

19.0 PROBABILISTIC RISK ASSESSMENT (RELATED TO RG 1.206, SECTION C.III.1, CHAPTER 19, C.I.19, “PROBABILISTIC RISK ASSESSMENT AND SEVERE ACCIDENT EVALUATION”)

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 52, Subpart C, Section 52.79, “Contents of applications; technical information in final safety analysis report,” requires applicants to submit a description of the plant-specific probabilistic risk assessment (PRA) and its results. The PRA provides an evaluation of the risk of core damage and release of radioactive material associated with both internal and external events that can occur during plant operation at power or while shutdown.

Appendix 19A to this safety evaluation (SE) section evaluates the measures identified by the applicant needed to comply with requirements to address loss of large areas (LOLAs) of the plant due to explosions or fires from a beyond-design basis event (BDBE). These requirements are in 10 CFR 50.54(hh)(2) and 10 CFR 52.80(d). It should be noted that the attachment to Appendix 19A (Attachment A), as well as some documents referenced in Appendix 19A, include security-related or safeguards information. Therefore, Attachment A to Appendix 19A and the references that include security-related or safeguards information, are withheld from the public in accordance with 10 CFR 2.390.

19.1–19.54, 19.56–19.57, and Appendices 19A–19F Probabilistic Risk Assessment

The Vogtle Electric Generating Plant (VEGP) combined license (COL) Final Safety Analysis Report (FSAR), Revision 2, incorporates by reference, with no departures or supplements, Sections 19.1 through 19.54, 19.56, 19.57, and Appendices 19A through 19F of the AP1000 Design Control Document (DCD) Revision 17:

- 19.1, “Introduction”
- 19.2, “Internal Initiating Events”
- 19.3, “Modeling of Special Initiators”
- 19.4, “Event Tree Models”
- 19.5, “Support Systems”
- 19.6, “Success Criteria Analysis”
- 19.7, “Fault Tree Guidelines”
- 19.8, “Passive Core Cooling System – Passive Residual Heat Removal”
- 19.9, “Passive Core Cooling System – Core Makeup Tanks”
- 19.10, “Passive Core Cooling System – Accumulator”
- 19.11, “Passive Core Cooling System – Automatic Depressurization System”
- 19.12, “Passive Core Cooling System – In-containment Refueling Water Storage Tank”
- 19.13, “Passive Containment Cooling”
- 19.14, “Main and Startup Feedwater System”
- 19.15, “Chemical and Volume Control System”
- 19.16, “Containment Hydrogen Control System”
- 19.17, “Normal Residual Heat Removal System”
- 19.18, “Component Cooling Water System”
- 19.19, “Service Water System”
- 19.20, “Central Chilled Water System”

- 19.21, "AC Power System"
- 19.22, "Class 1E DC and UPS System"
- 19.23, "Non-Class 1E DC and UPS System"
- 19.24, "Containment Isolation"
- 19.25, "Compressed and Instrument Air System"
- 19.26, "Protection and Safety Monitoring System"
- 19.27, "Diverse Actuation System"
- 19.28, "Plant Control System"
- 19.29, "Common Cause Analysis"
- 19.30, "Human Reliability Analysis"
- 19.31, "Other Event Tree Node Probabilities"
- 19.32, "Data Analysis and Master Data Bank"
- 19.33, "Fault Tree and Core Damage Quantification"
- 19.34, "Severe Accident Phenomena Treatment"
- 19.35, "Containment Event Tree Analysis"
- 19.36, "Reactor Coolant System Depressurization"
- 19.37, "Containment Isolation"
- 19.38, "Reactor Vessel Reflooding"
- 19.39, "In-Vessel Retention of Molten Core Debris"
- 19.40, "Passive Containment Cooling"
- 19.41, "Hydrogen Mixing and Combustion Analysis"
- 19.42, "Conditional Containment Failure Probability Distribution"
- 19.43, "Release Frequency Quantification"
- 19.44, "MAAP4.0 Code Description and AP1000 Modeling"
- 19.45, "Fission Product Source Terms"
- 19.46 Not used
- 19.47 Not used
- 19.48 Not used
- 19.49, "Offsite Dose Evaluation"
- 19.50, "Importance and Sensitivity Analysis"
- 19.51, "Uncertainty Analysis"
- 19.52, Not used
- 19.53, Not used
- 19.54, "Low Power and Shutdown PRA Assessment"

- 19.56, "PRA Internal Flooding Analysis"
- 19.57, "Internal Fire Analysis"

- Appendix 19A, "Thermal Hydraulic Analysis to Support Success Criteria"
- Appendix 19B, "Ex-Vessel Severe Accident Phenomena"
- Appendix 19C, "Additional Assessment of AP1000 Design Features"
- Appendix 19D, "Equipment Survivability Assessment"
- Appendix 19E, "Shutdown Evaluation"
- Appendix 19F, "Malevolent Aircraft Impact"

The Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.¹ The NRC staff's review confirmed that there are no outstanding issues related to these sections. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," (FSER) and its supplements.

For the remaining sections of Chapter 19, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Section 19.0, "Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors," was the principal source of guidance for the review. NUREG-0800, Section 19.1, "Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," was also used. The acceptability of the risk to public health and safety was determined on the basis of the results and insights derived from the applicant's plant-specific internal events PRA, site-specific assessment of external events, and severe accident evaluations. The staff's evaluation of the remaining sections of Chapter 19 is described below.

19.55 Seismic Margin Analysis

19.55.1 Introduction

The NRC staff reviewed Section 19.55 of the VEGP COL FSAR and found that due to the site-specific design response spectra exceedances discussed below, incorporation of DCD Section 19.55 by reference, with no departures or supplements, was insufficient.

The seismic analysis and design of the AP1000 plant is based on the certified seismic design response spectra (CSDRS) shown in DCD Tier 1 Figures 1.0-1 and 1.0-2. These spectra are based on Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 1, (RG 1.60) with an increase in the 25 Hertz (Hz) region to account for increased high-frequency ground motion at some prospective sites. The CSDRS has its dominant energy content in the frequency range of 2 to 10 Hz.

The VEGP Units 3 and 4 soil conditions and ground motion response spectra (GMRS) are described in VEGP COL FSAR Sections 2.5 and 3.7. In FSAR Figures 3.7-201 and 3.7-202, the VEGP GMRS are compared with the AP1000 CSDRS. These comparisons indicated that the site-specific GRMS exceed the AP1000 CSDRS in the high and low frequency ranges. In FSAR Appendix 3GG, "3-D SSI Analysis of AP1000 at Vogtle Site using NI15 Model for VEGP Units 3 & 4," the applicant described the detailed soil-structure interaction analysis performed to justify that the VEGP GMRS excitation will not damage seismic structures, systems, or components (SSCs). The staff's review of these analyses are provided in Section 3.7 of this safety evaluation report (SER).

The staff's review of the AP1000 PRA-based seismic margin analysis is described in Section 19.1.5.1 of NUREG-1793. The AP1000 seismic margin analysis (SMA) estimated the

¹ See Section 1.2.2 for a discussion of the staff's review related to verification of the scope of information to be included in a COL application that references a design certification.

high confidence, low probability of failure (HCLPF) capacity of the AP1000 plant in terms of a free-field peak ground acceleration (PGA) expressed in terms of g (the acceleration of gravity). Specifically, in a staff requirements memorandum (SRM) dated July 21, 1993, the Commission approved the following staff recommendation specified in SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," Section II.N, "Site Specific Probabilistic Risk Assessments and Analysis of External Events," with a modification:

PRA insights will be used to support a margins type assessment of seismic events. A PRA based seismic margins analysis will consider sequence level HCLPFs and fragilities for all sequences leading to core damage or containment failures up to approximately one and two thirds the ground motion acceleration of the design-basis SSE [safe shutdown earthquake].

