

## 19.0 PROBABILISTIC RISK ASSESSMENT AND SEVERE ACCIDENTS

This Chapter describes the North Anna 3 plant-specific probabilistic risk assessment (PRA) and severe accident evaluations and corresponding regulatory requirements. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 52.79(a)(46), a combined license (COL) application is required to contain a description of the plant-specific PRA and its results. In addition, 10 CFR 52.79(d)(1) specifies that if the COL application references a design certification (DC), then plant-specific PRA information must use the PRA information from the DC and be updated to account for site-specific design information and any design changes or departures. 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 shut down.

Attachment 19.A “Loss of Large Areas of the Plant due to Explosions or Fire” (public-version) to this section of the Safety Evaluation Report (SER) evaluates the measures identified by the applicant that are needed to comply with requirements to address the loss of large areas of the plant due to explosions or fires from a beyond-design-basis event (BDBE). The U.S. Nuclear Regulatory Commission (NRC) regulations in 10 CFR 50.54(hh)(2) and 10 CFR 52.80(d) describe these requirements. It should be noted that the non-public Attachment 19.B “Loss of Large Areas of the Plant due to Explosions or Fire,” as well as some documents referenced in Attachment 19.A, include security-related or safeguards information. Therefore, Attachment 19.B, 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 Introduction

This section describes the objectives of the design-specific PRA and severe accident evaluations, and the corresponding regulatory requirements. Section 19.1 of the North Anna 3 COL Final Safety Analysis Report (FSAR), Revision 8, incorporates by reference, with no departures or supplements, Chapter 19.1, “Introduction,” of the ESBWR DCD, Revision 10.

As documented in NUREG–1966 “Final Safety Evaluation Report related to the Certification of the Economic Simplified Boiling-Water Reactor Standard Design,” the staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. The staff’s review confirmed that the application addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Appendix [E], Section VI.B.1, all nuclear safety issues relating to the “Introduction” section, that were incorporated by reference have been resolved.

The inclusion of NAPS DEP 3.7-1 in Section 19.1 of the COL FSAR is being tracked as a confirmatory item [**Confirmatory Item 19.01-1**] pending its incorporation into the formal submission of the North Anna 3 COL FSAR, Revision 9. This NAPS DEP 3.7-1 provides an evaluation of the impacts of the seismic exceedances of the CSDRS on the seismic margin analysis (SMA) for site specific evaluation of North Anna 3. The staff evaluates the North Anna 3 SMA in Section 19.2 of this SER.

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<sup>1</sup> See “Finality of Referenced NRC Approvals” in SER Section 1.2.2 for a discussion on the staff’s review related to verification of the scope of information to be included in a COL application that references a design certification.

## 19.2 PRA Results and Insights

### 19.2.1 Introduction

This section of the safety evaluation report (SER) addresses the results and insights from the North Anna 3 plant-specific PRA, which are documented in Section 19.2 “PRA Results and Insights” of the North Anna 3 COL FSAR, Revision 8.

### 19.2.2 Summary of Application

Section 19.2 of the North Anna 3 COL FSAR, Revision 8 incorporates by reference Section 19.2 of the ESBWR DCD, Revision 10 with two departures.

#### Tier 2 Departure

- NAPS DEP 3.7-1 Seismic Margin Analysis

The applicant replaced the third and fourth sentences of the first paragraph under the heading, “Introduction to Evaluation of External Event Seismic” in Section 19.2.3.2.4 of the ESBWR DCD, Revision 10 with the following:

The seismic margin earthquake for the PRA-based seismic margin assessment is the SSE for each Seismic Category I structure as provided in Section 3.7.1. The site specific seismic margins High Confidence, Low Probability of Failures (HCLPF) accident sequence analysis shows that Unit 3 is inherently capable of safe shutdown in response to beyond design basis earthquakes and has a plant level HCLPF of at least 1.67 times the peak ground acceleration of a safe shutdown earthquake (SSE), where the SSE for each Seismic Category I structure is provided in Section 3.7.1, in compliance with the SECY 93-087 (DCD Reference 19.2-7) requirement that “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.

- NAPS DEP 3.7-1 Table 19.2-4R - ESBWR Systems and structures in Seismic Margins Analysis

The applicant replaced note 1 in Table 19.2-4R that stated that the ESBWR DCD minimum HCLPF value of  $1.67 \cdot SSE$ , for each Seismic Category I structure, will be met for the structures and equipment shown with the plant specific SSE as described in North Anna 3 FSAR Section 3.7.1.

#### COL Item

- NAPS COL 19.2.6-1-A Seismic High Confidence Low Probability of Failure Margins

The applicant replaced the second, third and fourth sentences of the first paragraph under the heading, “Significant Core Damage Sequences of External Event Seismic”, in Section 19.2.3.2.4 of the ESBWR DCD, Revision 10 with the following.

As-built SSC HCLPFs will be compared to those assumed in the seismic margin analysis for the SSCs listed in Table 19.2-4R for the Unit 3 SSE, as defined in Section 3.7.1. Deviations from the HCLPF values or other assumptions in the seismic margins evaluation will be analyzed to determine if any new vulnerabilities have been introduced. This comparison and analysis will be completed prior to fuel load. A minimum HCLPF value of  $1.67 \times \text{SSE}$  will be met for the SSCs identified in Table 19.2-4R.

The applicant stated in Section 19.2.6 of the North Anna 3 COL FSAR, Revision 8, that COL Item 19.2.6-1-A, “Seismic High Confidence Low Probability of Failure Margins” is addressed in Section 19.2.3.2.4 of the COL FSAR. In North Anna 3 FSAR Section 19.2.3.2.4, the applicant provides information to address DCD COL Item 19.2.6-1-A. The applicant stated that an SMA update (Reference 19.1-201) using site-specific seismic loads documents the results of the fragility analyses and HCLPF values. In addition, a comparison of the as-build SSC HCLPFs will be performed prior to fuel load.

### **19.2.3 Regulatory Basis**

The regulatory basis of the information incorporated by reference is in NUREG–1966. In addition, the relevant requirements of the Commission regulations for PRA results, and the associated acceptance criteria, are in Chapter 19 of NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (LWR Edition),” the Standard Review Plan (SRP). The staff review also follows the guidance provided in DC/COL-ISG-020, “Implementation of a Probabilistic Risk Assessment-Based Seismic Margin Analysis for New Reactors” (ML1004912330), which provides a detailed process that a COL applicant may use to update the PRA-based seismic margin analysis (SMA) of the referenced DC.

The NRC has indicated in SECY-93-087 and the associated Staff Requirements Memorandum (SRM) that a plant designed to withstand the design basis SSE should have a plant HCLPF capacity of at least 1.67 times the acceleration of the SSE in order to demonstrate adequate safety margin with respect to beyond design-basis events.

- 10 CFR 52.79(a)(46) requires that each application for combined license (COL) must include a description of the plant-specific probabilistic risk assessment (PRA) and its results. 10 CFR 52.79 (d) (1) further requires that this plant-specific PRA must use the PRA information for the referenced design certification (DC) and must be updated to account for site-specific design information and any design changes or departures.
- 10 CFR 50.71(h) requires each COL holder shall maintain and upgrade the PRA. 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 the scheduled date for initial loading of fuel and each required upgrade thereafter.

### **19.2.4 Technical Evaluation**

As documented in NUREG-1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor.", the staff reviewed and approved Section 19.2 of the certified ESBWR DCD, Revision 10. The staff reviewed Section 19.2 "PRA Results and Insights" of the North Anna 3 COL FSAR, Revision 8, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the North Anna 3 COL FSAR, Revision 8 represents the complete scope of information relating to this review topic.<sup>1</sup> The staff's review confirmed that the applicant has addressed the required information, and no outstanding information is expected to be addressed in the COL FSAR, related to this section. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna COL application are documented in NUREG-1966 "Final Safety Evaluation Report related to the Certification of the Economic Simplified Boiling-Water Reactor Standard Design."

