15.0 SAFETY ANALYSES

15.1 Introduction

This chapter provides analyses of the plant's responses to postulated disturbances in process variables and postulated equipment failures or malfunctions, determines their consequences, and evaluates the capability of the plant to control or accommodate these events. These analyses help determine the limiting conditions for operation, limiting safety system settings, and design specifications for safety-related components and systems.

This chapter includes a discussion of: (1) the classification of the transients and accidents and the analyses results in order to ensure that the applicant has considered a sufficiently broad spectrum of initiating events and postulated equipment failures, (2) the frequency of occurrence for initiating events for anticipated operational occurrences and highly unlikely accidents, (3) plant characteristics considered in the safety evaluation, (4) assumed protection system actions, (5) evaluation of individual initiating events and systems that operate to reduce the probability of occurrence of specific events, and (6) analysis of anticipated transients without scram. The safety analyses provide a significant contribution to the selection of limiting conditions for plant operation, limiting safety system settings, and design specifications for plant components and systems from the standpoint of public health and safety.

15.2 Summary of Application

Chapter 15 of the North Anna 3 combined license (COL) Final Safety Analysis Report (FSAR) incorporates by reference Chapter 15 of the Economic Simplified Boiling-Water Reactor (ESBWR) Design Control Document (DCD), Revision 5. In addition, in FSAR Chapter 15 the applicant provided the following additional information:

Supplemental Information:

- STD SUP 15.3-1 Radiological Consequences

The applicant added that procedures will detail the use of nuclear instrumentation to help in detecting a possible mislocated fuel bundle after fuel loading.

- NAPS SUP 15.3-2 Early Site Permit (ESP) Information

The applicant stated that Chapter 15 of the North Anna ESP Site Safety Analysis Report (SSAR) is incorporated by reference, except information related to the ESBWR is replaced by DCD Chapter 15. This supplemental information is identified as NAPS ESP variance (VAR) 2.0-6.

15.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the Final Safety Evaluation Report related to the DCD.

Compliance with the non-seismic siting criteria of 10 CFR 100.21 and General Design Criterion (GDC) 19 requires that the applicant show that, for a plant located at the North Anna site, the radiological consequences of postulated accidents meet the criteria set forth in 10 CFR 52.79(a)(1) and for GDC 19 that the control room provides adequate radiation protection to

ensure that radiation exposures shall not exceed 0.05 Sv (5 rem) total effective dose equivalent (TEDE) to permit access and occupancy of the control room under accident conditions for the duration of the accident. Requirements for the technical information in the FSAR in the application for a combined license are given in 10 CFR 52.79. In particular, 10 CFR 52.79(a)(1)(vi) requires a description and safety assessment of the site on which the facility is to be located, including an evaluation of the offsite radiological consequences of postulated accidents to show that the site characteristics comply with 10 CFR Part 100.

Both 10 CFR 100.21, which references 10 CFR 50.34(a)(1)(ii)(D), and 10 CFR 52.79(a)(1)(iv) have the same following offsite radiological consequence evaluation factors:

(A) An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of [0.25 Sv] 25 rem total effective dose equivalent (TEDE).

(B) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of [0.25 Sv] 25 rem TEDE

15.4 Technical Evaluation

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed Chapter 15 of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information contained in and incorporated by reference addresses the required information related to the Safety Analyses. Chapter 15 of the ESBWR DCD is being reviewed by the staff on Docket No. 52-010. The staff's technical evaluation of the information is incorporated by reference and all information related to accident analysis will be documented in the staff safety evaluation report (SER) on the design certification application for the ESBWR design.

In addition, the NRC staff checked the referenced North Anna ESP SSAR. The NRC staff's review confirmed that the information contained in the North Anna 3 COL application and incorporated by reference from the North Anna ESP SSAR, Revision 9, addresses the required information related to the radiological consequence analyses (RCA). The NRC staff's technical evaluation of the information incorporated by reference to the North Anna ESP SSAR related to the RCA is documented in the corresponding SER (i.e., NUREG-1835).

The staff reviewed the relevant information in the COL FSAR:

[1] See Section 1.2.2, "Finality of Referenced NRC Approvals," for a discussion on the staff's review related to verification of the scope of information to be included within a COL application that references a design certification.