A review-level earthquake (RLE) equal to 0.5 g was established for the SMA and used to demonstrate a margin over the SSE of 0.3 g.

The AP1000 DCD, Tier 1, Table 5.0-1, "Site Parameters," states:

If the site-specific spectra exceed the response spectra in Figures 5.0-1 and 5.0-2 at any frequency, or if soil conditions are outside the range evaluated for AP1000 design certification, a site-specific evaluation can be performed. This evaluation will consist of a site-specific dynamic analysis and generation of in-structure response spectra at key locations to be compared with the floor response spectra of the certified design at 5-percent damping. The site is acceptable if the floor response spectra from the site-specific evaluation do not exceed the AP1000 spectra for each of the locations or the exceedances are justified.

19.55.2 Summary of Application

Section 19.55 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 19.55 of the AP1000 DCD, Revision 17. In a letter dated September 20, 2010, the applicant proposed to supplement the application with a new Section 19.55.6.3, "Site Specific Seismic Margin Analysis." This section provides the basis for the applicant's conclusion that the SMA documented in Section 19.55 of the DCD is applicable to the VEGP site.

- VEGP COL 19.59.10-6

In a letter dated September 20, 2010, the applicant proposed to add a new COL Information Item 9 (VEGP COL 19.59.10-6) to reflect a response from Westinghouse dated August 23, 2010, regarding confirmation that the Seismic Margin Analysis documented in the AP1000 DCD section is applicable to the VEGP site.

19.55.3 Regulatory Basis

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

In addition, the applicable regulatory requirements for the evaluation of plant-specific information evaluated in Section 19.55 of this SER are as follows:

- 10 CFR 52.79(a)(46), “The final safety analysis report shall include...at a level of information sufficient to enable the Commission to reach a final conclusion on all safety matters that must be resolved...before issuance of a combined license:...[a] description of the plant-specific PRA and its results.”
- 10 CFR 52.79(d)(1), “If the combined license application references a standard design certification, then the...final safety analysis report need not contain information or analyses submitted to the Commission in connection with the design certification, provided, however, that the final safety analysis report must either include or incorporate by reference the standard design certification final safety analysis report and must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the site characteristics fall within the site parameters specified in the design certification. In addition, the plant-specific PRA information must use the PRA information for the design certification and must be updated to account for site-specific design information and any design changes or departures.”

Interim staff guidance in the form of DC/COL-ISG-3, “Probabilistic Risk Assessment Information to Support Design Certification and Combined License Applications,” provides clarifying guidance regarding the scope and quality of PRAs being used to support COL applications, and documentation that must be submitted in support of these applications.

For external events analysis purposes, DC/COL-ISG-3 considers the requirements of 10 CFR 52.79(d)(1) met if the COL applicant compares the site’s characteristics to those assumed in the bounding analyses to ensure that the site is enveloped. If the site is enveloped, the COL applicant need not perform further PRA evaluations for these external events. However, the COL applicant should perform site-specific PRA evaluations to address any site-specific hazards for which a bounding analysis was not performed or that are not enveloped by the bounding analyses to ensure that no vulnerabilities due to siting exist.

DC/COL-ISG-20, “Implementation of a Probabilistic Risk Assessment-Based Seismic Margin Analysis for New Reactors,” provides guidance on plant-specific updates of the DC PRA-based seismic margin evaluation for COL applications.

19.55.4 Technical Evaluation

The NRC staff reviewed Section 19.55 of the VEGP COL FSAR and found that due to the site-specific design response spectra exceedances, incorporation of DCD Section 19.55 by reference was insufficient. Although the applicant performed site-specific soil-structure interaction analysis to demonstrate that the VEGP GMRS will not damage seismic SSCs for design basis seismic loading, there was no mention of beyond-design basis loading such as that described in SECY-93-087. The associated SRM states that at the plant level, the HCLPF should be at least 1.67 times the ground motion acceleration of the site-specific GMRS.

To address the above concern, the staff issued a request for additional information (RAI) demonstrating that VEGP will have adequate seismic margin as described in SECY-93-087

(RAI 19-10). In response to this request, in a letter dated October 30, 2009, the applicant provided an evaluation of site-specific features with the potential to reduce seismic margin. The applicant evaluated the potential for soil liquefaction and its effect on bearing capacity as well as nuclear island seismic demand, and seismic stability.

Soil Liquefaction and Bearing Capacity

The applicant stated that the increased seismic demand (i.e., 1.67 times the GMRS) results in a PGA of 0.44 g on subsurface soils beneath VEGP Units 3 and 4. Further, the applicant stated that the subsurface materials are dense compacted structural fill that would not be expected to liquefy at acceleration values less than or equal to 0.44 g. The applicant also assessed the liquefaction potential of the Blue Bluff marl (BBM), which is approximately 86 feet below plant grade elevation. The applicant stated that the BBM is not susceptible to liquefaction because the BBM is a highly over-consolidated, very strong middle-Eocene-age material consisting almost entirely of clay with some partially cemented, well indurated lenses.

The applicant stated that in terms of bearing capacity, the increased seismic demand will reduce average site-specific ultimate dynamic bearing capacity, while the seismic bearing pressure will increase. Using these assumptions, the applicant predicted that the resulting capacity-to-demand ratio will still be more than 2.0 and, therefore, will provide sufficient margin for the beyond-design basis seismic loading.

The staff reviewed the applicant's evaluations of soil liquefaction and bearing capacity of the soils supporting the nuclear island and finds them to be consistent with Regulatory Guide 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites," and NUREG-0800 Section 3.8.5, "Foundations." Therefore, the staff finds the applicant's response regarding soil liquefaction and bearing capacity to be acceptable.

Nuclear Island Seismic Demand

The staff reviewed the applicant's response to RAI 19-10 and noted that the applicant did not perform an explicit analysis of the effects of the 0.5 g RLE on in-structure response spectra. Instead, the applicant makes the case that the exceedances of the AP1000 CSDRS are non-damaging because they either: (1) occur in a frequency range above tank sloshing resonance; or (2) occur at locations where there are no SSCs having resonances in the exceeded frequency range.

To evaluate the site-specific exceedances of the AP1000 CSDRS, the applicant performed two-dimensional (2-D) soil-structure interaction analyses in support of the early site permit (ESP). The applicant performed three-dimensional (3-D) soil-structure interaction analyses for design-basis loading. The 2-D analyses are described in VEGP Early Site Permit Application Site Safety Analysis Report, Revision 5, Appendix 2.5E, "Vogtle Site Specific Seismic Evaluation Report." The 3-D analyses are described in VEGP COL FSAR Appendix 3GG. To support the applicant's ESP, the staff previously reviewed and approved the applicant's 2-D analyses for the purpose of confirming adequate foundation stability. The staff noted in Section 3.7 of NUREG-1923, "Safety Evaluation Report for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant (VEGP) ESP Site," that 3-D analyses are required for assessing in-structure response. The applicant's response to RAI 19-10 states that the 3-D analyses show small exceedances of the envelope spectra at two of the six key locations

specified in the DCD. These exceedances occur in the frequency ranges of 0.5 to 0.6 Hz in the north-south direction, 0.45 to 0.65 Hz in the east-west direction, and 1.5 to 2 Hz at high elevations in the shield building in the east-west directions. With respect to the exceedances below 1.0 Hz, the applicant claims that these are due to tank sloshing and that the sloshing resonances are below 0.5 Hz. With respect to the exceedances in the 1.5-2 Hz range, the applicant states that Westinghouse reviewed the seismic Category I SSCs above this elevation and concluded that there are no items with fundamental frequencies in this range. Therefore, these exceedances have no impact on the design.