In addition, the staff reviewed Parts 4 and 7 of the North Anna 3 COL Application which includes the Technical Specifications and Departures Report, respectively. The staff has determined from this review that the ESBWR Generic Technical Specifications (GTS) and Bases of the referenced certified design are incorporated by reference into the North Anna 3 plant specific technical specifications with only minor modifications that would not impact the ESBWR design specific PRA. The staff has also determined that the applicant has taken one departure from the information provided in Section 19.2.3.2.4 of the ESBWR DCD, Revision 10. The departure is described in two parts above in SER Section 19.2.2.

- NAPS DEP 3.7-1 Seismic Margins Analysis DCD

The staff has reviewed North Anna 3 DEP 3.7-1 with respect to the seismic margins assessment provided in ESBWR DCD, Revision 10, including a review of GEH report 003N1084, Rev. 2, "North Anna Unit 3 Site-Specific Seismic Margins Analysis Update." The staff has also conducted two audits of the applicant's seismic analysis and seismic design evaluation of North Anna Unit 3, the latter of which included a review of the supporting documents for HCLPF calculations for RB/FB, RCCV, RPV Support Brackets, RPV Pedestal, CB, FWS, and FPE. From its review the staff has found that the applicant's departure from the DCD included the use of the North Anna 3 site specific SSE for Seismic Category I structures as described in Section 3.7.1 of the North Anna 3 COL FSAR, Revision 8 as the seismic margin earthquake for the PRA-based site specific seismic margin assessment rather than the ESBWR Certified Seismic Design Response Spectra (CSDRS). Section 3.7.1 of the North Anna 3 COL FSAR, Revision 8 describes the seismic design basis earthquake for structures that must withstand the effects of the earthquakes according to GDC 2, Appendix S of 10 CFR Part 50, (i.e., the design basis SSE). The staff notes that the site-specific ground motion response spectra defined as the foundation input response spectra (FIRS) at the foundation level of each Seismic Category I structure in the FSAR Section 3.7.1 are not enveloped by the ESBWR DC CSDRS. The staff finds that use of the North Anna 3 design basis SSE in the PRA-based seismic margins assessment as the bases for establishing adequate seismic margin is acceptable because it is consistent with guidance provided by the NRC in SECY-93-087, the associated SRM and DC/OL-ISG-020. As described in Section 3.7.1 of the North Anna 3 COL FSAR, Revision 8, the seismic demands for the NA3 SSCs are based on the CSDRS and the site-specific FIRS. In response to Request for Additional Information (RAI), 19.02-1 dated December 16, 2015 Agencywide Documents Access and Management System (ADAMS) Accession No.(ML15364A384), the applicant indicates that the SMA for the CSDRS continues to be applicable to NA3, to the extent that seismic analyses using the CSDRS continue to apply, and is supplemented by the site-specific SMA update. The staff finds this approach is acceptable because the NA3 site-specific design improvements in a limited number of locations

are not considered to reduce the capacities of the SSCs to resist the CSDRS induced loads, and the applicant has updated the SMA for the standard design's Seismic Category I structures to reflect the NA3 site conditions in accordance with the DC/COL-ISG-020 guidance.

This RAI response also indicates that except for the seismic margin earthquake being the NA3 design basis SSE, there is no other changes to the DCD PRA model including seismic initiating events, site-specific effects and plant-specific features, and the systems model. The NA3 PRA-based site-specific SMA update as documented in GEH report 003N1084, Rev. 2, and the supporting calculations describes the seismic fragility calculations for the Seismic Category I structures for which seismic design information is available. For safety-related components that do not have detailed information yet, the NA3 site-specific SMA update assumes a HCLPF capacity of 1.67\*SSE, with a commitment that these components will be designed to achieve at least this capacity. GEH report 003N1084, Rev. 2 also presents a brief summary of the seismic capacity results of the Lungmen Nuclear Power Plant and finds that there is a high confidence that a HCLPF capacity of 1.67\*SSE is achievable for key components at NA3. The NA3 site-specific SMA update concludes that the NA3 site-specific ESBWR plant is inherently capable of safe shutdown in response to beyond design-basis earthquake events, and the plant level HCLPF value is at least 1.67 times the NA3 site-specific SSE. The staff review and audit confirmed the validity of the NA3 seismic fragility calculations and the reasonableness of the assumptions (i.e. the commitment for safety-related components), and finds the NA3 site-specific SMA updates acceptable.

NAPS DEP 3.7-1 also affects Table 19.2-4R - ESBWR Systems and structures in Seismic Margins Analysis, in that the applicant has taken a departure from the standard COL item 19.2.6-1-A associated with Table 19.2-4R. The staff has reviewed the proposed departure and identified the following differences between the North Anna 3 departure and the ESBWR DCD.

The minimum plant-level HCLPF value (1.67\*SSE) for the systems and structures listed in Table 19.2-4R will be different from that described in the ESBWR DCD, because the seismic margin earthquake for the North Anna 3 PRA-based seismic margin assessment is the North Anna 3 design basis SSE rather than the ESBWR CSDRS. The North Anna 3 design basis SSE is the SSE for Seismic Category I structures as described in Section 3.7.1 of the North Anna 3 COL FSAR, Revision 9 markup. This COL FSAR change is being tracked as a confirmatory item **[Confirmatory Item 19.02-1]** pending its incorporation into the formal submission of the North Anna 3 COL FSAR, Revision 9. This departure is acceptable because the applicant will ensure, prior to fuel load, the as-built HCLPF capacity to be at least 1.67 times the acceleration of the site specific SSE, consistent with the criteria provided in SECY 93-087 and DC/COL-ISG-020.

The staff reviewed the following COL information item contained in the North Anna 3 COL FSAR, Revision 8:

COL Item

- NAPS COL 19.2.6-1-A                      Seismic High Confidence Low Probability of Failure Margins

The standard COL item is described in ESBWR DCD Tier 2, Section 19.2.6, Revision 10, and reads as follows:

The COL applicant will identify a milestone for completing a comparison of the as-built SSC HCLPFs to those assumed in the ESBWR seismic margin analysis shown in Table 19.2-4. Deviations from the HCLPF values or other assumptions in the seismic margins evaluation shall be analyzed to determine if any new vulnerabilities have been introduced. A minimum HCLPF value of  $1.67 \times \text{SSE}$  will be met for the SSCs identified in DCD Table 19.2-4 (Subsection 19.2.3.2.4).

As-built SSCs whose HCLPF values will be compared with values assumed in the ESBWR SMA are described in Table 19.2-4R of the North Anna 3 COL FSAR, Revision 8 rather than Table 19.2-4 of the ESBWR DCD, Revision 10.

The acceptability of using a site-specific characterization for the design basis SSE instead of the ESBWR CSDRS is evaluated in SER Section 3.7.

The staff compared the list of SSCs in Table 19.2-4R of the North Anna 3 COL FSAR, Revision 8 with the list of SSCs in Table 19.2-4 of the ESBWR DCD, Revision 10 and found them to be identical. The staff compared the footnote referenced in the title of Table 19.2-4R and the footnote referenced in the title of Table 19.2-4 of the ESBWR DCD and found that both stated that a minimum HCLPF value of  $1.67 \times \text{SSE}$  for each Seismic Category I structure will be met for the structures and systems listed in the respective Table, but that the footnote in Table 19.2-4R defines the seismic margin earthquake as the North Anna 3 design basis SSE for Seismic Category I structures as described in Section 3.7.1 of the North Anna 3 COL FSAR, Revision 8 while the footnote in Table 19.2-4 of the ESBWR DCD, Revision 10 defines the seismic margin earthquake as the ESBWR CSDRS.