Supplemental Information:

- STD SUP 15.3-1 Radiological Consequences

- NAPS SUP 15.3-2
  (NAPS ESP VAR 2.0-6) ESP Information

North Anna COL FSAR, Revision 0, incorporated by reference the analysis of the radiological consequences from the ESBWR DCD, Revision 4, Section 15.4 and from Chapter 15 of North Anna ESP SSAR. The staff review of the incorporated by reference sections identified that the isotopic time-dependent fission product release rates to the environment for each design-basis accident (DBA) analyzed in the ESBWR DCD, Revision 4 were not bounded by those values specified in Appendix B, "Controlling Values of Parameters and Design-Basis Accident Source Term Plant Parameters," in ESP No. ESP-003 issued for the North Anna site.

Therefore, the staff requested, in request for additional information (RAI) 15.06.05-1, that if the isotopic activity releases per time period specified in the RCA for each DBA analyzed in the ESBWR DCD, Revision 5 and from Chapter 15 of North Anna ESP SSAR are not bounded by those specified in Appendix B to the North Anna ESP, provide the site-specific radiological consequence doses for exclusion area boundary (EAB), low population zone (LPZ), and control room for each DBA to demonstrate that North Anna site still meets the dose evaluation factors set forth in 10 CFR 50.34(a)(1)(ii)(D), 10 CFR 52.79(a)(1)(vi), and GDC 19.

In response to RAI 15.06.05-1, the applicant stated the following in its submittal dated October 17, 2008:

1. For the EAB and LPZ, the North Anna Unit 3 FSAR, Revision 0, Table 2.0-201, "Evaluation of Site/Design Parameters and Characteristics," shows that the site-specific χ/Q values for Unit 3 fall within those values in the DCD, Revision 5 and therefore, the North Anna Unit 3 meets the dose evaluation factors set forth in 10 CFR 50.34(a)(1)(ii)(D), and 10 CFR 52.79(a)(1)(vi).

   The staff finds that this response is acceptable.

2. For the control room, the DCD, Revision 5 χ/Qs also remain bounding except for those associated with the DCD COL Item 2A.2-2-A, "Confirmation of Reactor Building χ/Q values." This COL item specifies administrative controls to be implemented if the χ/Q values for a release from certain reactor building or fuel building doors are not bounded by the DCD, Revision 5 χ/Q values. The North Anna FSAR, Revision 0 did not specify this condition in its administrative controls. In the North Anna FSAR, Revision 1, Chapter 2, "Site Characteristics," NAPS COL 2A.2-2-A, the applicant stated that the North Anna administrative controls will be such that the doors and personnel air locks on the east side of the Reactor Building or Fuel Building are promptly closed under conditions indicative of a fuel handling accident.

   The staff finds that this response is acceptable.

3. The bounding values for isotopic activity release rates to the environment for the DBAs in ESP No. ESP-003, Appendix B, were not available for inclusion in North Anna FSAR Revision 0 because the ESP was issued on the same day that the Unit 3 COL application was submitted. A subsequent review of the COL application with respect to

the as-issued ESP by the applicant identified that the DBA source terms evaluated in the DCD Revision 4, Chapter 15 were not bounded by the ESP-003 source terms in all cases. Therefore, the applicant stated that it will revise the COL application to address the DCD Revision 5 source terms and will include a request for a variance to use the DCD Revision 5 source terms in lieu of the ESP values. In the North Anna FSAR, Revision 1, the applicant revised the FSAR to address the ESBWR DCD, Revision 5, Chapter 15 source terms and requested a variance, NAPS ESP VAR 2.0-6, to use the North Anna Unit 3 source terms from the DCD Revision 5 in lieu of those values specified in the North Anna ESP.

The staff finds that this variance is acceptable because the calculated doses in the ESBWR, Revision 5 are within the regulatory limits and the site-specific χ/Q values are lower than those values specified in the ESBWR DCD, Revision 5.

4. The applicant stated that the North Anna 3 COL application Departure Report is being revised to clarify the criteria under which a variance is requested. In the North Anna COL Departure Report, Revision 1, the applicant revised the variance sections to clarify the criteria under which a variance is requested.

Therefore, RAI 15.06.05-1 is closed.

