otherwise essential in preventing significant release of radioactive material to the environment or in mitigating the consequences of accidents.

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

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

3.10.2 Summary of Application

Section 3.10 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.10 of the AP1000 DCD, Revision 19.

Section 3.10 of the LNP 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.

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

3.10.4 Technical Evaluation

The NRC staff reviewed Section 3.10 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the seismic and dynamic qualification program. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

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

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

Implementation Program

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

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

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

Resolution of Open Item 3.10-1

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

Resolution of Standard Content Confirmatory Item 3.10-1

Confirmatory Item 3.10-1 is an applicant commitment to revise its FSAR to address seismic qualification for Category I equipment. The staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 3.10-1 is now closed.

3.10.5 Post Combined License Activities

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

3.10.6 Conclusion

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

The staff compared the information in the application to the relevant NRC regulations, the acceptance criteria in Section 3.10 of NUREG-0800. The staff's review confirmed 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 which specifies the replacement frequencies of affected safety-related equipment in harsh environments, and nonsafety-related equipment whose failure under the postulated environmental conditions could prevent satisfactory performance of the safety functions of the safety-related equipment, and certain post-accident monitoring equipment. The seismic qualification of mechanical and electrical equipment is presented in Section 3.10. The portions of post-accident monitoring equipment required to be environmentally qualified are identified in AP1000 DCD Table 7.5-1.

RG 1.206 discusses the Commission's position provided in SECY-05-0197 that operational programs should be fully described in COL applications to avoid the need to specify ITAAC for those programs. The applicant relies on the LNP COL application with its incorporation by reference of the AP1000 DCD and supplemental information to fully describe the EQ and other related operational programs in support of the COL application for LNP Units 1 and 2.

3.11.2 Summary of Application

Section 3.11 of the LNP COL FSAR, Revision 9, incorporates by reference Section 3.11 of the AP1000 DCD, Revision 19. Section 3.11 of the AP1000 DCD describes the EQ Program for electrical and mechanical equipment to be used in the AP1000 certified design.

Departures

- LNP DEP 3.11-1

In a letter dated May 13, 2013, the applicant proposed departure LNP DEP 3.11-1 relating to the "Environmental Zone" for three spent fuel pool level instruments.

- LNP 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 LNP COL FSAR about LNP 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 LNP 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 LNP COL FSAR Section 3.11.5, "Combined License Information Item For Equipment Qualification File," the applicant provided additional information to address COL Information Item 3.11-1 (COL Action Item 3.11.2-1) regarding administrative control of the EQ Program for LNP Units 1 and 2.

License Conditions

- Part 10, License Condition 3, Item G1

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

- Part 10, License Condition 6

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

3.11.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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

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

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

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

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

3.11.4 Technical Evaluation

The NRC staff reviewed Section 3.11 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the EQ of mechanical and electrical equipment. The results of the NRC staff's evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

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

Departure

- LNP DEP 3.11-1

In a letter dated May 13, 2013, the applicant proposed 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. The applicant stated that this change corrects inconsistency shown in the DCD. 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 has reviewed the proposed 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 Section 3.11.4 of the VEGP SER:

AP1000 COL Information Item

- *STD COL 3.11-1*

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

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

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

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

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

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

In STD COL 3.11-1, the applicant describes under “Combined License Information Item for Equipment Qualification File,” that the COL holder is responsible for the maintenance of the equipment qualification file. The NRC

staff reviewed STD COL 3.11-1 related to equipment qualification file included under Section 3.11.5 of the BLN COL. The NRC staff's evaluation is as follows.

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

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

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

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

BLN COL FSAR Section 3.11 incorporates by reference AP1000 DCD Tier 2, Section 3.11.2.2, "Environmental Qualification of Mechanical Equipment," in the AP1000 DCD, which references Appendix 3D, "Methodology for Qualifying AP1000 Safety-Related Electrical and Mechanical Equipment." In RAI 3.11-1, the NRC staff requested that the applicant describe in more detail the EQ Program for safety-related mechanical equipment to be used at BLN Units 3 and 4. In its response, the applicant stated that the EQ Program will be performed as described in Section 3.11 and Appendix 3D of the AP1000 DCD, by reference as stated in the BLN COL FSAR. The EQ Program will be implemented through design specifications, equipment procurement documents, and equipment qualification procedures. Equipment qualification specifications and equipment design specifications will be developed based on the AP1000 EQ

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

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

AP1000 DCD, Appendix 3D, Section 3D.6.3, "Operating Experience in the Equipment Qualification Program," states that the COL applicant will provide documentation of the EQ methodology where seismic experience data are used. In RAI 3.11-3, the NRC staff requested that the applicant discuss the documentation of the EQ methodology where seismic experience data are used.

In its response to this RAI, the applicant stated that Westinghouse would revise the AP1000 DCD to resolve this issue. Revision 17 to the AP1000 DCD, Appendix 3D, Section 3D.6.3 specifies that qualification by experience is not employed in the AP1000 equipment qualification program as a method of qualification. The applicant revised the BLN COL FSAR to reflect the revision to the AP1000 DCD. Therefore, RAI 3.11-3 is resolved.