The staff noted that the only difference between the two is the definition of seismic margin earthquake, which is used to determine the HCLPF values. GEH report 003N1084, Rev. 2 explains that verification of the plant-specific HCLPF includes an as-built engineering walk-down to verify assumptions made in the SMA and identify any components that require strengthening if the as-built SMA indicates additional capacity margin is required. The staff found the applicant's response to this COL Item acceptable because: (1) consistent with guidance in DC/COL-ISG-020, the applicant has updated the SMA for the standard design of Seismic Category I structures to reflect the NA3 site SSE and (2) the applicant will conduct an as-built engineering walk-down as part of verification of the plant-specific HCLPF values.

### **19.2.5 Post-Combined License Activities**

The applicant identified the following in the FSAR to address COL Item 19.2.6-1-A:

As-built SSC HCLPFs will be compared to those assumed in the seismic margin analysis for the SSCs listed in Table 19.2-4R for the Unit 3 SSE, as defined in Section 3.7.1. Deviations from the HCLPF values or other assumptions in the seismic margins evaluation will be analyzed to determine if any new vulnerabilities have been introduced. This comparison and analysis will be completed prior to fuel load. A minimum HCLPF value of  $1.67 \times \text{SSE}$  will be met for the SSCs identified in Table 19.2-4R.

## **19.2.6 Conclusion**

The staff reviewed North Anna 3 COL FSAR Revision 8, the proposed NA3 COL FSAR, Revision 9 markup and the associated reports and calculations in accordance with the relevant NRC regulations and the guidance in Chapter 19 of NUREG-0800 and DC/COL-ISG-020. The staff's review concludes that the applicant has presented adequate information in proposed North Anna 3 COL FSAR, Revision 9 markup, and finds acceptable the applicant's conclusion that the NA3 site-specific ESBWR plant has a HCLPF capacity of at least 1.67 times the NA3 design basis SSE with a commitment that the as-built safety-related components will be ensured to have a HCLPF capacity of at least 1.67 times the NA3 design basis SSE. This COL FSAR change is being tracked as a confirmatory item [**Confirmatory Item 19.02-1**] pending its incorporation into the formal submission of the North Anna 3 COL FSAR, Revision 9.

## **19.3 Severe Accident Evaluation**

Section 19.3 of the North Anna 3 COL FSAR incorporates by reference, with no departures or supplements, Section 19.3, "Severe Accident Evaluations," of the ESBWR DCD, Revision 10. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. The staff's review confirmed that the application addressed the required information relating the severe accident evaluations and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this Section. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna COL application are documented in NUREG-1966.

## **19.4 PRA Maintenance**

Section 19.4 of the North Anna 3 COL FSAR incorporates by reference, with no departures or supplements, Section 19.4, "PRA Maintenance," of the ESBWR DCD, Revision 10. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. The staff's review confirmed that the application addressed the required information relating the severe accident evaluations and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this Section. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna COL application are documented in NUREG-1966.

## **19.5 Conclusions**

### **19.5.1 Introduction**

The PRA and severe accident evaluations contained in Chapter 19 of the ESBWR DCD Tier 2, Revision 10 demonstrate that the ESBWR is designed with safety features that have high reliability and availability with significant redundancy and diversity.

### **19.5.2 Summary of Application**

Section 19.5 "Conclusions" of the North Anna 3 COL FSAR, Revision 8 incorporates by reference, with no departures, Section 19.5 of the ESBWR DCD Tier 2, Revision 10.

In addition, in FSAR Section 19.5, the applicant provided the following information:

#### **Supplemental Information**

- NAPS SUP 19.5-1

In FSAR Section 19.5, the applicant stated that it reviewed site and plant-specific information to determine if any changes from the certified design PRA were warranted.

- NAPS DEP 3.7-1

In proposed FSAR, Revision 9, Section 19.5 markup, the applicant stated that the description of the certified design PRA results and insights, together with the treatment of the seismic exceedance described in FSAR Section 19.2.3.2.4, satisfy the requirement of 10 CFR 52.79(a)(46) for a description of the plant-specific PRA and its results.

### **19.5.3 Regulatory Basis**

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the regulatory basis for requiring the supplementary information on consideration of site-specific and plant-specific information and design features is established in 10 CFR 52.79(a)(46) and in 10 CFR 52.79(d)(1), which requires (1) a COL applicant referencing a certified design to include, in the FSAR, information sufficient to demonstrate that the site characteristics fall within the site parameters specified in the design certification, and (2) that plant-specific PRA information in a COL application that references a standard design certification must use the PRA information from the design certification and must be updated to account for site-specific design information and any design changes or departures.

Consistent with 10 CFR 50.71(h), each COL holder shall maintain and upgrade the PRA. The upgraded PRA must cover initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect one year before each required upgrade.

### **19.5.4 Technical Evaluation**

As documented in NUREG-1966, the staff reviewed and approved Section 19.5 of the certified ESBWR DCD. The staff reviewed Section 19.5 of the North Anna 3 COL FSAR, Revision 8, proposed COL FSAR, Revision 9 markup and checked the referenced DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.<sup>1</sup>

The staff's review confirmed that the information in the application and the information incorporated by reference address the required information related to this section.

In addition the staff reviewed the following site specific information in the COL FSAR:

#### Supplemental Information

- NAPS SUP 19.5-1
- NAPS DEP 3.7-1

In FSAR Section 19.5 and Appendix 19AA, the applicant provided supplementary information (North Anna 3 SUP 19.5-1 and NAPS DEP 3.7-1) which describes the results of its review and

evaluation of site-specific information, plant-specific information, design changes and departures from the certified design. The purpose of this evaluation is to determine if any changes from the certified design PRA are warranted. The evaluation included consideration of site-specific information such as site meteorological data and site-specific population distributions, as well as plant-specific design information that replaced conceptual design information described in the DCD. The applicant also reviewed Section 1.8.5 of North Anna 3 COL FSAR, Revision 8 to determine if there were any departures affecting the PRA results. The review of site-specific information and plant-specific design information determined that, with one exception, the DCD PRA bounds site-specific and plant-specific design parameters and design features. The exception is that the site-specific seismic design response spectra exceed the CSDRS for seismic margins analysis of the standard plant design. The applicant stated that this departure is accounted for in the plant-specific PRA by requiring a minimum HCLPF value of  $1.67 \cdot SSE$  for each Seismic Category I and II structure and therefore, did not have a measureable impact on the DCD PRA results and insights. The staff findings associated with North Anna 3 SUP 19.5-1 and NAPS DEP 3.7-1 are addressed as part of the staff evaluation of Appendix 19AA in section 19AA of this SER below. This COL FSAR change is being tracked as a confirmatory item [**Confirmatory Item 19.05-1**] pending its incorporation into the formal submission of the North Anna 3 COL FSAR, Revision 9.

#### **19.5.5 Post Combined License Activities**

There are no post COL activities related to this section.

#### **19.5.6 Conclusion**

The staff's findings related to information incorporated by reference are in NUREG-1966. The staff reviewed the application and checked the referenced DCD. The staff's review finds that the applicant has addressed the required information and that there is no outstanding information expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix [E], Section VI.B.1, all nuclear safety issues relating to this section that were incorporated by reference have been resolved.

Based on the above, staff concludes that the applicant information to address supplemental information item NA3 SUP 19.5-1 as provided in the North Anna 3 COL FSAR meets the relevant guidelines in SRP Chapter 19 of NUREG-0800, and is therefore, acceptable.

The staff finds the information in the evaluation summarized in Section 19.5 and discussed in Appendix 19AA of this SER support the conclusion that differences between site-specific parameters and features and assumptions in the DCD are minimal and do not invalidate the applicant's reference of the DCD PRA results and insights provided in Chapter 19 of the certified ESBWR DCD.

### **Appendix 19A Regulatory Treatment of Non-Safety Systems (RTNSS)**

Appendix 19A of the North Anna 3 COL FSAR incorporates by reference, with an exemption and two departures, Appendix 19A, "Regulatory Treatment of Non-Safety Systems," of the ESBWR DCD, Revision 10. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. In addition the staff reviewed the following North Anna 3 exemption and tier 2 departures.

