

## **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) 52.79, “Contents of applications; technical information in final safety analysis report,” Subpart C, 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, “Public inspections, exemptions, requests for withholding.”

### **19.1–19.40, 19.42–19.54, 19.56–19.57, and Appendices 19A, 19B, 19C, and 19D, Probabilistic Risk Assessment**

The William States Lee III Nuclear Station (WLS) combined license (COL) Final Safety Analysis Report (FSAR), Revision 11, incorporates by reference, with no departures or supplements, Sections 19.1 through 19.40, 19.42 through 19.54, 19.56, 19.57, and Appendices 19A, 19B, 19C, and 19D of the AP1000 Design Control Document (DCD) Revision 19:

- 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"
  
- 19.42, "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"

The staff of the Nuclear Regulatory Commission (NRC) reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.<sup>1</sup> 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 WLS COL application are documented in NUREG-1793, "Final Safety Evaluation Report [FSER] Related to Certification of the AP1000 Standard Design," 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.

#### **19.41 Hydrogen Mixing and Combustion Analysis**

In the course of a severe accident, the oxidation of the zirconium and other metals can generate a substantial amount of combustible gas in the reactor vessel. This gas will migrate to the containment. Section 19.41 presents the design features of the AP1000 containment that control the concentration of combustible gases, including hydrogen igniters. Section 19.41 of the WLS COL FSAR, Revision 11, incorporates by reference Section 19.41, "Hydrogen Mixing and Combustion Analysis," of the AP1000 DCD, Revision 19. Section 19.41 of the DCD provides a hydrogen analysis that quantifies the threat to containment integrity with and without hydrogen igniters.

By reference, Section 19.41 of the WLS COL FSAR incorporates Section 19.41 of the AP1000 DCD, "Hydrogen Mixing and Combustion Analysis." It includes an analysis that quantifies the threat of combustible gas to containment integrity, both with and without igniters (which are not safety-related).

In addition, in the WLS COL FSAR, the applicant provided the following:

##### **Departures**

- WLS DEP 6.2-1

The applicant provided additional information in Section 19.41 of the WLS COL FSAR about WLS DEP 6.2-1 related to changes to the acceptance criteria applied to a specific Inspection, Test, Analysis, and Acceptance Criteria (ITAAC) design commitment and associated inspection, test, or analysis in Tier 1 Table 2.3.9-3, Item 3 (for control of containment hydrogen concentration for beyond-design-basis accidents) to establish consistency with the current

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<sup>1</sup> 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).

detailed design of the plant. This information, as well as related WLS DEP 6.2-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.4 of this safety evaluation report (SER).

The NRC staff reviewed Section 19.41 of the WLS COL FSAR and confirmed that the combination of the DCD and the COL application is sufficient. The staff's review confirmed that with this departure, the evaluation criteria are still satisfied. The results of the NRC staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

## **19.55 Seismic Margin Analysis**

### **19.55.1 Introduction**

The NRC staff reviewed Section 19.55 of the WLS COL FSAR, which incorporated Section 19.55 of the DCD with no departures or supplements.

The seismic analysis and design of the AP1000 plant is based on the certified seismic design response spectra (CSDRS) shown in AP1000 DCD Tier 1, Figures 1.0-1 and 1.0-2. These spectra are based on Regulatory Guide (RG) 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 1, 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. Additional analyses were performed for five different site profiles, including a hard-rock, high-frequency (HRHF) site with spectra corresponding to those shown in AP1000 DCD Tier 1, Figures 1.0-3 and 1.0-4.

### **19.55.2 Summary of Application**

Section 19.55 of the WLS COL FSAR, Revision 11, incorporates by reference Section 19.55 of the AP1000 DCD, Revision 19.

#### Departures

- WLS DEP 2.0-1

The applicant provided additional information in Section 19.55.6.3 of the WLS COL FSAR about WLS DEP 2.0-1 related to updated seismic hazards and updated site-specific foundation response spectra for WLS that exceed the AP1000 Certified Seismic Design Response Spectra (CSDRS). The staff's evaluation of WLS DEP 2.0-1 and supporting site-specific analysis is included in Section 3.7.2.4 of this report.