The section titled "In-Service Vibration" in Section B.4.5, "External Stresses," in Attachment B, "Aging Evaluation Program," to Appendix 3D to Chapter 3 in the AP1000 DCD, states that inservice pipe and FIV may be significant for line-mounted equipment. As a consequence, the section states that an additional vibration aging step is included in the aging sequence. Operating experience has revealed that FIV from acoustic resonance and hydraulic loading can adversely impact safety-related mechanical equipment at nuclear power plants. The COL applicant will demonstrate the performance of this additional vibration aging step specified in the AP1000 DCD in the EQ of safety-related mechanical equipment to be used at BLN Units 3 and 4. This technical issue is addressed in Section 3.9.6 of this SER.

License Conditions

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

Resolution of Standard Content Open Item 3.11-1

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

Supplemental Review of Operational Aspects of the EQ Program

As discussed in RG 1.206 and Commission Paper SECY-05-0197, COL applicants must fully describe their operational programs to avoid the need for ITAAC regarding those programs. In addition to the initial EQ of electrical and mechanical equipment, the NRC staff reviewed the VEGP COL FSAR Section 3.11 with its incorporation by reference of the AP1000 DCD and supplemental information for operational aspects of the EQ Program. For example, AP1000 DCD Tier 2, Appendix 3D, Section 3D.7, "Documentation," states that information regarding maintenance, refurbishment, or replacement of the equipment will be included in the equipment qualification package if necessary to provide confidence in the equipment's capability to perform its safety function. Further, Section 3D.7.1, "Equipment Qualification Data Package," states that equipment qualification data packages will specify preventive maintenance that is required to support qualification or the qualified life, including maintenance or periodic activities assumed as part of the qualification program or necessary to support qualification. With respect to safety-related mechanical equipment, AP1000 DCD Tier 2, Section 3D.6.2.3.8, "Equipment Qualification Maintenance Requirements," specifies that maintenance requirements resulting from EQ activities will be based on: (1) qualification evaluation results (for example, periodic replacement of age-susceptible parts before the end of their qualified life); (2) equipment qualification-related maintenance activities derived from the qualification report; and (3) vendor recommended equipment qualification maintenance, if required, in order to maintain qualification. The staff finds that the VEGP COL applicant provides an acceptable description of the transition from the initial to the operational aspects of the EQ Program in support of the VEGP COL application through the VEGP COL FSAR with its incorporation by reference of the AP1000 DCD Tier 2, Section 3.11. The NRC staff will evaluate the implementation of the EQ Program through inspections conducted during plant construction and operation. The NRC inspection activities will include consideration of: (1) evaluation of EQ results for design life to establish activities to support continued EQ; (2) determination of surveillance and preventive maintenance activities based on EQ results; (3) consideration of EQ maintenance recommendations from equipment vendors; (4) evaluation of operating experience in developing surveillance and preventive maintenance activities for specific equipment; (5) development of plant procedures that specify individual equipment identification, appropriate references, installation requirements, surveillance and maintenance requirements, post-maintenance testing requirements, condition monitoring requirements, replacement part identification, and applicable design changes and modifications; (6) development of plant procedures for reviewing equipment performance and EQ operational activities, and for trending the results to incorporate lessons learned through appropriate modifications to the EQ Program; and (7) development of plant procedures for the control and maintenance of EQ records.

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

License Conditions

- *Part 10, License Condition 3, Item G1*

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

- *Part 10, License Condition 6*

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

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

3.11.5 Post Combined License Activities

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 (3-9) – Before initial fuel load, the licensee shall implement the Environmental Qualification Program.

- License Condition (3-10) – 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 NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the EQ Program, and there is no outstanding information expected to be addressed in the LNP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

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

- LNP 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.

- LNP 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 LNP Units 1 and 2, is acceptable because the requirements of 10 CFR 52.79(a)(10) and 10 CFR 52.79(a)(29)(i) are satisfied.

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

3.12.1 Introduction

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

3.12.2 Summary of Application

Chapter 3 of the LNP COL FSAR, Revision 9, incorporates by reference Chapter 3 of the AP1000 DCD, Revision 19. Sections 3.7 and 3.9 of the AP1000 DCD address Section 3.12, "ASME Code Class 1, 2, and 3 Piping Systems, Piping Components and their Associated Supports" of NUREG-0800.

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

AP1000 COL Information Item

- STD COL 3.9-2

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

- STD COL 3.9-5

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

- STD COL 3.9-7

In its letter dated September 23, 2010, the applicant endorsed the letter dated April 23, 2010, from the VEGP applicant, that 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.

Supplemental Information

- LNP SUP 3.7-3

LNP SUP 3.7-3 adds new Sections 3.7.1.1.1 and 3.7.1.1.2 to provide the seismic response spectra design information for the LNP site.

License Condition

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

In its letter dated September 23, 2010, the applicant endorsed the letter dated April 23, 2010, from the VEGP applicant, that proposed a license condition addressing the as-designed piping analysis completion schedule.