As discussed below, the staff requested the applicant to address site-specific missiles generated from hurricane winds associated with Exemption 5 and Departure 19A-1. The applicant provided the necessary information which will be incorporated in the next update to the COLA application. This item is being tracked as an FSAR confirmatory item. **[Item Number 19A-1]**

### Exemption and Tier 1 and Tier 2 Departures

The applicant proposed a site-specific Tier 1 DCD departure from DCD Tier 1, Table 5.1-1, "Envelope of ESBWR Standard Plant Site Parameters," which includes criteria for the design of structures housing RTNSS SSCs to resist maximum hurricane winds and hurricane wind generated missiles.

- Exemption 5: Design of Structures Housing RTNSS Equipment for Hurricane Wind Generated Missiles

As permitted by 10 CFR 52.7 and Section VIII.A.4 of the Design Certification Rule, an exemption is requested for certain information described in ESBWR DCD Tier 1. The applicant has requested that DCD Tier 1 Table 5.1-1 be modified to include North Anna 3 structures housing RTNSS equipment to withstand the most limiting hurricane missiles generated by hurricane winds using a missile spectrum and velocities that take into account both the hurricane generated missiles described in the DCD and the Unit 3 site-specific hurricane generated missiles evaluated in accordance with new NRC guidance since the ESBWR DCD approval, in Regulatory Guide (RG) 1.221, "Design Basis-Hurricane and Hurricane Missiles for Nuclear Power Plants." The applicant states that:

This exemption modifies Footnote 7 to DCD Tier I Table 5.1-1 to specify that the Unit 3 site-specific missile velocities derived in accordance with RG 1.221 are used in the design of structures housing RTNSS equipment when the site-specific missiles are more severe than the missiles specified in the DCD.

This Tier 1 departure is further described in detail below under NAPS DEP 19A-1.

### Exemption Approval determination:

In the North Anna 3 COLA, Revision 7, Part 7, "Departures Report," the applicant requested an exemption from the provisions of 10 CFR Part 52, Appendix D, Section III.B, "Design Certification Rule for the ESBWR Design, Scope and Contents," which requires an applicant referencing a certified design to incorporate by reference Tier 1 information. Specifically, in North Anna Part 7, Exemption 5, the applicant proposed to revise the ESBWR DCD, Tier 1, Table 5.1-1, to include new RG 1.221 guidance on wind generated missile protection for RTNSS systems. This RG followed the final design certification rule on October 15, 2014 (79 FR 61944) as Appendix E to 10 CFR 52.

### Regulations

- 10 CFR Part 52, Appendix E, Section VIII.A.4 states that exemptions from Tier 1 information are governed by the requirements of 10 CFR 52.63(b) and 10 CFR 52.98(f). 10 CFR Part 52, Appendix E, Section VIII.A.4 also states that the Commission will deny such a request if it finds that the design change will result in a significant reduction in the level of safety otherwise provided by the design.

- 10 CFR Part 52.63(b)(1) allows an applicant to request NRC approval for an exemption from one or more elements of the certification information. The Commission may only grant such a request if it determines that the request complies with the requirements of 10 CFR 52.7, which, in turn, points to the requirements listed in 10 CFR 50.12 for specific exemptions, and if the special circumstances present outweigh the potential decrease in safety due to reduced standardization. Therefore, any exemption from the Tier 1 information certified by 10 CFR Part 52, Appendix D must meet the requirements of 10 CFR 50.12, 10 CFR 52.7, and 10 CFR 52.63(b)(1).

### Evaluation of Exemption

As stated in 10 CFR Part 52, Appendix E, Section VIII.A.4, an exemption from Tier 1 information is governed by the requirements of 10 CFR 52.63(b)(1) and 52.98(f). Additionally, the Commission will deny an exemption request if it finds that the requested change to Tier 1 information will result in a significant decrease in safety. Pursuant to 10 CFR 52.63(b)(1), the Commission may, upon application by an applicant or licensee referencing a certified design, grant exemptions from one or more elements of the certification information, as long as the criteria given in 10 CFR 50.12 are met and the special circumstances as defined by 10 CFR 50.12 outweigh any potential decrease in safety due to reduced standardization.

Applicable criteria for when the Commission may grant the requested specific exemption are provided in 10 CFR 50.12(a)(1) and (a)(2). 10 CFR 50.12(a)(1) provides that the requested exemption must be authorized by law, not present an undue risk to the public health and safety, and be consistent with the common defense and security. The provisions of 10 CFR 50.12(a)(2) list six special circumstances for which an exemption may be granted. It is necessary for one of these special circumstances to be present in order for NRC to consider granting an exemption request. The applicant stated that the requested exemption meets the special circumstances of 10 CFR 50.12(a)(2)(ii). That subsection defines special circumstances as when "...[a]pplication of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule." The staff's analysis of each of these findings is presented below.

### Authorized by Law

This exemption would allow the applicant to implement approved changes to Tier 1 information. This is a permanent exemption limited in scope to particular Tier 1 information, and subsequent changes to this Tier 1 information or any other Tier 1 information would be subject to full compliance by the applicant as specified in 10 CFR Part 52, Appendix E, Section III.B. As stated above, 10 CFR 52.63(b)(1) allows the NRC to grant exemptions from one or more elements of the certification information, namely, Tier 1. The staff determined that granting of the applicant's proposed exemption will not result in a violation of the Atomic Energy Act of 1954, as amended, or NRC regulations. Therefore, as required by 10 CFR 50.12(a)(1), the exemption is authorized by law.

### No Undue Risk to Public Health and Safety

The plant-specific Tier 1 DCD will continue to reflect the approved licensing basis for the applicant and will maintain a level of detail consistent with that which is currently provided elsewhere in Tier 1 of the plant-specific DCD. The affected design description in the plant-specific Tier 1 DCD will continue to provide the detail necessary to support the RTNSS requirements and the associated design function. The site-specific hurricane wind

generated missile velocities derived in accordance with the new NRC guidance in RG 1.221 exceed the missile velocities specified in the DCD for certain missiles specified by RG 1.221. The applicant has incorporated protection from wind generated missiles from both the DCD requirements as well as the new RG 1.221 requirement, therefore, these proposed changes are evaluated and found to be acceptable. Consequently, the staff finds the exemption presents no undue risk to public health and safety as required by 10 CFR 50.12(a)(1).

#### Consistent with Common Defense and Security

The proposed exemption would allow the applicant to implement modifications to the Tier 1 information requested in the applicant's submittal. This is a permanent exemption limited in scope to this particular Tier 1 information. Subsequent changes to this Tier 1 information or any other Tier 1 information would be subject to full compliance by the applicant as specified in 10 CFR Part 52, Appendix E, Section VIII.A.4. This change is not related to security issues. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that the exemption is consistent with the common defense and security.

#### Special Circumstances

Special circumstances, in accordance with 10 CFR 50.12(a)(2)(ii), are present whenever application of the regulation in the particular circumstances would not serve the underlying purposes of the rule or is not necessary to achieve the underlying purpose of the rule. The applicant included wind generated missile protection from both the DCD requirements as well as from the new RG 1.221 requirements that followed the approval of the DCD in North Anna 3 FSAR Section 19A as NAPS DEP 19A-1 and therefore the underlying purpose of the specific ESBWR DCD Tier 1, RTNSS missile protection is not changed. Accordingly, special circumstances are present because application of the requirement to incorporate the certified design information in specific ESBWR DCD Tier 1, Table 5.1-1, "Envelope of ESBWR Standard Plant Site Parameters," is not necessary to achieve the underlying purpose of the rule. Therefore, the staff finds that special circumstances required by 10 CFR 50.12(a)(2)(ii) for the granting of an exemption from Tier 1, exist.