#### AP1000 COL Information Item

- WLS COL 19.59.10-6

In WLS COL FSAR, the applicant added WLS COL 19.59.10-6 and a new Section 19.55.6.3, "Site-Specific Seismic Margin Analysis." This plant-specific COL item is in response to a new

COL Information Item 19.59.10-6 proposed for the AP1000 DCD in a letter from Westinghouse dated August 23, 2010, regarding confirmation that the seismic margin analysis (SMA) documented in the AP1000 DCD section is applicable to the WLS site. Specifically, WLS COL FSAR Section 19.55 describes features of the site and provides the applicant's basis for concluding that the seismic margin for WLS is bounded by the SMA for the certified design.

### **19.55.3 Regulatory Basis**

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

In addition, the applicable regulatory requirements for the evaluation of plant-specific information evaluated in Section 19.55 of this safety evaluation report (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 (ISG) in the form of DC/COL-ISG-1, "Interim Staff Guidance on Seismic Issues of High Frequency Ground Motion in Design Certification and Combined License Applications," provides clarifying guidance on implementation of the performance-based approach for determining site-specific ground motion. It also provides guidance on implementation of evaluation methodology to determine the effects of high-frequency ground motion.

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 risk evaluations to address any site-

specific hazards for which a bounding analysis was not performed or that are not enveloped by the generic analyses. This is to ensure that vulnerabilities related to siting are addressed.

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 WLS 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.<sup>1</sup> The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to SMA. The results of the NRC staff's evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the WLS COL FSAR:

##### AP1000 COL Information Item

- WLS COL 19.59.10-6

The staff's review of the AP1000 PRA-based SMA is described in Section 19.1.5.1 of NUREG-1793 and its supplements. The AP1000 SMA estimated the seismic capacity of the AP1000 plant at which there is high confidence in low probability of failure (HCLPF value). Equipment needed to safely shut down the plant is evaluated against acceleration spectra characterized by the associated 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 in the AP1000 DCD for the SMA and used to demonstrate a margin over the SSE of 0.3 g.

The NRC staff reviewed the proposed additions to Section 19.55 of the WLS COL FSAR. Because the ground motion response spectrum (GMRS) for the WLS site (presented in WLS COL FSAR Figures 2.0-201 and 2.0-202) is bounded by the HRHF spectrum evaluated in the

AP1000 DCD, the staff finds that using the SMA provided in the DCD is conservative and acceptable.

#### **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 confirmed that the applicant addressed the required information relating to site-specific features that may affect seismic margins in the WLS COL FSAR. The information provides sufficient basis to conclude that the incorporation of the SMA documented in the AP1000 DCD is acceptable. The results of the NRC staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the WLS COL FSAR is acceptable and meets the requirements of 10 CFR 52.79(a)(46) and 10 CFR 52.79(d)(1). The staff based its conclusion on the following:

- WLS DEP 2.0-1, related to updated seismic hazards and updated site-specific foundation response spectra for WLS that exceed the AP1000 CSDRS, is reviewed and found acceptable by the staff in Section 3.7.2.4 of this SER.
- WLS COL 19.59.10-6, as it relates to SMA, is acceptable based on the guidance in DC/COL-ISG-3 and -20.

### **19.58 Winds, Floods, and Other External Events**

#### **19.58.1 Introduction**

Section 19.58 of the WLS 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 WLS 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 WLS COL FSAR, Revision 11, incorporates by reference Section 19.58 of the AP1000 DCD, Revision 19.

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

Supplemental Information

- WLS 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 AP1000 DCD Section 19.58.3. WLS COL FSAR Table 19.58-201, "External Event Frequencies for WLS," documents the site-specific external events evaluation that has been performed for WLS. 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 WLS Units 1 and 2 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 NUREG-1793 and its supplements.

In addition, the applicable regulatory requirements for the evaluation of WLS 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 generic analyses to ensure that the site is bounded. If so, 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 the prior analysis does not bound to ensure that no vulnerabilities due to siting exist.