The staff reviewed the results of the applicant's site-specific seismic analyses in Section 3.7 of this SER. Westinghouse proposed design changes to the AP1000 shield building. These changes were reflected in the site-specific VEGP analysis models. The staff's evaluation of the modified shield building design and site-specific analysis models for VEGP is documented in Section 3.7 of this safety evaluation.

Seismic Stability

To assess the sliding stability of the nuclear island when subjected to seismic ground motion equal to 1.67 times the VEGP GMRS, the applicant compared the factors of safety provided in VEGP ESP SSAR Appendix 2.5E, Table 6.2-1. The applicant states that in the ESP, the upper bound case for the east-west response has the smallest factor of safety, which is equal to 2.45. Increasing the seismic demand by 1.67 reduced the factor of safety to 1.4, conservatively neglecting the effects of passive soil pressure.

The staff reviewed the applicant's technical basis for assessing sliding and overturning stability. The staff also reviewed VEGP ESP SSAR Appendix 2.5E, Tables 6.2-1, 6.2-2, and 6.2-3 and found the smallest factor of safety to resist sliding and overturning (based on best-estimate soil properties) to be 1.78 and 2.15, respectively. Based on these results, the staff finds the applicant's response regarding seismic stability to be acceptable.

The staff reviewed the applicant's analysis of the potential for soil liquefaction and its effect on bearing capacity as well as nuclear island seismic demand and seismic stability. The staff concludes that the applicant has adequately evaluated site-specific features with the potential to reduce seismic margin. The incorporation of the planned changes to the VEGP COL FSAR identified in the applicant's September 20, 2010, letter will be tracked as **Confirmatory Item 19.55-1**.

19.55.5 Post Combined License Activities

There are no post-COL activities identified in this section.

19.55.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review identified that the applicant needed to perform a site-specific evaluation to confirm adequate seismic margin in accordance with SECY-93-087. The applicant adequately addressed, pending closure of **Confirmatory Item 19.55-1**, the site-specific evaluation of soil liquefaction, bearing capacity, and nuclear island stability.

19.58 Winds, Floods, and Other External Events

19.58.1 Introduction

Section 19.58 of the VEGP COL FSAR discusses risks associated with external events other than earthquakes. The staff uses this information to confirm that the total risk represented by core damage frequency (CDF) and large release frequency (LRF) remains acceptably low when accounting for external events.

With respect to external events, the applicant's response to COL Information Item 19.59.10-2 may also affect VEGP COL FSAR Section 19.58. Therefore, the staff's evaluation of this COL information item is discussed in Section 19.58.4 below.

19.58.2 Summary of Application

Section 19.58 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 19.58 of the AP1000 DCD, Revision 17.

In addition, in VEGP COL FSAR Section 19.58, the applicant provided the following:

Supplemental Item

- VEGP Supplement (SUP) 19.58-1

The applicant provided supplemental information to address a portion of COL Information Item 19.59.10-2 by adding text to the end of DCD Section 19.58.3. Table 19.58-201, "External Event Screening for VEGP," documents the site-specific external events evaluation that has been performed for VEGP Units 3 and 4. This table provides a general explanation of the evaluation and resultant conclusions and provides a reference to applicable sections of the COL where supporting information is located. The applicant concluded that the VEGP Units 3 and 4 site is bounded by the high winds, floods and other external events analysis documented in DCD Section 19.58 and no further evaluations are required at the COL application stage.

19.58.3 Regulatory Basis

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

In addition, the applicable regulatory requirements for the evaluation of VEGP SUP 19.58-1 are as follows:

- 10 CFR 52.79(a)(46), "The final safety analysis report shall include...at a level of information sufficient to enable the Commission to reach a final conclusion on all safety matters that must be resolved...before issuance of a combined license:...[a] description of the plant-specific PRA and its results."
- 10 CFR 52.79(d)(1), "If the combined license application references a standard design certification, then the...final safety analysis report need not contain information or

analyses submitted to the Commission in connection with the design certification, *provided, however*, that the final safety analysis report must either include or incorporate by reference the standard design certification final safety analysis report and must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the site characteristics fall within the site parameters specified in the design certification. In addition, the plant-specific PRA information must use the PRA information for the design certification and must be updated to account for site-specific design information and any design changes or departures.”

DC/COL-ISG-3 provides clarifying guidance regarding the scope and quality of PRAs being used to support COL applications, and documentation that must be submitted in support of these applications.

For external events analysis purposes, DC/COL-ISG-3 considers the requirements of 10 CFR 52.79(d)(1) met if the COL applicant compares the site’s characteristics to those assumed in the bounding analyses to ensure that the site is enveloped. If the site is enveloped, the COL applicant need not perform further PRA evaluations for these external events. However, the COL applicant should perform site-specific PRA evaluations to address any site-specific hazards for which a bounding analysis was not performed or that are not enveloped by the bounding analyses to ensure that no vulnerabilities due to siting exist.

19.58.4 Technical Evaluation

The NRC staff reviewed Section 19.58 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.¹ The NRC staff’s review confirmed that the information in the application and incorporated by reference addresses the required information relating to winds, floods, and other external events. The results of the NRC staff’s evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the VEGP COL FSAR:

Supplemental Item

- VEGP SUP 19.58-1

The NRC staff reviewed VEGP SUP 19.58-1 related to COL Information Item 19.59.10-2.

In support of the AP1000 design certification amendment (DCA), and to address part of COL Information Item 19.59.10-2, the DC applicant submitted APP-GW-GLR-101, “AP1000 Probabilistic Risk Assessment Site-specific Considerations.” This technical report expanded Section 19.58 of the AP1000 DCD with descriptions of its analyses of selected external events at a hypothetical AP1000 site. The DC applicant gathered site-specific data for those external events hazards determined applicable to each of the sites proposing to build AP1000 plants. For each event, it used the most limiting of the parameters provided by the several sites to characterize the generic AP1000 site. This produced a set of bounding analyses for the selected external events. The DC applicant evaluated these limiting external events against the

criteria of NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," suitably modified.

Section 19.58 of the AP1000 DCD provides an analysis of the capability of the AP1000 design to withstand external flooding, tornadoes, hurricanes, and other site-specific external events. The second portion of COL Information Item 19.59.10-2 in the AP1000 DCD makes the following statement:

The Combined License applicant will confirm that the High Winds, Floods, and Other External Events analysis documented in Section 19.58 is applicable to the COL site. Further evaluation will be required if the COL site is shown to be outside of the bounds of the High Winds, Floods, and Other External Events analysis documented in Section 19.58.

In the VEGP COL FSAR the applicant provided VEGP SUP 19.58-1, which included the following paragraph:

Table 19.58-201 documents the site-specific external events evaluation that has been performed for VEGP Units 3 and 4. This table provides a general explanation of the evaluation and resultant conclusions and provides a reference to applicable sections of the COL where more supporting information (including data used, methods and key assumptions) regarding the specific event is located. Based upon this evaluation, it is concluded that the VEGP Units 3 and 4 site is bounded by the High Winds, Floods and Other External Events analysis documented in DCD Section 19.58 and APP-GW-GLR-101 ([FSAR] Reference 201) and no further evaluations are required at the COL application stage.

Staff Request for Additional Information

Although site-specific information at currently proposed AP1000 sites was considered in performing the generic analyses of DCD Section 19.58, details were not made available to the staff. The staff issued RAI 19-1, requesting the applicant provide sufficient information to confirm the basis for concluding that the VEGP site was bounded by the generic analysis.