#### Special Circumstances Outweigh Reduced Standardization

This exemption would allow the applicant to change certain ESBWR DCD Tier 1 information proposed in the North Anna 3 COL application. The key design functions of the RTNSS will be maintained. Since the changes are from new NRC guidance that is different than the generic ESBWR DCD Tier 1 design wind missile protection function for RTNSS, it is likely that all other ESBWR licensees and applicants would request the same exemption using the same required guidance in RG 1.221 in subsequent COL applications.

However, this exemption request and the associated changes to North Anna 3 COL Tier 1 information, demonstrate that there is a minimal change from the standard information provided in the ESBWR DCD. Consequently, the decrease in safety due to reduced standardization is minimal. For this reason, the staff determined that even if other ESBWR licensees and applicants do not request similar departures, the special circumstances outweigh the potential decrease in safety due to reduced standardization of the ESBWR design, as required by 10 CFR 52.63(b)(1).

#### No Significant Reduction in Safety

The proposed exemption would not significantly modify the function of the North Anna 3 missile protection for RTNSS as described in the ESBWR DCD. Therefore, the staff finds that granting the exemption would not result in a significant decrease in the level of safety otherwise provided by the design, as required by 10 CFR Part 52, Appendix E, Section VIII.A.4.

### Conclusion

For the reasons set forth above, the staff has concluded that pursuant to 10 CFR Part 52, Appendix E, Section VIII.A.4, the exemption: (1) is authorized by law, (2) presents no undue risk to the public health and safety, (3) is consistent with the common defense and security, (4) has special circumstances that outweigh the potential decrease in safety due to reduced standardization, and (5) does not significantly reduce the level of safety at the licensee's facility. Therefore, the staff finds that the applicant's request to depart from the information in ESBWR DCD Tier 1, design of missile protection for RTNSS systems, to be acceptable and the applicant's request for an exemption from these Tier 1 requirements is granted.

The applicant has taken two departures from ESBWR DCD, Revision 10, regarding augmented design standards discussed in Section 19A.8.3.

The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. In addition the staff reviewed the following North Anna 3 Tier 2 departures.

- NAPS DEP 3.7-1 Non-seismic structures that house RTNSS Criterion C systems

The applicant has removed the reference to ESBWR Certified Seismic Design Spectra taken from Figures 2.0-1 and 2.0-2 of the ESBWR DCD, Revision 10, as the source for the SSE ground motion input for design of certain non-seismic structures that house RTNSS systems and replaced it with a reference to the site-dependent SSE at grade taken from Section 3.7.1 of the North Anna 3 COL FSAR, Revision 8. This departure is acceptable to the staff because the site-dependent SSE is the appropriate source for the SSE ground motion input for non-seismic structures that house RTNSS systems and are located on the North Anna 3 site.

- NAPS DEP 19A-1 Design of Structures Housing RTNSS Equipment for Hurricane Wind Generated Missiles

This departure addresses higher North Anna 3 site-specific hurricane wind generated missile velocities since the site-specific missile parameters are more severe than those specified in the ESBWR DCD.

In 2011 the NRC issued new guidance for hurricanes in RG 1.221, "Design Basis-Hurricane and Hurricane Missiles for Nuclear Power Plants." This guidance demonstrated that hurricane missiles could be more severe than tornado missiles. In addition, the ESBWR design certification rule includes an exclusion from finality for loads on applicable systems, structures, and components (SSCs) from hurricane-generated missiles, but only to the extent that such loads are not bounded by other loads analyzed in the ESBWR DCD. It was not clear to the staff whether North Anna 3 site-specific hurricane missile loads were bounded by the ESBWR standard plant. Therefore, the staff issued RAI 03.05.01.04-1 dated April 2, 2014, (ADAMS Accession No ML14092A573), requesting the applicant to address hurricane missiles in accordance with RG 1.221.

The applicant's response to RAI 03.05.01.04-1 dated April 29, 2014 (ADAMS Accession No. ML14120A239), stated that, for seismic category I structures, all missiles generated by extreme winds at the North Anna 3 site are bounded by the DCD standard plant tornado missile spectrum, and provided a table showing the ESBWR standard-plant tornado and hurricane missile spectra and associated velocities compared to North Anna 3 site-specific values. This table indicates that site-specific wind-borne missiles are indeed bounded by the referenced DCD for seismic category I structures. However, the response did not discuss other ESBWR standard plant structures, such as structures housing regulatory treatment of non-safety systems (RTNSS) equipment, which, as non-seismic category I structures, are designed for hurricane missiles but not tornado missiles. The table included in the applicant's response indicated that all site-specific missiles are bounded by the ESBWR standard plant design except for the hurricane induced automobile impact on RTNSS structures. Therefore, the staff issued follow-up, RAI 03.05.01.04-2 dated June 18, 2014 (ADAMS Accession No. ML1469A655), requesting the applicant to address the site-specific automobile hurricane generated missile and its impact on RTNSS structures, and whether this requires a departure from the DCD.

The applicant's response to RAI 03.05.01.04-2 dated November 25, 2014 (ADAMS Accession No. ML14337A116), stated that:

“Dominion is taking a departure and exemption from the ESBWR design certification rule in order to meet the guidance provided in RG 1.221...the methodology specified in the RG for calculating missile velocities results in higher velocities for certain hurricane wind generated missiles. Dominion will design structures housing RTNSS equipment to withstand the most limiting hurricane missiles generated by hurricane winds using a missile spectrum and velocities that take into account both the hurricane generated missiles described in the DCD and the Unit 3 site-specific hurricane generated missiles described in the response to RAI 03.05.01.04-01 dated April 29, 2014 (ML14120A239).”

The applicant also proposed to insert the following at the end of the tenth paragraph of DCD Tier 2, Section 19A.8.3, “Augmented Design Standards:”

“The design of these structures also accounts for the Unit 3 site-specific hurricane generated missile velocities calculated in accordance with RG 1.221. The limiting hurricane generated missile velocities are shown in Table 19A-201.”

Table 19A-201, “Limiting Hurricane Missile Parameters for NA3 Structures Housing RTNSS Equipment,” is a new table added to the FSAR and identifies which hurricane generated missiles are most limiting for RTNSS structures. In addition, the applicant identified conforming changes to FSAR Tables 2.0-201, 19A-3R, 19A-4R, and DCD Tier 1, Table 5.1-1, Footnote 7 in order to clarify that the design of RTNSS structures will account for the most limiting hurricane missile.

The applicant provided a description of departure NAPS DEP 19A-1 in COL application Part 7, which states, “[t]his departure add requirements to address the site-specific hurricane wind generated missile velocities when the site specific missile parameters exceed those specified in the DCD.” The applicant also included an evaluation of the departure and determined that it complies with the requirements of 10 CFR 52 Appendix E, Section VIII.B.5.

The staff reviewed the information above and finds that the applicant has provided sufficient information to determine NAPS DEP 19A-1 to be acceptable because it conforms to the

guidance of RG 1.221, and complies with 10 CFR 52 Appendix E, Section VIII.B.5. In addition, the design requirements added by the departure ensure that RTNSS structures will be designed to the most limiting hurricane missile.

The FSAR revision related to the exemption and departures is being tracked as a confirmatory item. **[Item Number 19A-1]**

The staff's review confirmed that the application addressed the required information relating to RTNSS and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this appendix. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna COL application are documented in NUREG-1966.

#### **Appendix 19ACM    Availability Controls Manual**

Appendix 19ACM of the North Anna 3 COL FSAR incorporates by reference, with no departures or supplements, Appendix 19ACM, "Availability Controls Manual," of the ESBWR DCD, Revision 10. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. The staff's review confirmed that the application addressed the required information relating to the availability controls manual and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this appendix. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna 3 COL application are documented in NUREG-1966.

#### **Appendix 19B        Deterministic Analysis for Containment Pressure Capability**

Appendix 19B of the North Anna 3 COL FSAR incorporates by reference, with no departures or supplements, Appendix 19B, "Deterministic Analysis for Containment Pressure Capability," of the ESBWR DCD, Revision 10. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. The staff's review confirmed that the application addressed the required information relating to the deterministic analysis performed and results obtained for the containment ultimate capability under internal pressure and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this appendix. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna 3 COL application are documented in NUREG-1966.