#### **19.58.4 Technical Evaluation**

The NRC staff reviewed Section 19.58 of the WLS 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.<sup>1</sup> 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 WLS COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the WLS COL FSAR:

##### Supplemental Information

- WLS SUP 19.58-1

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

In support of the AP1000 DC amendment, 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 Section 19.59 of the WLS COL FSAR the applicant provided STD COL 19.59.10-2, which included the following paragraph:

As discussed in Subsection 19.58.3, it has been confirmed that the Winds, Floods, and Other External Events analysis documented in DCD Section 19.58 is applicable to the site. The site-specific design has been evaluated and is consistent with the AP1000 PRA assumptions. Therefore, Subsection 19.58 of the AP1000 DCD is applicable to this design.

#### Staff Request for Additional Information

Although site-specific information at currently proposed AP1000 sites was considered in performing the generic analyses of AP1000 DCD Section 19.58, details were not made available to the staff in the initial application. The staff issued a request for additional information (RAI) for the applicant to provide sufficient information for the staff to conclude that the WLS site was bounded by the generic analysis (RAI 19-1).

In a letter dated October 17, 2008, the applicant responded to RAI 19-1 by describing the methodology used to develop the generic external event analysis and providing a table of external event frequencies for WLS. This table documents the site-specific external events evaluation that has been performed for WLS. It provides a general explanation of the evaluation and resultant conclusions.

Potential external events and hazards were first screened for applicability to the WLS 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 AP1000 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 WLS 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 AP1000 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 AP1000 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  $1 \times 10^{-7}$ /year). Events that may occur more frequently but less than once in a million years (frequency less than  $1 \times 10^{-6}$ /year) are assessed to determine that their consequences make a negligible contribution to core damage

frequency (change CDF less than  $1 \times 10^{-8}$ /year). Other events, if any, must be explicitly evaluated and included in the plant-specific PRA.

A number of questions remained, and 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 WLS site (RAIs 19-3 through 19-11, 19-13 and 19-15):

- RAI 19-3 requested: (a) the basis for screening; (b) assessment of risk from events that cannot be screened (to be reported in the FSAR); and (c) the basis for the numerical values generated.
- RAI 19-4 requested clarification of the frequency of extratropical cyclones.
- RAI 19-5 requested tornadoes reported in the FSAR be reclassified using the enhanced Fujita (EF) scale to allow direct comparison between the FSAR and the referenced DCD.
- RAI 19-6 requested additional discussion of the basis for the WLS assessment of external flooding.
- RAI 19-7 requested additional discussion of the analysis for commercial aircraft.
- RAI 19-8 requested the basis for screening of external fires.
- RAI 19-9 requested additional discussion of risk related to onsite chemical storage.
- RAI 19-10 requested discussion of risk related to nearby facilities.
- RAI 19-11 requested discussion of risk related to the release of toxic materials.
- RAI 19-13 requested the basis for determining that the loss of offsite power frequencies and recovery probabilities assumed in the AP1000 PRA bound the expected site-specific values for WLS.
- RAI 19-15 requested site-specific actions that must be performed to meet the requirements for regulatory treatment of nonsafety system (RTNSS) that may be needed more than 72 hours after a high wind or external flood event.

In a letter dated August 17, 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 provide it in a plant-specific supplement to the WLS COL FSAR as Table 19.58-201, "External Event Frequencies for WLS." It documents the basis for the applicant's assessment of risks related to winds, floods, and other external events.

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

### High Winds

The applicant was 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 or to show that the category does not contribute to risk.

### Winds that would threaten safety-related SSCs

Because WLS safety-related structures, systems, and components (SSCs) are designed to withstand winds of 300 miles per hour (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 less than  $1 \times 10^{-7}$  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  $1 \times 10^{-7}$  to be 230 mph. The expected frequency of 300 mph tornadoes is significantly lower. Therefore, the staff considers such events at the WLS site to be screened from further analysis on the basis of negligible frequency.

### High Winds—Tornadoes

The applicant was 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.

In response to RAI 19-2, the applicant stated that it found this external event category to be applicable to the WLS site. The applicant provided data on observed tornadoes striking Cherokee County, in which the site is located, and seven other nearby counties. The applicant used this data to estimate the frequency of each class of tornado (on the enhanced Fujita scale) using a methodology that is described in Table 19.58-201 of the WLS COL FSAR. For each class of tornado, the frequency is less than the values assumed in Section 19.58 of the AP1000 DCD.