ITAAC

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

3.12.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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

3.12.4 Technical Evaluation

The NRC staff reviewed Section 3.9 of the LNP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope

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

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (VEGP Units 3 and 4) were equally applicable to the LNP Units 1 and 2 COL application, the staff undertook the following reviews:

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

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

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

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

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

> *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.*
>
> *<u>AP1000 COL Information Items</u>*
>
> - *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 "Pressurizer Surge Line Thermal Stratification." 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, and August 6, 2010, letters will be tracked as ***Confirmatory Item 3.12-1****.*

Resolution of 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.# [where # is the next sequential number] 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****.*

Resolution of Standard Content Confirmatory Item 3.12-2

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 [Section 14.3.3.2 for LNP] *for pipe analysis and add an ITAAC (Table 3.8-2)* [Table 3.8-3 for LNP] *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)* [Table 3.8-3 for LNP] *were appropriately updated. As a result, Confirmatory Item 3.12-2 is now closed.*

- LNP COL 3.7-3

Sections 3.7.1.1.1 and 3.7.1.1.2 of the LNP COL FSAR provide the seismic response spectra design information. The staff reviewed the seismic response input information and SSI analysis and documented its evaluation in Section 3.7.1 and 3.7.2 of this SER. The staff also concluded that the LNP site-specific ISRS are enveloped by the ISRS of the AP1000 CSDRS and HRHF during the review of section 3.7.1 and 3.7.2. On the basis of the LNP site-specific piping analysis seismic input ISRS are enveloped by the ISRS of the AP1000 design, the staff finds that the AP1000 standard piping analyses are acceptable for the LNP site. As discussed above, Confirmatory Item 3.12-2 for LNP is now resolved. In a September 23, 2010, letter, the applicant endorsed SNC's April 23, 2010 response that included planned changes to the FSAR. These changes were included in Revision 4 to the LNP COL FSAR. Therefore, this issue is resolved for the LNP COL application.

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 SER Table 3.12-1.

- License Condition (3-11) – 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 NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to piping design, and there is no outstanding information expected to be addressed in the LNP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the LNP COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the LNP COL application is acceptable and meets the NRC regulations. The staff based its conclusion on the following:

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

- LNP SUP 3.7-3 is acceptable because the LNP site-specific ISRS are enveloped by the ISRS of the AP1000 CSDRS and HRHF spectra and, therefore, the AP1000 DCD piping design analyses are acceptable for the LNP site.

Table 3.6-1. Pipe Rupture Hazards Analysis ITAAC

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

Table 3.8-1 Roller Compacted Concrete ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
The RCC Bridging Mat is seismic Category I and is designed and constructed to bridge over the design basis karst feature when subjected to design basis loads as specified in the Design Description in FSAR Subsection 2.5.4.5.4 without loss of structural integrity and the safety related functions.	i) An inspection of the bridging mat placement will be performed. Deviations in the RCC Bridging Mat properties due to as-built conditions that fall outside the range considered in the design as described in FSAR Subsection 2.5.4.5.4 will be analyzed for the design basis karst feature when subjected to design basis loads. ii) An inspection of the RCC mix and bedding mix constituents will be performed in accordance with FSAR Subsection 3.8.5.11.4. Deviations from the design constituents will be evaluated against the range of properties established for these materials during the design phase. iii) An inspection of the as-built RCC thickness will be performed.	i) A report exists which reconciles deviations from design and placement process of the RCC during construction and concludes that the as-built RCC bridging mat conforms to the approved design and will bridge over a design basis karst feature when subjected to design basis loads specified in the Design Description without loss of structural integrity and the safety related functions. ii) A report exists which reconciles deviations in mix constituents used in construction and concludes that the as-built RCC conforms to the design requirements for these properties. iii) A document exists that verifies that the as-built thickness of the RCC bridging mat is at least as thick as the design requirement.

Table 3.8-2 Drilled Shaft Foundation ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
Drilled Shaft Foundations for the Turbine, Radwaste, and Annex Buildings will preclude movement of the building foundations in excess of the separation provided between the structural elements of the Turbine, Radwaste, and Annex Buildings and the nuclear island structures.	During construction, inspection of the physical properties of the rock socket for each drilled shaft will be performed in accordance with LNP FSAR Chapter 3 Subsection 3.8.5.9. Inspection of the as-built drilled shaft foundation physical arrangement will also be performed.	A report exists that reconciles the during construction physical properties of the rock socket for each drilled shaft and the as-built physical arrangement of the Turbine, Radwaste, and Annex Buildings' drilled shaft foundations with design specifications and drawings. The report concludes that the as-built drilled shaft foundation conforms to the design commitment.

Table 3.8-3 Waterproof Membrane ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
The friction coefficient to resist sliding is ≥ 0.55.	Testing will be performed to confirm that the mudmat-waterproofing-RCC interface beneath the Nuclear Island basemat has a coefficient of friction to resist sliding of ≥ 0.55.	A report exists and documents that the as-built waterproof system mudmatwaterproofing-RCC interface) has a coefficient of friction of ≥ 0.55 as demonstrated through material qualification testing.

Table 3.12-1 Piping Design ITAAC

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