#### **Appendix 19C        Probabilistic Analysis for Containment Pressure Fragility**

Appendix 19C of the North Anna 3 COL FSAR incorporates by reference, with no departures or supplements, Appendix 19C, "Probabilistic Analysis for Containment Pressure Fragility," of the ESBWR DCD, Revision 10. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. The staff's review confirmed that the application addressed the required information relating to the probabilistic analyses and results for the fragility of the ESBWR primary containment system for over-pressurization and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this appendix. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna COL application are documented in NUREG-1966.

#### **Appendix 19D        Assessment of Malevolent Aircraft Impact**

Appendix 19D of the North Anna 3 COL FSAR incorporates by reference, with no departures or supplements, Appendix 19D, "Assessment of Malevolent Aircraft Impact," of the ESBWR DCD, Revision 10. The staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remains for review<sup>1</sup>. The staff's review confirmed that the application addressed the required information relating a design-specific assessment of the intentional impact of a large commercial aircraft on the ESBWR and there is no outstanding information expected to be addressed in the North Anna 3 COL FSAR related to this appendix. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna 3 COL application are documented in NUREG-1966.

## **Appendix 19AA      Summary of Plant-Specific PRA Review**

### **19AA.1      Introduction**

In accordance with 10 CFR 52.79(a)(46), this FSAR appendix provides a summary of plant-specific PRA and its results.

### **19 AA.2      Summary of Application**

Appendix 19AA of the North Anna 3 COL FSAR provides a summary of plant-specific PRA and its results. In FSAR Appendix 19AA, the applicant summarized the results of its evaluation of site-specific and plant-specific information with respect to pertinent assumptions made in the certified design PRA. In addition, the applicant provides a summary of the Supplemental Information NA3 SUP 19.5-1 in Appendix 19AA.

In Section 19AA.2 of the application, the applicant discussed the following North Anna 3 site-specific PRA attributes that were compared to ESBWR PRA.

The parameters and features discussed by the applicant included the following:

- loss of preferred power (LOPP) frequency
- loss of service water frequency
- site-specific terrain and meteorological data
- seismic fragilities
- other known site-specific issues

### **19AA.3      Regulatory Basis**

The regulatory basis of the information incorporated by reference is in NUREG-1966. In addition, the regulatory basis for requiring the supplementary information on consideration of site-specific and plant-specific information and design features is established in 10 CFR 52.79(a)(46) and in 10 CFR 52.79(d)(1), which requires (1) COL applicants referencing a certified design to include, in the FSAR, information sufficient to demonstrate that the site characteristics fall within the site parameters specified in the DC, and (2) plant-specific PRA information in a COL application that references a standard DC must use the PRA information

from the DC and must be updated to account for site-specific design information and any design changes or departures. Consistent with 10 CFR 50.71(h), each COL holder shall maintain and upgrade the PRA. The upgraded PRA must cover initiating events and modes of operation contained in NRC-endorsed consensus standards on PRA in effect one year before each required upgrade.

#### **19AA.4 Technical Evaluation**

As documented in NUREG–1966, the staff reviewed and approved Chapter 19 of the certified ESBWR DCD, Revision 10. The staff reviewed Appendix 19AA of the North Anna 3 COL FSAR, Revision 8, and checked the referenced DCD to ensure that the combination of the information in the COL FSAR and the information in the ESBWR DCD represents the complete scope of information relating to this review topic.<sup>1</sup> The staff's review confirmed that information in the application and the information incorporated by reference address the required information related to this section.

##### Supplemental Information

The staff reviewed the following information in the COL FSAR:

- loss of preferred power (LOPP) frequency;
- loss of service water frequency;
- site-specific terrain and meteorological data
- seismic fragilities
- plant-specific flooding zones of the yard and service water building.

Each of these parameters and features are evaluated below.

##### Loss of Preferred Power Frequency

The applicant stated in Section 19AA.2 of the North Anna 3 COL FSAR, Revision 8 that North Anna frequencies for LOPP accident scenarios were compared with LOPP frequencies assumed in the ESBWR design PRA described in the ESBWR DCD, Revision 10. The applicant also stated that, although there are variances between the values assumed for North Anna 3 and the values assumed in the ESBWR design PRA, they are minor and their range is acceptable.

In order to determine if the North Anna 3 specific values for LOPP frequencies are bounded by the values assumed in the ESBWR design PRA, the staff issued RAI 19-7 dated November 7, 2013, (ADAMS Accession No. ML13311C289), which requested that the applicant (1) specify the plant-specific values of the LOPP frequencies expected for North Anna 3, (2) provide the technical basis for the values, and (3) provide a comparison of the LOPP frequencies assumed for North Anna 3 and those assumed in the ESBWR PRA. In its response to RAI 19-7 on December 11, 2013, (ADAMS Accession No. ML13351A046), the applicant provided the requested information for at-power and shutdown conditions and provided tabular data and related references. The staff compared the LOPP frequencies reported by the applicant for

North Anna 3 with the latest published data for North Anna 1 and 2 and found the North Anna 3 frequencies to be the same as the higher of the values for North Anna 1 and 2. The staff considers this comparison to be acceptable and reasonable since all units are on the same site. The staff compared expected North Anna 3 values with values used in the ESBWR design PRA (NEDO-33201, Revision 6) and found the values used in the ESBWR design PRA to be bounding. Therefore, the staff finds that the ESBWR design PRA provides a bounding assessment of LOPP events.

#### Loss of Service Water Frequency

The applicant stated in Section 19AA.2 of the North Anna 3 COL FSAR, Revision 8 that the ESBWR loss of service water frequency is based on NUREG/CR-5750, "Rates of Initiating Events at U. S. Nuclear Power Plants: 1987-1995." The applicant also stated that the value assumed in the ESBWR PRA would be bounding for North Anna 3. To justify the assertion that this approach is bounding, the applicant provided a detailed description of the features included in the North Anna 3 service water system design to improve reliability over that of designs used in operating plants. The applicant also stated in Section 19AA.2 of the North Anna 3 COL FSAR, Revision 8 that in addition to the bounding treatment of PRA parameters, there are no changes from the standard design in any systems considered in the PRA model, and therefore, there are no site-specific design features that affect the PRA because the boundary of the certified design covers all of the SSCs necessary for the PRA.

The staff evaluated the assertions regarding service water system failure frequency by comparing the North Anna 3 service water system design with the service water system modeled in the ESBWR design PRA. The staff found that the North Anna service water system design as described in the North Anna 3 COL FSAR, Revision 8 was included in the ESBWR PRA model. The staff finds this to be a reasonable basis to expect that the plant-specific service water system will not introduce design differences that would create substantial additional risk over and above that described in the certified ESBWR DCD.

#### Site-Specific Terrain and Meteorological Data

The applicant states that there are no terrain features specific to North Anna 3 that would affect the meteorological data or plume dispersion and that the site is bounded by the DCD in Section 19.2.5 for offsite consequences.

Based on its review of information in the PRA report referenced in the ESBWR DCD, Tier 2, Revision 10, the staff found that the assumptions for tornado and hurricane frequencies in the ESBWR PRA are bounding with respect to the North Anna 3 site. Indeed, the tornado frequencies assumed in the ESBWR PRA were generated using data from the central region of the United States (U.S) where the tornado intensities and frequencies of occurrence are highest. The North Anna 3 site is an inland site located in Virginia on the shore of Lake Anna. Historical data from the National Oceanic and Atmospheric Administration (NOAA) ([www.noaa.gov](http://www.noaa.gov)) show that the frequency of tornados in Virginia is less than half of that for states in the middle of the United States. The hurricane frequencies applied in the ESBWR PRA were developed using data from a set of plants operating on the Atlantic coast in the southeastern U.S. Data in NOAA Technical Memorandum NWS NHC-6, dated August 2011, show the frequency of intense hurricane winds in Virginia to be far below that on the south eastern coast of the U.S. Based on the location of the North Anna site, the staff finds it reasonable to conclude that the tornado and hurricane frequencies applied in the ESBWR PRA are bounding with respect to the North Anna 3 site.