The staff finds that the method used to calculate tornado frequencies was conservative and, therefore, acceptable. The staff concludes that the risk from tornados at the WLS site is bounded by the risk identified in the AP1000 DCD and that no further analysis is required.

### High Winds—Hurricanes and Extratropical Cyclones

The applicant was expected to verify that the frequency of each of the five hurricane categories at the proposed site is bounded by the frequency assumed in Section 19.58 of the AP1000 DCD. In addition, risk associated with extratropical cyclones must be addressed.

In response to RAI 19-1, the applicant identified this external event category as applicable to the WLS 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 because all site structures are designed to withstand them: they do not contribute to risk. In response to RAI 19-15, the applicant stated that in accordance with the RAI 19-4 response, the event frequencies for external events associated with hurricanes are bounded by the limiting initiating event frequencies given in Table 3.0-1 of APP-GW-GLR-101.

The staff evaluated the method used to calculate hurricane frequencies and finds that it was realistic and acceptable. The staff concludes that the risk from hurricanes at the WLS site is bounded by the risk identified in the AP1000 DCD. In addition, applying the screening criteria documented in the certified design, the staff finds that the consequences of extratropical cyclones present a negligible contribution to risk. For that reason, no further analysis of risk from extratropical cyclones is required.

### External Floods

The AP1000 DCD calls for a site-by-site evaluation of susceptibility to 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. The DCD states that the AP1000 is protected against floods up to the plant grade, which, at the WLS site, is 590 feet above mean sea level.

In response to RAI 19-1, the applicant identified this external event category as applicable to the WLS site. In response to RAI 19-6, the applicant provided additional justification for screening external flooding from further risk analysis for the WLS site and cited studies documented in Chapter 2 of the WLS COL FSAR. Flooding due to surge, seiches, snow melt, ice effects, flood waves from landslides, and tsunamis was evaluated and determined not to be applicable to the WLS site. The probable maximum flood considered dam failure and coincident wind wave effects, and did not result in levels that could affect safety-related structures.

The staff's evaluation of the applicant's hydrologic analyses is presented in Section 2.4 of this SER. The staff concludes that the applicant has demonstrated that consequential flooding from external sources is so unlikely that it can be screened from further risk analysis.

### Transportation and Nearby Facility Accidents—Aviation Accidents

The applicant was expected to demonstrate that it is bounded by Section 19.58 of the AP1000 DCD by limiting impact frequencies to  $1.2 \times 10^{-6}$  per year by small aircraft and  $1.0 \times 10^{-7}$  per year by large, commercial 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 nonsafety-related systems. Larger (commercial) aircraft may have the capacity to challenge some safety-related SSCs, although the spatial separation of redundant safety-related system trains provides confidence that required functions will be maintained.

In response to RAI 19-1, the applicant identified this event category as applicable to the WLS site, and referenced WLS COL FSAR Section 3.5.1.6, which provides details of aircraft impact analysis. The applicant determined that the total probability of aircraft accidents that hit safety-related structures is less than  $1.0 \times 10^{-7}$  per year. The applicant stated that the calculated event is based on the general aviation crash rate and that this event frequency is bounded by

the limiting value of  $1.21 \times 10^{-6}$  events/year for small aircraft in APP-GW-GLR-101. In response to RAI 19-7, the applicant provided additional justification for why the commercial aircraft impact frequency is less than  $1.0 \times 10^{-7}$  per year for the site. The applicant determined that there are only two airways that require further review. The estimated frequency of an accident arising from commercial aircraft would be less than  $1.0 \times 10^{-7}$  per year. On this basis, aircraft hazards were screened from further analysis.

The staff's evaluation of the applicant's aircraft impact assessment is presented in Sections 2.2 and 3.5 of this SER. The staff concludes that aviation accidents provide a negligible contribution to risk of core damage and that no further evaluation of risk from these accidents is required.

#### Transportation and Nearby Facility Accidents—Marine Accidents

In response to RAI 19-1, the applicant found that this event category was not applicable to the WLS site.