In a letter dated February 10, 2009, the applicant, in response to RAI 19-1, described the methodology used to develop the generic external event analysis and provided some additional information on event frequency and severity.

Potential external events and hazards were first screened for applicability to the VEGP site. For events that were judged applicable, the applicant developed an initiating event frequency and provided this information to Westinghouse for use in the bounding analysis of the generic AP1000 site. Westinghouse developed a limiting event to bound the severity and frequency of all reported events; a hypothetical site for the generic analysis was characterized by these limiting events.

To address the external events in the scope of the generic analysis, the applicant provided a comparison between the DCD limiting events and site-specific events in the response to RAI 19-1. Table 1 in the RAI 19-1 response provides an assessment of external event

applicability to the VEGP site (with a brief justification), as well as the applicant's estimate of event frequency for relevant external events. The staff independently compared these inputs to the event frequencies assumed in the DCD.

The staff reviewed the data, the applicability justifications, and the basis for event frequency estimations in this table. Events that were bounded by the external events documented in the DCD (no more frequent and no more damaging) required no additional evaluation. Events that are predicted to occur no more than once in ten million years can be screened because they occur so infrequently (frequency less than $1E-07$ /year). Events that may occur more frequently but less than once in a million years (frequency less than $1E-06$ /year) are assessed to determine that their consequences make a negligible contribution to CDF (change CDF less than $1E-08$ /year). Other events, if any, must be explicitly evaluated and included in the plant-specific PRA.

Because a number of questions remained, the staff issued several RAIs requesting additional details and clarification to allow the staff to confirm that the key site-related assumptions in the AP1000 DCD, Section 19.58 external events analyses remain valid for the VEGP site (RAIs 19-3 through 19-9):

- RAI 19-3 requested (a) the basis for screening and (b) assessment of risk from events that cannot be screened (to be reported in the FSAR).
- RAI 19-4 requested clarification of the frequency of extratropical cyclones.
- RAI 19-5 requested additional discussion of the basis for the VEGP assessment of external flooding.
- RAI 19-6 requested the basis for screening of external fires.
- RAI 19-7 requested additional discussion of risk related to onsite chemical storage.
- RAI 19-8 requested discussion of risk related to nearby facilities.
- RAI 19-9 requested discussion of risk related to the release of toxic materials.

In a letter dated May 22, 2009, the applicant responded to these RAIs with the requested clarification and discussion. In addition, the applicant revised the table that had been submitted in response to RAI 19-1 and proposed to include it in the VEGP COL FSAR as Table 19.58-20, "External Event Screening for VEGP," to document the basis for its assessment of risk related to winds, floods, and other external events. This table has been incorporated into the VEGP COL FSAR.

A summary of the staff's review of each of the external event categories follows.

Winds that would threaten safety-related SSCs (exceed 300 miles per hour)

Because VEGP safety-related SSCs are designed to withstand winds of 300 mph, the COL applicant should confirm the assumption that high wind events exceeding 300 mph (the design

basis for the structures of the nuclear island) are extremely rare (frequency $<1E-7$ per year). Subsequent to certification of the AP1000 design, the staff issued RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1. This guide states that for the continental United States, the staff considers the highest tornado wind speed with a frequency as high as $1E-07$ to be 230 mph. Clearly, the expected frequency of 300 mph tornadoes is significantly lower. Therefore, the staff considers such events at the VEGP site to be screened from further analysis based on negligible frequency.

High Winds—Tornadoes

The applicant is expected to verify that the frequency of each of the six tornado classes at the proposed site is bounded by the frequency assumed in Section 19.58 of the AP1000 DCD.

The applicant found this external event category applicable to the VEGP site, and estimated frequencies for tornadoes striking the seven counties around the site. The applicant's estimated frequency for each class of tornado (on the enhanced Fujita scale) is less than what is assumed in Section 19.58 of the AP1000 DCD.

In response to RAI 19-1, the applicant reported that the large structure strike probability from any tornado at the VEGP site is $7.74E-5$ per year and assumed this frequency for each class of tornado. This event was evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.3.1 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAIs 19-1 and 19-4, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to tornadoes are directly applicable to the VEGP COL application.

High Winds—Hurricanes and Extratropical Cyclones

The applicant is expected to verify that the frequency of each of the 12 high wind categories at the proposed site is bounded by the frequency assumed in Section 19.58 of the AP1000 DCD.

In response to RAI 19-1, the applicant identified this external event category as applicable to the VEGP site. In response to RAI 19-4, the applicant clarified the frequency of extratropical cyclones and stated that all events with winds below hurricane force had been screened out from further evaluation.

This event was also evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.3.1 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAIs 19-1 and 19-4, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to hurricanes and extratropical cyclones are directly applicable to the VEGP COL application.

External Floods

The applicant is expected to verify that the frequency of external flooding at the proposed site is bounded by the frequency assumed in Section 19.58 of the AP1000 DCD.

In response to RAI 19-1, the applicant identified this external event category as applicable to the VEGP site. In response to RAI 19-5, the applicant considered additional sources of flooding and provided justification for considering the VEGP site to be bounded by the AP1000 DCD.

This event was also evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.3.4 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAIs 19-1 and 19-5, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to the event of external floods are directly applicable to the VEGP COL application.

Transportation and Nearby Facility Accidents—Aviation Accidents

The applicant is expected to demonstrate that it is bounded by Section 19.58 of the AP1000 DCD by limiting impact frequencies to $1.2E-06$ per year by small aircraft and $1.0E-07$ per year by commercial size aircraft. The bounding analysis for a small aircraft in the AP1000 DCD assumes that the impact would result in a loss of offsite power initiating event with subsequent loss of non-safety-related systems. Larger (commercial) aircraft may have the capacity to challenge safety-related SSCs, although some safety-related systems are expected to survive and remain functional. Because of the uncertainty of the consequences of the impact, the acceptable screening criterion for large, commercial aircraft is to demonstrate an accidental impact frequency of $1.0E-07$ per year or less.

In response to RAI 19-1, the applicant identified this event category as not applicable to the VEGP site, and referenced VEGP ESP SSAR Section 3.5.1.6, which provides details of aircraft impact analysis. The applicant determined that Airway V185 is the only one affected. The applicant determined 51,000 flights per year would be needed in order to reach the $1.0E-07$ per year threshold. This exceeds the total number of flights expected to utilize the airway.

This event was also evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 3.5.1.6 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAI 19-1, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to aviation accidents are directly applicable to the VEGP COL application.

Transportation and Nearby Facility Accidents—Marine Accidents

The applicant is expected to verify that the limiting initiating event frequency of $1E-06$ per year is not exceeded for the release of toxic materials toward the plant (which can affect plant and control room habitability). This is not a screening based on frequency alone; it also considers consequence. It is predicated on a very low conditional core damage probability when there is no operator action or no operator action after tripping the reactor.

In response to RAI 19-1, the applicant found that this event category was not applicable to the VEGP site. The applicant referenced VEGP ESP SSAR Section 2.2.3.3.1 and stated that no barge traffic exists by the VEGP site.

This event was also evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.2.2 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAI 19-1, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to marine accidents are directly applicable to the VEGP COL application.

Transportation and Nearby Facility Accidents—Rail Accidents

As in the case of marine-based hazards, there are two event subcategories of rail-based hazards: toxic materials and explosive hazards.

In response to RAI 19-1, the applicant found that neither event category applies to the VEGP site. Accordingly, the applicant does not discuss the toxic materials event subcategory. The safe standoff distance for an explosive hazard (based on a tank car of trinitrotoluene) is less than the distance from the site boundary to the nearest railway.