### Site-specific Seismic Design Response Spectra

The acceptability of using the North Anna 3 site-specific characterization for the design basis SSE, which exceeds ESBWR CSDRS, is evaluated in Section 3.7 of this safety evaluation report.

### Plant-specific Flooding Zones of the Yard and Service Water Building

The evaluation of flooding associated with the yard area provided in Section 19AA.3 of the North Anna 3 application indicated that site-specific design basis flooding conditions would not cause risk to increase beyond the level determined with the ESBWR design PRA because all SSCs modeled in the PRA are located above the design basis flood level. External flooding events that could cause a flood more severe than the design basis flood were not addressed in the application.

The applicant stated that the service water structure is a site-specific design feature and is treated in a bounding manner in the ESBWR PRA. The service water structure houses the four service water pumps and their associated power supplies and controls. The applicant stated that, in the ESBWR PRA model, the service water structure is conservatively considered to be one flood zone and all four pumps are assumed to fail in an internal flood. It was also stated that the ESBWR PRA model does not credit operator actions to mitigate a service water structure flooding event, so differences in building location are not significant.

Based on its evaluation, the applicant concluded that none of the North Anna 3 parameters and features have a significant impact on the DCD PRA results and insights; and therefore, there is no significant change from the certified design PRA, and incorporation of DCD Chapter 19 into the North Anna 3 COL FSAR, Revision 8 satisfies the requirement of 10 CFR 52.79(a)(46) for a description of the plant-specific PRA and its results.

### Plant-specific Flooding Zone of the Yard

Because the applicant only addressed design basis flooding in the application, the staff issued RAI 19-8 dated November 7, 2013, (ADAMS Accession No.ML13311C289), requesting that the applicant address the risk associated with beyond design basis external flooding events for North Anna 3. In its response to RAI 19-8 dated December 11, 2013, (ADAMS Accession No. ML13351A046), the applicant addressed potential flooding from severe precipitation, dam failures, surge or seiche flooding and tsunami flooding. The applicant also stated that flooding from extreme precipitation presented the highest potential risk from external flooding for the following reasons:

1. There are no dams located upstream of the facility, and therefore it is not subject to sudden flooding due to dam failure.
2. The facility is not located on an estuary or open coast, and therefore not subject to flooding due to seiche, surge or tsunami.

The staff considered the applicant's response and compared it with information regarding potential flooding at the site provided in Chapter 2 of the North Anna 3 COL FSAR, Revision 8. The information in the response is consistent with information provided in the North Anna 3 COL FSAR, Revision 8. Based on the features of the North Anna site listed above and information

provided in Chapter 2 of the North Anna 3 COL FSAR, Revision 8 regarding flooding from extreme precipitation, the staff finds the applicant's bases for concluding that potential severe flooding from extreme precipitation poses the greatest risk from external flooding events are logical and reasonable, and therefore acceptable.

In their response, the applicant cited the following screening criterion from the ASME/ANS Standard entitled, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications"<sup>2</sup> as the basis for not providing further risk evaluation of floods from precipitation beyond the Probable Maximum Precipitation (PMP) described in Chapter 2 of the North Anna 3 COL FSAR, Revision 8:

*Criterion 5:* The event is slow in developing, and it can be demonstrated that there is sufficient time to eliminate the source of the threat or to provide an adequate response.

The staff agrees that flooding from severe precipitation would present a challenge to the plant that is slow in developing compared to most upset conditions. The staff also finds that there is a reasonable basis for concluding that an adequate response to such a flooding event that challenged safe plant operation could be made expeditiously. This is because the design of North Anna 3, as described in the North Anna 3 COL FSAR, Revision 8, includes safety systems (i.e., the isolation condenser system, automatic depressurization system, gravity driven cooling system and the primary containment cooling system) whose components are located either inside containment or above the containment, and therefore protected from floods. Once initiated, these systems can be used to remove decay heat for up to 72 hours with no intervention, as described in the North Anna 3 COL FSAR, Revision 8. Initiating these safety systems generally involves only a few valve manipulations that can be performed from the control room. The isolation condenser system initiates automatically on loss of electric power. Since these are safety-related systems, procedures for initiating cooling with these systems must be provided in accordance with the Commission's regulations in 10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants*. After 72 hours, action is required to refill cooling water tanks in the containment which allows these systems to maintain cooling for an additional 4 days. These actions are described in the North Anna 3 COL FSAR, Revision 8 and the staff's review of these actions is contained in Chapter 22 of NUREG-1966.

Based on its evaluation, the staff finds the applicant's bases for screening external floods from quantitative analysis in the PRA to be acceptable.

#### Plant-specific Flooding Zone of the Service Water Building

The staff reviewed flooding analysis documented in Chapter 13 of the ESBWR PRA report referenced in the ESBWR DCD, Revision 10 and confirmed that the service water building is considered a single flood zone in the ESBWR PRA model. The staff also confirmed that all equipment in a single flood zone is assumed to fail in the model, and the model does not credit operator actions to mitigate a service water structure flooding event. In light of these assumptions, the staff finds that flooding of the service water building is treated in a bounding manner in the ESBWR PRA, and this provides reasonable assurance that site-specific differences in service water structure design will not have a significant effect on the PRA results.

#### **19AA.5 Post-Combined License Activities**

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<sup>2</sup> ASME/ANS RA-Sa-2009, New York, NY, 2009.

As-built SSC HCLPFs will be compared to those assumed in the ESBWR seismic margin analysis and site-specific update shown for the SSCs listed in Table 19.2-4R for the Unit 3 SSE, as defined in Section 3.7.1. Deviations from the HCLPF values or other assumptions in the seismic margins evaluation will be analyzed to determine if any new vulnerabilities have been introduced. This comparison and analysis will be completed prior to fuel load. A minimum HCLPF value of  $1.67 \times \text{SSE}$  will be met for the SSCs identified in Table 19.2-4R.

#### **19AA.6 Conclusion**

The staff's findings related to information incorporated by reference are in NUREG-1966. The staff reviewed the application and checked the referenced DCD. The staff's review confirms finds that the applicant has addressed the required information relating to the PRA and that there is no outstanding information expected to be addressed in the COL FSAR related to this section. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix [E], Section VI.B.1, all nuclear safety issues relating to the summary of plant-specific PRA review that were incorporated by reference have been resolved.

The staff also compared the supplemental COL information within the application to the relevant NRC regulations. The regulatory basis for acceptance of the supplementary information on consideration of site-specific and plant-specific information and design features is established in 10 CFR 52.79(d)(1). The staff finds the applicant's consideration of site-specific and plant-specific information and design features sufficient to support the conclusion that differences between the site-specific parameters, other than the seismic ground motion departure NAPS DEP 3.7-1 that was explicitly evaluated to ensure a minimum plant-level HCLPF value of  $1.67 \times \text{SSE}$ , and features and the assumptions in the DCD are small and do not invalidate the applicant's reference to the DCD PRA results and insights provided in Chapter 19 of the ESBWR DCD.

## **ATTACHMENT 19.A**

### **LOSS OF LARGE AREAS OF THE PLANT DUE TO EXPLOSIONS OR FIRES**

#### **19.A.1 Introduction**

The applicant described the North Anna 3 LOLA strategies in the Appendix 8B of the “North Anna 3 Combined License Application Part 8: Security,” Revision 4, submitted December 2013 (ADAMS Accession No. ML14007A424, non-public) (hereafter referred to as the mitigative strategies report (MSR)).