The staff finds that because there is no commercial shipping or barge traffic on waterways near the site, marine accidents need not be considered for the WLS site.

#### Transportation and Nearby Facility Accidents—Pipelines

In response to RAI 19-1, the applicant states that the pipelines within five miles of the WLS site do not pose a credible hazard and references WLS COL FSAR Section 2.2.3.1.1.2. In Section 2.2 of the WLS COL FSAR, the applicant concluded that the safe standoff distance for an explosive hazard is less than the distance from the site boundary to the nearby facilities.

Because the limiting event evaluated for pipeline-related explosion in the AP1000 DCD was a 30-inch pipe at a distance of 5800 feet from the plant, the applicant states that explosion hazards due to pipeline accidents can be screened from further evaluation.

The staff finds that because the risk from pipeline gas release is bounded by the AP1000 analysis, no further evaluation is required.

#### Transportation and Nearby Facility Accidents—Rail Accidents

In response to RAI 19-1, the applicant found that the safe standoff distance for an explosive hazard (based on trinitrotoluene equivalency) is less than the distance from the site boundary to the nearest railway. Unconfined vapor clouds of various combustible materials released at this distance were also determined not to result in any significant damage to the plant.

In response to RAI 19-11, the applicant referenced WLS COL FSAR Section 2.2.3.1.3, which provides a more detailed analysis of this scenario.

The staff's assessment of these accidents is documented in Chapter 2 of this SER. The staff concludes that they do not contribute to risk of core damage and that no further evaluation of risk from these accidents is required.

### Transportation and Nearby Facility Accidents—Truck Accidents

Hazards from trucks were evaluated in the same manner as railway accidents. 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 19-11, the applicant referenced WLS COL FSAR Section 2.2.3, which provides a more detailed analysis of explosions and combustible material releases from trucks.

The staff's assessment of these accident analyses is documented in Chapter 2 of this SER. The staff concludes that they do not contribute to risk of core damage and no further evaluation of risk from truck accidents is required.

### 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 19-10 was issued requesting additional information about the toxic and explosive hazards associated with nearby facilities.

In response to RAI 19-10, the applicant referenced Section 2.2 of the WLS COL FSAR, where 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 a negligible effect on safety.

The staff's assessment of the applicant's analysis is documented in Chapter 2 of this SER. Because accidents at nearby facilities do not have consequences that contribute to risk, the staff finds that they can be screened from further analysis.

### External Fires

The AP1000 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  $1 \times 10^{-7}$  per year. The NRC issued RAI 19-8 to request documentation of this reevaluation or assessment in the WLS COL FSAR.

External fires are discussed in WLS 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 19-8, the applicant proposed to present the risks associated with external fires in WLS COL FSAR Table 19.58-201.

The staff's assessment of the applicant's analysis is documented in Chapter 2 of this SER. Because external fires do not contribute to risk, the staff finds that no further evaluation of risk from external fires is required.

### Toxic Chemical Releases

The consequences of toxic chemical releases from stationary sources onsite and within five miles of the WLS site as well as mobile sources were described in WLS COL FSAR Chapters 2 and 6. The applicant reported that such releases did not pose a credible risk to control room operators.

The staff's evaluations of these analyses are documented in Chapters 2 and 6 of this SER. Because the staff concluded that the release of toxic chemicals from identified external sources did not challenge control room habitability, it does not contribute to plant risk and no further evaluation is required.

### Major Depots and Storage Areas

In Chapter 2 of the WLS COL FSAR, the applicant identified three mines within five miles of the site and assessed the associated risk under this category. Explosives are not used at any of these mines and no other potential hazards are associated with these mining activities.

The staff's evaluation of this analysis is documented in Chapter 2 of this SER. Because the staff concluded that there is no hazard associated with them, they do not contribute to plant risk and no further evaluation is required.

### Summary

On the basis of this additional information, the staff confirmed that for all external events that contribute to risk, the parameters used for the AP1000 DCD external events analysis bound the reported parameters of the WLS 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, 19-3 through 19-11, 19-13, and 19-15. The staff confirmed that the proposed FSAR updates discussed above were appropriately incorporated into the WLS COL FSAR.