In response to RAI 19-9, the applicant referenced VEGP ESP SSAR Section 2.2.3.1.4, which provides a more detailed analysis of this scenario.

This event was also evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.2.3 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAI 19-1 and RAI 19-9, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to rail accidents are directly applicable to the VEGP COL application.

Transportation and Nearby Facility Accidents—Truck Accidents

Similar to rail and marine accidents, there are two event subcategories of truck-based hazards: toxic materials and explosive hazards. In response to RAI 19-1, the applicant states truck accidents are not applicable to the VEGP site. Accordingly, the applicant does not discuss the toxic materials event subcategory. As previously noted, RAI 19-9 was issued to the applicant to provide an evaluation of this subcategory for all mobile sources, including truck traffic, and to document the assessment of associated risk in Section 19.58 of the VEGP COL FSAR.

The applicant's response to RAI 19-1 with respect to truck-based explosive and flammable vapor cloud hazards is similar to that for rail-based hazards, and it concluded that the safe standoff distance for an explosive hazard is less than the distance from the site boundary to the nearest highway.

Additionally, in response to RAI 19-9, the applicant referenced VEGP ESP SSAR Section 2.2.3.1.1 and Section 2.2.3.2.1, which provide a more detailed analysis of this scenario.

This event was also evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.2.3 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAI 19-1 and RAI 19-9, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to truck accidents are directly applicable to the VEGP COL application.

Transportation and Nearby Facility Accidents—Pipelines

In response to RAI 19-1, the applicant states that there are no major pipelines within five miles of the VEGP site and references VEGP ESP SSAR Section 2.2.3.1.3. The position of the staff is that a release of hazardous material beyond this distance need not be considered in accordance with NUREG-0800, Section 2.2.1-2.2.2. The staff confirmed that residential, commercial, and industrial distribution pipelines within five miles of the site do not constitute major pipelines. Because the limiting event evaluated for pipeline-related explosion in the DCD was a 76 cm (30-inch) pipe at a distance of 1700 m (5800 feet) from the plant, the applicant states that explosion hazards due to pipeline accidents can be screened.

This event was evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.2.3 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAI 19-1, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to pipelines are directly applicable to the VEGP COL application.

Transportation and Nearby Facility Accidents—Nearby Facilities

Section 19.58.2.3 of the AP1000 DCD, “Transportation and Nearby Facility Accidents,” indicates that this section discusses events that “consist of accidents related to transportation near the nuclear power plant and accidents at industrial and military facilities in the vicinity.” RAI 19-8 was issued requesting additional information about the toxic and explosive hazards associated with nearby facilities.

In response to RAI 19-8, the applicant referenced Section 2.2.3.2.2 of the VEGP ESP SSAR, the military and industrial facilities within five miles of the plant are identified, the inventories of hazardous materials associated with each one are documented, and the potential consequences of release are evaluated. The applicant found the potential consequences to have negligible effects on safety. The applicant also proposed to document the basis for screening these sources from further evaluation.

This event was evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.2.3 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAI 19-1 and RAI 19-9, and found them to follow essentially identical logic. Therefore, the conclusions reached in NUREG-1923 related to nearby facility accidents are directly applicable to the VEGP COL application.

External Fires

The DCD calls for the applicant to “reevaluate the qualitative screening of external fires” and perform a risk assessment if it cannot be demonstrated that the frequency of hazard is less than 1E-07 per year. The NRC issued RAI 19-6 to request documentation of this re-evaluation or assessment in the VEGP COL FSAR.

External fires are discussed in VEGP ESP SSAR Section 2.2.3.3 and VEGP COL FSAR Chapter 2. On the basis of the distance separating the plant from potential external fires, the

applicant concluded that safe operation of the plant is not jeopardized by external fires. In response to RAI 19-6, the applicant proposed to document the basis for screening these sources from further evaluation, and subsequently revised the VEGP COL FSAR to do so.

This event was evaluated in the VEGP ESP SSAR and, subsequently, found acceptable by the staff in Section 2.2.3 of NUREG-1923. The NRC staff compared the analyses presented in both the VEGP ESP SSAR and the information presented in response to RAI 19-1 and RAI 19-6, and found them to follow essentially identical logic. Section 2.2.3.3 of the VEGP COL FSAR includes information that supplements the discussion of external fires in VEGP ESP SSAR Section 2.2.3.3. The NRC staff has reviewed this information and concludes that it clarifies information presented in the VEGP ESP SSAR. Furthermore, the staff finds that the conclusions reached in Section 2.2.3 of NUREG-1923 remain valid. Therefore, the conclusions reached in NUREG-1923 related to external fires are directly applicable to the VEGP COL application.

Summary

Based on this additional information, the staff confirmed that the AP1000 DCD external events analysis envelops the reported parameters of the VEGP site. The staff concludes that the incorporation of AP1000 DCD Section 19.58 by reference with plant-specific supplemental information is acceptable, resolving RAIs 19-1 and 19-3 through 19-9.

19.58.5 Post Combined License Activities

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

19.58.6 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 winds, floods, and other external events, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

The staff concludes that the relevant information presented in VEGP SUP 19.58-1 is consistent with the requirements of 10 CFR 52.79(a)(46) and 10 CFR 52.79(d)(1) and is, therefore, acceptable.

19.59 PRA Results and Insights

19.59.1 Introduction

This section describes the use of the PRA in the design process. It also provides an overall summary of PRA results, including those from the following analyses:

- full power, internal events PRA (both Level 1 and Level 2, providing information on CDF and LRF)

- shutdown and low power events PRA (both Level 1 and Level 2 PRA, with information on CDF and LRF)
- internal flooding assessment (both Level 1 and Level 2 PRA, with information on CDF and LRF for both full power and shutdown/low power conditions)
- internal fire assessment (both Level 1 and Level 2 PRA, with information on CDF and LRF for both full power and shutdown/low power conditions)
- seismic margin analysis

In addition, this section discusses key insights from the PRA. It describes those plant features that are important to risk. It also provides information on where the PRA was used to support the certification of the AP1000 design, such as the assessment of design alternatives and scoping of the reliability assurance program.

19.59.2 Summary of Application

Section 19.59 of the VEGP COL FSAR, Revision 2, incorporates by reference Section 19.59 of the AP1000 DCD, Revision 17.

In addition, in VEGP COL FSAR Section 19.59.10.5, the applicant provided the following:

AP1000 COL Information Items

- STD COL 19.59.10-1

The applicant provided additional information in STD COL 19.59.10-1 to address COL Information Item 19.59.10-1. This item will evaluate any differences between the as-built plant and the certified design to confirm that seismic margins remain adequate. In a letter dated September 20, 2010, the applicant proposed to revise item 1 of COL Information Item to reflect a revision to the DCD proposed by Westinghouse in a letter dated August 23, 2010.

- STD COL 19.59.10-2

The applicant provided additional information in STD COL 19.59.10-2 to address a portion of COL Information Item 19.59.10-2. The portion of this item dealing with evaluation of the as-built plant for conformance to the design modeled in the AP1000 PRA was originally identified in Revision 15 of the AP1000 DCD as a COL applicant's responsibility. It was subsequently identified as a licensee's responsibility.

The portion of COL Information Item 19.59.10-2 dealing with the site-specific PRA for external events remains the responsibility of the COL applicant and is discussed in Section 19.58 of this SER as part of the review of VEGP SUP 19.58-1.

- STD COL 19.59.10-3

The applicant provided additional information in STD COL 19.59.10-3 to address COL Information Item 19.59.10-3. This item will evaluate any differences between the as-built plant and the certified design to confirm that there are no significant adverse changes to the internal fire and internal flood analysis results.