In the submittal, the applicant described how it will meet the requirements to address loss of large areas (LOLAs) of the plant due to explosions or fires from a beyond design basis event (BDBE). Title 10 of the Code of Federal Regulations (10 CFR) 52.80(d) and 10 CFR 50.54(hh)(2) detail these requirements. The attachment to this safety evaluation section, Attachment 19.B, “Loss of Large Areas of the Plant due to Explosions or Fire” (non-public), as well as some documents referenced in this safety evaluation section, include security related or safeguards information and are not publicly available.

The provisions of 10 CFR 52.80(d) require an applicant for a combined license (COL) to submit a description and plans for implementation of the guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities under the circumstances associated with LOLAs of the plant due to explosions or fire as required by 10 CFR 50.54(hh)(2).

The provisions of 10 CFR 50.54(hh)(2) require licensees to develop and implement guidance and strategies for addressing LOLAs of the plant due to explosions or fires from a BDBE. Specifically, the guidance and strategies are intended to maintain or restore core cooling, containment, and SFP cooling capabilities and include the following:

- firefighting
- operations to mitigate fuel damage
- actions to minimize radiological release

#### **19.A.2 Summary of Application**

The applicant submitted (Appendix 8B to ADAMS Accession No. ML14007A424, non-public) the MSR for the North Anna 3 LOLA strategies titled “North Anna 3 Mitigative Strategies Description and Plans.” The applicant will incorporate this report, including any applicable changes identified in response to NRC requests for RAIs into a future revision of the North Anna 3 COL application. The applicant stated that it would implement the LOLA mitigative strategies, including implementation of operational and programmatic aspects of responding to LOLA events, before initial fuel load.

### 19.A.3 Regulatory Basis

NRC regulations in 10 CFR Part 50 and 52 provide the regulatory basis for the staff's review of the information in the North Anna 3 COL application. For example, the applicable regulatory requirements for LOLAs of the plant due to explosions or fires are as follows:

- 10 CFR 50.54(hh)(2)
- 10 CFR 52.80(d)

The applicable regulatory guidance includes Interim Staff Guidance (ISG) DC/COL-ISG-016, "Interim Staff Guidance Compliance with 10 CFR 50.54(hh)(2) and 10 CFR 52.80(d) Loss of Large Areas of the Plant Due to Explosions or Fires from a Beyond-Design-Basis Event," dated April 20, 2010 (ADAMS Accession No. ML101030529) (not publically available), which provides an acceptable means of meeting the requirements of 10 CFR 50.54(hh)(2) and 10 CFR 52.80(d). DC/COL-ISG-016 references the February 25, 2005, guidance letter (not publically available) to operating reactor licensees for Phase 1 and the Nuclear Energy Institute (NEI) document NEI 06-12, "B.5.b Phase 2 & 3 Submittal Guideline," dated September 2009, Revision 3 (ADAMS Accession No. ML092890400) (not publically available), for Phases 2 and 3. DC/COL-ISG-016 takes exception to a few areas of NEI 06-12 and provides additional clarification and enhancement of NEI 06-12 and the staff's guidance letter dated February 25, 2005, based on NRC inspections of operating reactor implementation. DC/COL-ISG-016 has two attachments: Attachment 1, "Supplementary Guidance for Implementing Mitigation Strategies"; and Attachment 2, "Experience Gained from Implementation of Temporary Instruction 2515/171 at Currently Licensed Power Reactor Sites and Related Staff Positions."

### 19.A.4 Technical Evaluation

The staff reviewed the applicant's submittal consistent with the requirements of 10 CFR 52.80(d) and 10 CFR 50.54(hh)(2). The staff also used the guidance in DC/COL-ISG-016 to perform its review. DC/COL-ISG-016 references the February 25, 2005, guidance letter for Phase 1 and NEI 06-12 for Phases 2 and 3. Attachment 19.B (not publically available), discusses the staff's technical evaluation of the North Anna 3 LOLA Plan submittal.

The North Anna 3 COL applicant provided the LOLA event evaluation via a three-phase approach similar to that for existing plants and consistent with Phases 1, 2, and 3 in the NEI 06-12 guidance. The applicant wrote its "Mitigative Strategies Description and Plans" report, dated December, 2013, at the programmatic level for licensing approval; the implementation details and documentation will be made available for inspection by the NRC before initial fuel load.

In the applicant's submittal of the MSR, the applicant follows the template guidance in Appendix D to NEI 06-12, addresses various areas and issues pertinent to LOLAs, and describes commitments for areas that are best resolved closer to the completion of the building of North Anna 3. All commitments made in the submittal will be implemented before the initial fuel load of the unit.

The MSR addresses the three phases considered in NEI 06-12:

- Phase 1—firefighting response strategy

- Phase 2—SFP cooling
- Phase 3—reactor core cooling and fission product release mitigation

Phases 1, 2, and 3 of NEI 06-12 are similar to the three areas included as part of the requirements in 10 CFR 50.54(hh)(2): firefighting, operations to mitigate fuel damage, and actions to minimize radiological release. However, the three phases are categorized differently. In 10 CFR 50.54(hh)(2); the category of operations to mitigate fuel damage includes both the reactor core and the SFP, and the category of actions to minimize radiological release is separate. In NEI 06-12, separate phases address SFP and reactor core cooling, and reactor core cooling and fission product release mitigation are combined. Despite the differences between the categorization of the phases in NEI 06-12 and the areas of the regulatory requirements, the staff finds that the submittal included all of the necessary information.

The guidance for Phases 1, 2, and 3 suggests development of certain strategies or processes to mitigate the consequences of a LOLA event. The applicant addressed all of these suggested strategies or processes. In evaluating each plant specific mitigating strategy against its functional objective, the staff weighed whether the strategy reasonably can be expected to successfully provide SFP cooling or to maintain or restore the key safety functions necessary to protect the reactor core and containment. The staff's review considered the expected effectiveness of strategies and the ease and timeliness of strategy implementation.

The staff reviewed the MSR for content using DC/COL-ISG-016 and finds that it includes all strategies considered essential for such a program and is acceptable. The staff finds that the regulatory requirements of 10 CFR 52.80(d) and 10 CFR 50.54(hh)(2) are met.

#### **19.A.5 Post Combined License Activities**

Although some strategies needed to meet 10 CFR 50.54(hh)(2) can be developed and implemented in the near future, some strategies and planning efforts cannot be effectively determined or implemented until the plant is further along in construction.

In Part 10 of the North Anna 3 COL application Revision 8, the applicant has identified the following License Conditions to meet the requirements of 10 CFR 50.54(hh)(2) and 10 CFR 52.80.

##### **Fuel Load Authorization**

The licensee shall implement the operational program identified below prior to fuel load authorization per 10 CFR 52.103(g):

Mitigative Strategies Description and Plans (for responding to circumstances associated with loss of large areas of the plant due to explosions or fire developed in accordance with 10 CFR 50.54(hh)(2))

## Operational Program Implementation Schedule

The licensee shall submit to the Director of NRO, a schedule, no later than 12 months after issuance of the COL, for implementation of the operational programs listed in FSAR Table 13.4-201. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until the operational programs in the FSAR table have been fully implemented. This schedule shall also address:

- The implementation of site-specific Severe Accident Management Guidelines
- The spent fuel rack coupon monitoring program implementation

The staff reviewed the license conditions proposed by the applicant in its submittal and is satisfied that the timing of all procedural or strategy development was appropriately scheduled before the initial fuel load.

### **19.A.6 Conclusion**

The staff reviewed the information provided by the applicant under 10 CFR 52.80(d). The staff concludes that the applicant has adequately followed the guidance of DC/COL-ISG-016, NEI 06-12, and the February 25, 2005, guidance letter. The staff finds that the applicant provided sufficient information at the COL application stage, including commitments made in the North Anna 3 COL application, to meet the requirements of 10 CFR 52.80(d) and to provide reasonable assurance that the requirements in 10 CFR 50.54(hh)(2) will be met before the initial fuel load of North Anna 3.