#### **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 WLS COL FSAR related to this section. The results of the NRC staff's technical evaluation

of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

The staff concludes that the relevant information presented in WLS 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)
- SMA

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 WLS COL FSAR, Revision 11, incorporates by reference Section 19.59 of the AP1000 DCD, Revision 19.

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

#### **Departure**

- WLS DEP 6.3-1

The applicant provided additional information in Section 19.59 of the WLS COL FSAR about WLS DEP 6.3-1 related to quantifying the duration that the passive residual heat removal system heat exchanger can maintain safe shutdown conditions. This information, as well as

related WLS DEP 6.3-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.1 of this SER.

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.

- STD COL 19.59.10-2

The applicant provided additional information in STD COL 19.59.10-2 to address 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 COL holder'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.

- 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).

- WLS COL 19.59.10-6

In WLS COL FSAR Revision 4, the applicant added WLS COL 19.59.10-6 to reflect a COL information item that is part of the DC amendment. The applicant confirmed that the SMA

documented in the AP1000 DCD section is applicable to the WLS site. This COL information item is evaluated in SER Section 19.55.4.

Section 19.59 of the WLS 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 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 WLS 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. It 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 NUREG-1793 and its supplements.

In addition, the following regulations apply to Sections 19.59.10.5 and 19.59.10.6 of the WLS 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.
- 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 WLS 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.<sup>1</sup> 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 WLS 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 (Vogtle Electric Generating Plant, Units 3 and 4 (VEGP)) were equally applicable to the WLS COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 5 to the WLS COL FSAR. In performing this comparison, the staff considered changes made to the WLS COL FSAR (and other parts of the COL application, as applicable) resulting from 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 WLS 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) includes evaluation material from the SER for the Bellefonte Nuclear Plant (BLN), Units 3 and 4 COL application.

The following portion of this technical evaluation section is reproduced from Section 19.59.4 of the VEGP 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 WLS 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 at least 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 WLS PRA will be updated to account for WLS 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 WLS 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 WLS 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 requested in RAI 19-12 that the applicant discuss the basis for concluding that the site-specific systems described in the COL application (e.g., raw water system, turbine building closed cooling water system) and modeled in the WLS PRA are consistent with the assumptions made in the development of initiating event frequencies and support system failure probabilities in the AP1000 PRA.

In response to RAI 19-12, the applicant indicated that the site-specific systems described in the COL application (e.g., raw water system, turbine building closed cooling water system, circulating water system) are designed as Class E systems and have no safety-related function and do not contain sufficient radioactive material such that a release could exceed applicable limits. The applicant also stated that 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 departures from the DC PRA.

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 WLS 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 VEGP 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 revise the proposed License Condition 6 to [include] 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**

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 (19-1) – The licensee shall 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 shall perform a verification walkdown to identify differences between the as-built plant and the design. The licensee shall evaluate any differences and shall 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 shall compare the as-built SSC HCLPFs to those assumed in the AP1000 seismic margin evaluation prior to initial fuel load. The licensee shall 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) – Before initial fuel load, the licensee shall review differences between the as-built plant and the design used as the basis for the AP1000 probabilistic risk assessment (PRA) and the AP1000 DCD, Rev. 19, Table 19.59-18. The licensee shall evaluate the plant-specific PRA-based insight differences and shall modify the plant-specific PRA model as necessary to account for the plant-specific design and any design changes or departures from the design certified in Rev. 19 of the AP1000 DCD.
- License Condition (19-3) – Before initial fuel load, the licensee shall review differences between the as-built plant and the design used as the basis for the AP1000 internal fire and internal flood analysis. The licensee shall evaluate the plant-specific internal fire and internal flood analyses and shall modify the analyses as necessary to account for the plant-specific design and any design changes or departures from the design certified in Rev. 19 of the AP1000 DCD.
- License Condition (19-4) – 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 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 this license condition has been fully implemented. The schedule shall identify the implementation of the site-specific severe accident management guidelines (before startup testing).

- License Condition (19-5) – Prior to initial fuel load, the licensee shall perform 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 shall 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 Electric Power Research Institute (EPRI) NP-4354, “Large Scale Hydrogen Burn Equipment Experiments.”