- STD COL 19.59.10-4

The applicant provided additional information in STD COL 19.59.10-4 to address COL Information Item 19.59.10-4. The COL applicant states that severe accident management guidance (SAMG) is implemented on a site-specific basis.

- STD COL 19.59.10-5

The applicant provided additional information in STD COL 19.59.10-5 to address COL Information Item 19.59.10-5. This item, thermal lag assessment of the as-built equipment required to mitigate severe accidents, must be completed prior to initial fuel loading (for equipment that has not been tested at severe accident conditions).

- STD COL 19.59.10-6 and VEGP COL 19.59.10-6

In a letter dated September 20, 2010, the applicant proposed to add COL Information Items (STD COL 19.59.10-6 and VEGP COL 19.59.10-6) to reflect a revision proposed by Westinghouse in a letter dated August 23, 2010, regarding confirmation that the seismic margin analysis documented in the AP1000 DCD section is applicable to the VEGP site. These COL information items are evaluated in SER Section 19.55.4.

Section 19.59 of the VEGP COL FSAR adds Section 19.59.10.6 to include the following:

Supplemental Information

- STD SUP 19.59-1

The applicant provided the following supplemental (SUP) information, discussing the processes for:

- maintaining the PRA to reflect the as-built, as-operated plant
- upgrading the PRA to incorporate improved methodologies and other information, as well as ensuring that it continues to meet the required NRC-endorsed consensus standards
- maintaining proper quality controls on the PRA, including computer codes used to support PRA quantification
- maintaining the PRA documentation current
- using the PRA in applications, including those that support decision making

In addition, the applicant describes where the VEGP PRA is expected to provide input to other programs and processes.

License Conditions

- Part 10, License Condition 2

The proposed license condition identifies required actions that cannot be accomplished until a license is granted and provides milestones for their completion.

- Part 10, License Condition 6

The proposed license condition requires submittal of a schedule to support NRC inspections of operational programs, including those related to implementation of SAMG.

19.59.3 Regulatory Basis

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

In addition, the following regulations apply to Sections 19.59.10.5 and 19.59.10.6 of the VEGP COL FSAR:

- 10 CFR 50.71(h)(1), “No later than the scheduled date for initial loading of fuel, each holder of a combined license under subpart C of 10 CFR Part 52 shall develop a level 1 and a level 2 probabilistic risk assessment (PRA). The PRA must cover those initiating events and modes for which NRC-endorsed consensus standards on PRA exist one year prior to the scheduled date for initial loading of fuel.”
- 10 CFR 50.71(h)(2), “Each holder of a combined license shall maintain and upgrade the PRA required by paragraph (h)(1) of this section. The upgraded PRA must cover initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect one year prior to each required upgrade. The PRA must be upgraded every four years until the permanent cessation of operations under 10 CFR 52.110(a) of this chapter.”
- 10 CFR 52.79(a)(46), “The final safety analysis report shall include...at a level of information sufficient to enable the Commission to reach a final conclusion on all safety matters that must be resolved...before issuance of a combined license:...[a] description of the plant-specific probabilistic risk assessment (PRA) and its results.”
- 10 CFR 52.79(a)(38), “The final safety analysis report shall include...at a level of information sufficient to enable the Commission to reach a final conclusion on all safety matters that must be resolved...before issuance of a combined license :...a description and analysis of design features for the prevention and mitigation of severe accidents....“
- 10 CFR 52.79(d)(1), “If the combined license application references a standard design certification, then the...final safety analysis report need not contain information or

analyses submitted to the Commission in connection with the design certification, *provided, however*, that the final safety analysis report must either include or incorporate by reference the standard design certification final safety analysis report and must contain, in addition to the information and analyses otherwise required, information sufficient to demonstrate that the site characteristics fall within the site parameters specified in the design certification. In addition, the plant-specific PRA information must use the PRA information for the design certification and must be updated to account for site-specific design information and any design changes or departures.”

NUREG-0800 provides the following guidance:

- Section 19.0, Section III.1.C provides guidance for reviewing a COL application referencing a DC, with emphasis on documented assumptions and insights from the PRA.
- Section 19.0, Section III.3 provides guidance for reviewing COL action items.
- Section 19.1 provides information regarding the review of the technical adequacy of a design-specific, site-specific PRA.

Additional guidance is found in the following documents:

- RG 1.200, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities,” Revision 1, provides guidance on determining whether a PRA provides an adequate basis for issuing a COL.
- DC/COL-ISG-3 clarifies the staff’s expectations for information to be included in the COL application.
- DC/COL-ISG-20 provides guidance on plant-specific updates of the DC PRA-based seismic margin evaluation for COL applications.
- SECY-05-0197 “Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria,” establishes expectations for reporting scheduled implementation of operational programs.

19.59.4 Technical Evaluation

The NRC staff reviewed Section 19.59 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.¹ The NRC staff’s review confirmed that the information in the application and incorporated by reference addresses the required information relating to the PRA results and insights. The results of the NRC staff’s evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in

evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the Bellefonte Nuclear Plant (BLN) Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1 to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.
- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.
- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. There were two confirmatory items (Confirmatory Items 19.59-1 and 19.59-2) related to the standard content in the BLN SER. Their resolution is addressed in this SER.

The following portion of this technical evaluation section is reproduced from Section 19.59.4 of the BLN SER:

AP1000 COL Information Items

- *STD COL 19.59.10-1*

The NRC staff reviewed STD COL 19.59.10-1, which is related to the seismic margin evaluation found in Section 19.55 of the AP1000 DCD, incorporated by reference into the BLN COL FSAR. RAI 19-1 requested justification of an apparent difference between STD COL 19.59.10-1 and the corresponding information item in the DCD. The applicant revised BLN COL FSAR Section 19.59.10.5 as follows:

The requirements to which the equipment is to be purchased are included in the equipment specifications. Specifically, the equipment specifications include:

1. *Specific minimum seismic requirements [are] consistent with those used to define the Table 19.55-1 [high confidence, low probability of failure] HCLPF values. This includes the known frequency range used to define the HCLPF by comparing the required response spectrum (RRS) and test response spectrum (TRS). The range of frequency response that is required for the equipment with its structural support is defined.*

2. *Hardware enhancements that were determined in previous test programs and/or analysis programs will be implemented.*

This is consistent with the AP1000 DCD, and is therefore acceptable to the staff. As a result, the staff considers RAI 19-1 to be closed.

STD COL 19.59.10-1 states that this should be completed prior to initial fuel load, rather than at the time of the COL application. The required comparison cannot be performed until completion of fabrication, installation, and construction of SSCs, and the as-built review of the seismic margin evaluation.

The NRC staff concluded in Section 19.1.5.1 of NUREG-1793 that the methodology for calculating the HCLPF values complied with the relevant regulatory requirements, based on the certified seismic design response spectra (CSDRS). The staff concludes that it is acceptable to complete the final verification of seismic margins when the walkdowns are performed after the plant is built.

- STD COL 19.59.10-2

As noted in SER Section 19.59.2 above, this COL information item has two parts. The first part requires the COL holder to compare the as-built plant to the design used as the basis for the AP1000 PRA and DCD Table 19.59-18 (which was incorporated by reference into Chapter 19 of the applicant's FSAR). The COL holder must update the site-specific PRA to reflect differences if they potentially result in a significant increase in CDF or LRF.