#### **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 WLS COL FSAR related to this section. The results of the NRC staff’s technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements. In addition, WLS DEP 6.3-1, related to quantifying the duration that the passive residual heat removal system heat exchanger can maintain safe shutdown conditions, is reviewed and found acceptable by the staff in Section 21.1 of this SER.

The staff concludes that the relevant information presented in Section 19.59 of the WLS 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.

#### **Appendix 19E Shutdown Evaluation**

Appendix 19E presents the design features of the active systems and passive safety-related systems that address the issues of shutdown risk and shutdown safety. It also evaluates the design features with respect to their ability to reduce or mitigate the consequences of events that can occur during shutdown, including discussions of the following:

- Systems designed to operate during shutdown
- Shutdown operations (including maintenance insights, risk management, and Emergency Response Guidelines (ERGs))
- Safety analyses and evaluations for shutdown operations
- Chapter 16, “Technical Specifications”
- Shutdown risk evaluations (including shutdown PRA results and fire/flood risk)
- Consistency with the guidance in NUREG-1449

Appendix 19E of the WLS COL FSAR, Revision 11, incorporates by reference Appendix 19E, "Shutdown Evaluation," of the AP1000 DCD, Revision 19. Appendix 19E of the DCD provides a shutdown evaluation and includes Sections 19E.2.3, "Passive Core Cooling System," 19E.4.3, "Decrease in Heat Removal by the Secondary System," and 19E.4.10.2, "Shutdown Temperature Evaluation."

In addition, in the WLS COL FSAR, the applicant provided the following:

Departures

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

The applicant provided additional information in Appendix 19E of the WLS COL FSAR about WLS DEP 3.2-1 and WLS DEP 6.3-1 related to design modifications to the condensate return portion of the Passive Core Cooling System and quantifying the duration that the passive residual heat removal heat exchanger can maintain safe shutdown conditions, respectively. This information, as well as related WLS DEP 3.2-1 and WLS DEP 6.3-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.1 of this SER.

- WLS DEP 7.3-1

The applicant provided additional information in Appendix 19E of the WLS COL FSAR about WLS DEP 7.3-1 related to required design changes for the PMS source range neutron flux doubling logic to comply with the requirements of IEEE Std. 603-1991, Clause 6.6. This information, as well as related WLS DEP 7.3-1 information appearing in other chapters of the FSAR, is reviewed in Section 21.5 of this SER.

The NRC staff reviewed Appendix 19E of the WLS 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 section. The NRC staff's review confirmed that the applicant addressed the required information to satisfy the evaluation criteria. There is no outstanding information expected to be addressed in the WLS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the WLS COL application are documented in NUREG-1793 and its supplements.

**Appendix 19F      Malevolent Aircraft Impact**

Appendix 19 F of the WLS FSAR addresses the requirements related to 10 CFR 50.150, "Malevolent Aircraft Impact." In FSAR Appendix 19F, the applicant incorporated by reference Appendix 19F of the AP1000 DCD, Revision 19.

In 2016, the staff concluded an inspection of the Westinghouse Electric Company, LLC, to examine recent design changes and the resolutions of the 2010 notice of violations with respect to 10 CFR 50.150 (ADAMS Accession No. ML102980583). The April 19, 2016 inspection report identified two issues with the existing AP1000 aircraft impact assessment (AIA) and the AP1000 DCD (ADAMS Accession No. ML16099A049).

The first issue involved the crediting of the Auxiliary Building in the AIA as a key design feature for protecting the integrity of the spent fuel pool and for protecting from physical damage the equipment needed to maintain core cooling. However, only the spent fuel pool integrity credit was translated into Appendix 19F of the AP1000 DCD incorporated by reference by the WLS COL applicant. Since the AP1000 DCD was missing the information about the Auxiliary Building credit to protect core cooling equipment from physical damage, the WLS COL application also omits this citation of the Auxiliary Building as a key design feature relied upon to ensure core cooling capability.

The second issue involved the fire damage spread in certain plant areas not following the methodology in NEI 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," Revision 7. Fire protection features with specific ratings cited in the NEI 07-13 guidance had not been incorporated into Appendix 19F or Appendix 9A of the AP1000 DCD, and thus not incorporated into the WLS COL application.

At the conclusion of the inspection, the staff found the revised AIA acceptable, including the addition of specific pressure-rated fire doors.

To address and capture the missing information identified in the April 19, 2016, inspection report, the staff proposes the following license condition. This license condition would allow the staff to conclude that the WLS Units 1 and 2 would be constructed and operate in compliance with the requirements of 10 CFR 50.150:

- License Condition (19-6) – At the first annual update of the WLS FSAR required by 10 CFR 50.71(e) DEC shall include the following changes based on inspection findings from NRC Inspection Report No. 99900404/2015-203:
  - a) Revise Appendix 19F.4.1, "Malevolent Aircraft," to include the Auxiliary Building as a key design feature that also protects from physical damage the core cooling credited to meet 10 CFR 50.150(b)(2).
  - b) Revise DCD drawings to show the 5 psid and 3 hour fire rated doors that have been added to the inner portion (annulus side) of the shield building in accordance with final markups used to satisfy NRC Inspection Report No. 99900404/2015-203 and 50.150 (a)(1). The DCD figures listed below are to be revised:
    1. Figure 1.2-7 - Nuclear Island General Arrangement Plan at Elevation 107'-2" & 111'-0"
    2. Figure 1.2-10 - Nuclear Island General Arrangement Plan at El. 135'-3"
    3. Figure 9A-1 (Sheet 5 of 16) - Nuclear Island Fire Areas Plan at Elevation 100'-0" & 107'-2"
    4. Figure 9A-1 (Sheet 7 of 16) - Nuclear Island Fire Area Plan at Elevation 135'-3"
    5. Figure 12.3-1 (Sheet 6 of 16) - Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 100'-0" & 107'-2"

6. Figure 12.3-1 (Sheet 8 of 16) - Radiation Zones, Normal Operations/Shutdown Nuclear Island, Elevation 135'-3"
7. Figure 12.3-2 (Sheet 6 of 15) - Radiation Zones, Post-Accident Nuclear Island, Elevation 100'-0" & 107'-2"
8. Figure 12.3-2 (Sheet 8 of 15) - Radiation Zones, Post-Accident Nuclear Island, Elevation 135'-3"
9. Figure 12.3-3 (Sheet 6 of 16) - Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 100'-0" & 107'-2"
10. Figure 12.3-3 (Sheet 8 of 16) - Radiological Access Controls, Normal Operations/Shutdown Nuclear Island, Elevation 135'-3"

The license condition part (a) requires the applicant to include, as an update to the applicant's UFSAR Appendix 19F, the Auxiliary Building as a structure to protect core cooling equipment from structural physical damage in addition to its role of protecting the spent fuel pool integrity as analyzed in the aircraft impact assessment. Therefore, the staff finds that with the incorporation of this change, the applicant meets the requirements of 10 CFR 50.150(b)(2) which require applicants to describe in their FSAR how each key design feature meets the acceptance criteria credited in 10 CFR 50.150(a) because UFSAR Appendix 19F will reflect that the Auxiliary Building is credited to protect from physical damage the core cooling equipment in the AIA.

The license condition part (b) requires the applicant to incorporate, as an update to the applicant's UFSAR, those design changes contained in the identified figures to be revised, and within Westinghouse's Design Change Proposal APP-GW-GEE-2450, "Relocation of AIA Blast Doors and Addition of Shielding Doors to Annulus Personnel Access Portals," Revision 0. Specifically, those changes which address, in part, the specific 3-hour fire rated door additions and their proper pressure ratings. The staff reviewed these proposed changes during the Inspection 99900404/2015-203 and found them acceptable in accordance with the guidance in NEI 07-13, Revision 7. Therefore, the staff finds that with the incorporation of these changes, the applicant meets the requirements of 10 CFR 50.150(b)(1), which require the applicant to identify and describe in the FSAR those key design features required to satisfy 10 CFR 50.150(a)(1), because the revised figures will identify and describe the added key design features (i.e., fire doors).