Revisions to 10 CFR Part 52 and related rules were issued after the initial AP1000 DC, but prior to the submittal of the VEGP COL application. Two of them, 10 CFR 52.79(d)(1) and 10 CFR 50.71(h), require that a COL application provide a description of a site-specific PRA, and that this PRA will, by fuel load, meet those industry consensus PRA standards endorsed by the NRC no earlier than one year prior to the scheduled fuel load date. Additional guidance was provided in DC/COL-ISG-3, which states, "PRA maintenance should commence at the time of application for both DC and COL applicants. This means that the PRA should be updated to reflect plant modifications if there are changes to the design." DC/COL-ISG-3 also clarifies the staff position on what constitutes a significant change in PRA results.

The staff requested clarification in RAI 19-2 of how the VEGP PRA will be updated to account for VEGP site-specific information by fuel load. It also requested a definition of a "significant increase."

In response to RAI 19-2, the applicant indicated that the PRA would be updated as described in VEGP COL FSAR Section 19.59.10.6. PRA updating will include evaluation of as-built plant differences, departures from the certified design, and a plant-specific review of all the PRA insights and assumptions as documented in AP1000 DCD Table 19.59-18. The applicant revised VEGP COL FSAR Section 19.59.10.6 to clarify that any differences found would be evaluated and that the plant-specific PRA model would be modified as necessary to reflect both the plant-specific design and PRA-based insights.

The staff agrees that the applicant's response meets the expectations of 10 CFR 52.79(d)(1) regarding the requirement for a site-specific PRA, as well as the additional guidance described in DC/COL-ISG-3. STD COL 19.59.10-2 now states that this should be completed prior to initial fuel load, rather than at the time of the COL application. The required updates cannot be finalized until completion of fabrication, installation, and construction.

The NRC staff concluded in Section 19.1.9 of NUREG-1793 that the quality and completeness of the AP1000 PRA are adequate and satisfy the regulatory requirements. The methodology for upgrading and updating the plant-specific PRA described in the VEGP COL FSAR satisfies the guidance of RG 1.200 and is, therefore, acceptable to the staff. The staff concludes that it is acceptable to update the plant-specific PRA when walkdowns are performed after the plant is built. This is consistent with the 10 CFR 50.71(h) requirement that the plant-specific PRA reflect the risk profile of the as-built, as-operated plant.

The second portion of this COL information item involves a review of site-specific external events to confirm that they are bounded by the external events addressed in the generic risk assessment for the AP1000 design. The staff's evaluation of this review is documented in Section 19.58 of this SER.

The following portion of this technical evaluation section is reproduced from Section 19.59.4 of the BLN SER:

- *STD COL 19.59.10-3*

In response to RAI 19-20, the applicant proposed a change to its response to STD COL 19.59.10-3 to the effect that plant-specific internal fire and internal flood analysis will be evaluated and the analysis modified as necessary to account for the plant-specific design, and any design changes or departures from the certified design.

The staff reviewed STD COL 19.59.10-3, which is related to the internal fire and internal flood analyses evaluation included under Sections 19.56 and 19.57 of the AP1000 DCD, incorporated by reference in the BLN COL FSAR.

The NRC staff discussed, in Sections 19.1.5.2 and 19.1.5.3 of NUREG-1793, the methodology for assessing the risk from internal fire and floods, respectively. In Section 19.1.9, the staff concluded that the quality and completeness of the AP1000 PRA are adequate and satisfy the applicable regulatory requirements. Because the as-built configuration cannot be assessed until construction is complete, the staff finds that it is acceptable to update internal fire and flood analyses if the need to do so is identified when walkdowns are performed after the plant is built.

In a letter dated April 15, 2009 (ML091100173), the applicant proposed to revise its response to STD COL 19.59.10-1 through 19.59.10-3 and to revise License Condition 2 to conform to the revised wording of these three STD COL items. The staff identifies incorporation of these changes as Confirmatory Item 19.59-1.

Resolution of Standard Content Confirmatory Item 19.59-1

Confirmatory Item 19.59-1 required the applicant to revise the proposed License Condition 2 (in Part 10 of the application) to reflect the revised wording of STD COL 19.59.10-1 through 19.59.10-3. The NRC staff verified that the proposed License Condition 2 in Part 10 of the application was updated to reflect the above. As a result, Confirmatory Item 19.59-1 is resolved.

The following portion of this technical evaluation section is reproduced from Section 19.59.4 of the BLN SER:

- *STD COL 19.59.10-4*

The AP1000 DCD closed this COL information item with respect to the development of the SAMG. The COL holder will implement the AP1000 SAMG.

For STD COL 19.59.10-4 in Section 19.59.10 of the BLN COL FSAR, the applicant states, "The AP1000 Severe Accident Management Guidance (SAMG) from APP-GW-GLR-070, Reference 1 of DCD Section 19.59, is implemented on a site-specific basis." In Table 1.8-202 of the BLN COL FSAR, the applicant identifies this as a COL holder item. In response to RAI 19-3, the applicant revised its response to STD COL 19.59.10-4 in the BLN COL FSAR. The staff found this response incomplete and issued RAI 19-21.

In a letter dated April 15, 2009 (ML091100173), in response to RAI 19-21, the applicant proposed to revise License Conditions 2 and 6 to conform to the revised FSAR wording. Specifically, the applicant proposed to revise License Condition 2, Item 19.59.10-4 to reflect the fact that the SAMG development had been completed in the AP1000 DCD. In addition, the applicant proposed to revise License Condition 6 (Operational Program Readiness in Part 10 of the BLN COL application) to include a schedule for the implementation of site-specific SAMG, thereby supporting NRC inspections of operational programs in the period between issuance of a COL and authorization to load fuel in accordance with 10 CFR 52.103. This is consistent with the staff position documented in SECY-05-0197, and therefore, acceptable to the staff. The staff identifies the incorporation of these changes as Confirmatory Item 19.59-2.

Resolution of Standard Content Confirmatory Item 19.59-2

Confirmatory Item 19.59-2 required the applicant to revise the proposed License Condition 2 (in Part 10 of the application), item 19.59.10-4, to reflect that the SAMG development was completed in the AP1000 DCD. In addition, the confirmatory item required that the applicant to revise the proposed license condition 6 to included a schedule for the implementation of site-specific SAMG. The NRC staff verified that the proposed License Conditions 2 and 6 in Part 10 of the application were updated to reflect the above. As a result, Confirmatory Item 19.59-2 is resolved.

The following portion of this technical evaluation section is reproduced from Section 19.59.4 of the BLN SER:

- *STD COL 19.59.10-5*

The AP1000 DCD, Revision 17, changed the wording of COL Information Item 19.59.10-5 to clarify which equipment requires thermal lag assessment. STD COL 19.59.10-5 in Chapter 19 of the BLN COL FSAR, as well as the COL holder item listed in License Condition 2 (Part 10 of the BLN COL application) have been revised to conform with the AP1000 DCD.

The NRC staff concluded, in Section 19.2.3.3.7.3 of NUREG-1793, that the equipment and instrumentation identified as required to mitigate severe accidents meets the guidance of SECY-93-087 and 10 CFR 50.34(f). In addition, the staff required that the COL applicant referencing the AP1000 certified design perform a thermal response assessment of as-built equipment used to mitigate severe accidents. Since the as-built equipment and configuration are not available until after the COL is issued, the staff concludes that it is acceptable to complete thermal lag assessments prior to fuel load.

COL Action Items from Chapter 19 of NUREG-1793

The staff compared COL information items in Chapter 19 of the AP1000 DCD with the COL action items from NUREG-1793. The staff identified differences between them, which resulted in two RAIs:

RAI 19-6

Two items from NUREG-1793 relate to the training of operators to respond to certain conditions during shutdown. The first calls for the COL applicant to train operators to quickly close containment hatches and penetrations in the event of an accident during Modes 5 or 6. This must be completed before boiling begins in the reactor coolant system (RCS).

The BLN COL FSAR cited APP-GW-GLR-040, "Plant Operations, Surveillance, and Maintenance Procedures." This is the template document for AP1000 procedure generation. The applicant also noted that BLN COL FSAR Section 13.2 incorporates by reference NEI 06-13, "Template for an Industry Training Program Description." Sections 1.1.1.1, 1.1.1.2, 1.1.2, and 1.2.1 of this document focus on training for operations during shutdown, including abnormal and emergency operations. Technical Specification 3.6.8 provides direction for maintaining containment closure capability prior to steaming during Modes 5 and 6, and it is expected that operators will be well versed in technical specification requirements.

The staff finds that this is an acceptable way to ensure that operators will be prepared to close containment hatches in the event of an accident during Mode 5 or 6.

The second calls for operator training in the use of the wide range pressurizer level indication to cross-check the safety-related narrow range hot-leg level

instruments. This is to avoid inadvertent over-draining of the RCS, particularly during reduced inventory operation. The staff reviewed Table 19.59-18, "AP1000 PRA-Based Risk Insights." Item 62 of the table explicitly states, "It is important to maximize the availability of the non-safety-related wide range pressurizer level indication during RCS draining operations during cold shutdown. Procedures and training must be developed to encompass this item." BLN COL 19.59.10-2 includes verification of every item in this table by the COL holder, prior to fuel load. This is accomplished by comparing each item to the as-built (and as operated) plant.

The staff finds this to be an acceptable way to confirm that operators are adequately trained on the use of wide range pressurizer level indication as a cross-check on the safety-related narrow range hot-leg level instruments. Therefore, RAI 19-6 is closed.

RAI 19-7

The staff sought more specific information about compensatory measures used to maintain adequate internal fire and flooding detection and suppression capability during maintenance activities that may impair these features.

The applicant responded by indicating that compensatory measures for fire protection are addressed in BLN COL FSAR Section 9.5.1.8.1.2, which describes use of a permit system that controls and documents inoperability of fire protection systems and equipment, and establishes requirements to initiate proper notifications and compensatory actions, such as fire watches, when the inoperability of any fire protection system or component, such as detectors or suppression devices, is identified. The staff reviewed the cited section of the BLN COL FSAR, and found that it adequately addresses situations when maintenance activities potentially impair fire detection and suppression equipment.

The applicant also responded that flooding detection and suppression equipment, such as sump level indicators, are identified as specific design features in BLN COL FSAR Sections 3.4 and 9.3.5. The most important ones, containment sump level indicators, are controlled by technical specification limiting conditions for operations (LCOs) with required actions and completion times. In addition, flood control in other places is managed by a floor drain system, which provides level detection, as well as manual or automatic pump down of the sumps, which collect water entering the floor drains. Administrative procedures described in BLN COL FSAR Section 13.5.1 control maintenance activities and provide for equipment control and, if needed, compensatory action when maintenance activities impair flooding control equipment.

The staff reviewed the references provided by the applicant and finds the applicant's responses provide adequate compensatory action; therefore, RAI 19-7 is closed.

Supplemental Information

- STD SUP 19.59-1

The applicant provided supplemental information in BLN COL FSAR Section 19.59.10.6, "PRA Configuration Controls." The applicant discusses how the BLN plant-specific PRA is developed and maintained to reflect the as-built and as-operated plant, as well as how it will be used to support other programs.

The applicant committed to upgrade the Level 1 and Level 2 PRA prior to fuel load to cover those initiating events and modes of operation set forth in NRC-endorsed consensus standards on PRA that are in effect one year prior to the scheduled date of the initial fuel load. In addition, upgrades are completed at least once every four years. This is consistent with 10 CFR 50.71(h) and, therefore, acceptable to the staff.

In addition, the applicant committed to monitor various information sources for changes or new information that could affect the model assumptions or quantification. Plant-specific design, procedure, and operational changes are reviewed for risk impact. A screening process determines whether a PRA update should be performed more frequently, and includes consideration of whether the changes affect the PRA insights. If the changes warrant a PRA update, the update is made as soon as practicable consistent with the importance of the change and the applications being used. Otherwise, changes are tracked and incorporated in the next regularly scheduled update. This is consistent with RG 1.200, Revision 1, and therefore acceptable to the staff.

PRA quality assurance (QA) provisions ensure that personnel involved in PRA are qualified, work is reviewed independently, documentation is adequately controlled, and upgrades to the PRA are peer-reviewed. When assumptions, analyses, or information used previously are changed or determined to be in error, potential impacts to the PRA model are tracked. If errors are found in the PRA model, they are tracked and appropriate corrective action governed by procedures is taken. This is consistent with RG 1.200 and, therefore, acceptable to the staff.

The PRA provides input to various programs and processes, such as implementation of the maintenance rule, reactor oversight process, the reliability assurance program, the program for regulatory treatment of non-safety systems, and the motor-operated valve (MOV) program. The staff agrees that a plant-specific, site-specific PRA, based on the generic PRA for the AP1000 and maintained as described in the BLN COL FSAR, is an appropriate model to provide input to each of these risk-informed activities.

19.59.5 Post Combined License Activities

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

- License Condition (19-1) – The licensee will review differences between the as-built plant and the design used as the basis for the AP1000 SMA prior to initial fuel load. The licensee will perform a verification walkdown to identify differences between the as-built plant and the design. The licensee will evaluate any differences and will modify the seismic margin analysis as necessary to account for the plant-specific design and any design changes or departures from the certified design. The licensee will compare the as-built SSC HCLPFs to those assumed in the AP1000 seismic margin evaluation prior to initial fuel load. The licensee will evaluate deviations from the HCLPF values or assumptions in the seismic margin evaluation due to the as-built configuration and final analysis to determine if vulnerabilities have been introduced.
- License Condition (19-2) – The licensee will review differences between the as-built plant and the design used as the basis for the AP1000 PRA and Table 19.59-18 prior to initial fuel load. The plant-specific PRA-based insight differences will be evaluated and the plant-specific PRA model modified as necessary to account for the plant-specific design and any design changes or departure from the certification PRA.
- License Condition (19-3) – The licensee will review differences between the as-built plant and the design used as the basis for the AP1000 internal fire and internal flood analysis prior to initial fuel load. The licensee will evaluate the plant-specific internal fire and internal flood analyses and will modify the analyses as necessary to account for the plant-specific design and any design changes or departures from the certified design.
- License Condition (19-4) – The licensee shall submit to the appropriate Director of the NRC, a schedule, no later than 12 months after issuance of the COL, that supports planning for and conduct of NRC inspections of the implementation of site-specific severe accident management guidelines. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the site specific severe accident management guidelines have been fully implemented.
- License Condition (19-5) – The licensee will perform, prior to initial fuel load, a thermal lag assessment of the as-built equipment listed in Tables 6b and 6c in Attachment A of APP-GW-GLR-069, “Equipment Survivability Assessment,” to provide additional assurance that this equipment can perform its severe accident functions during environmental conditions resulting from hydrogen burns associated with severe accidents. This assessment is required only for equipment used for severe accident mitigation that has not been tested at severe accident conditions. The licensee will assess the ability of the as-built equipment to perform during accident hydrogen burns using the environment enveloping method or the test based thermal analysis method described in EPRI NP-4354.

19.59.6 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 PRA results and insights, and there is no outstanding information expected to be addressed in the VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

The staff concludes that the relevant information presented in Section 19.59 of the VEGP COL FSAR is consistent with the requirements of 10 CFR 52.79(a)(46) and 10 CFR 52.79(d)(1) and is, therefore, acceptable.