ESBWR DCD, Revision 5, Section 15.4 provided details and results of analyses of the offsite radiological consequences for the DBAs in several sections discussing the accidents. A list of the DBAs analyzed for radiological consequences and the sections where the RCA for those DBAs are discussed in the ESBWR DCD, Revision 5, is given below.

DCD Section	Design-Basis Accident
15.4.1	Fuel Handling Accident
15.4.5	Main Steam Line Break Outside Containment
15.4.6	Control Rod Drop Accident
15.4.7	Feedwater Line Break Accident
15.4.8	Failure of Small Line
15.4.9	RWCU/SDC System Line Failure
15.4.10	Spent fuel Cask Drop Accident

The NRC staff's technical evaluation of the information incorporated by reference related to the DBA RCA will be documented in the corresponding final SER.

The DBA RCA in the ESBWR DCD, Revision 5 used design reference values for the offsite atmospheric dispersion factors, in place of site-specific values. The χ/Q values are the only input to the DBA RCA that are impacted by the site characteristics. The applicant provided and discussed the North Anna site-specific offsite χ/Q values in resolution of COL Item 2.0-10-A, "Short-Term Dispersion Estimates for Accidental Atmospheric Releases," and COL Item 2.3-2, "Atmospheric Dispersion Factors for Control Room." The applicant also provided supplemental information in North Anna 3 COL FSAR Table 2.3-207, "Unit 3 Cross Unit χ/Q Result," for evaluating the impact of a postulated DBA in North Anna Units 1 and 2 on the North Anna Unit 3 control room. The North Anna site-specific EAB and LPZ χ/Q values are given in the North Anna COL FSAR Table 2.3.4-1.

In Section 2.3.4, “Short-Term diffusion Estimates,” of this SER, the staff discusses its review and resolution of (1) COL item 2.0-10-A, (2) COL Item 2.3-2, and (3) the supplemental information, related to the North Anna site-specific χ/Q values as stated above, included under Section 2.3.4 of the North Anna COL FSAR, Revision 1.

The estimated offsite DBA dose calculated for a particular site is impacted by the site characteristics through the calculated χ/Q input to the analysis and the resulting dose would be different than that calculated generically for the ESBWR design. All other inputs and assumptions in the RCA remain the same as in the DCD. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing a DCD site parameter χ/Q value and a site characteristic χ/Q value, the site is acceptable for the design if the site characteristic χ/Q value is smaller than the site parameter χ/Q value. Such a comparison shows that the site has better dispersion characteristics than that required by the reactor design.

For each time averaging period, the North Anna site-specific offsite χ/Q values are less than the design reference offsite χ/Q values used by the ESBWR DCD, Revision 5 RCA for each of the DBAs. Since the result of the RCA for a DBA during any time period of radioactive material release from the plant is directly proportional to the χ/Q for that time period, and because the North Anna site-specific χ/Q values are less than the comparable ESBWR DCD, Revision 5, design reference χ/Q values for all time periods and all accidents, then the North Anna site-specific total dose for each DBA is therefore less than the ESBWR DCD, Revision 5, generic total dose for each DBA.

Since the ESBWR DCD, Revision 5, analyses show that the offsite and control room radiological consequences meet the regulatory dose requirements of 10 CFR 100.21, 10 CFR 50.34(a)(1), 10 CFR 52.79(a)(1), and GDC-19, and since, by the logic above, the North Anna site-specific DBA offsite and control room radiological consequences are less than those for the ESBWR DCD, Revision 5, then the applicant has sufficiently shown that the DBA offsite radiological consequences meet the requirements of 10 CFR 100.21, 10 CFR 50.34(a)(1), 10 CFR 52.79(a)(1), and GDC-19.

15.5 Post Combined License Activities

There are no post COL activities related to this Chapter.

15.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff’s review confirmed that the applicant addressed the required information relating to the Safety Analyses and there is no outstanding information expected to be addressed in the COL FSAR related to this chapter.

In addition, the staff has compared the additional COL supplemental information within the application to the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Chapter 15, and other NRC regulatory guides and concludes that the applicant is in compliance with NRC regulations.

The staff is reviewing the information in DCD Chapter 15 on Docket No. 52-010. The results of the NRC staff’s technical evaluation of the information of the information related to “Safety Analyses” incorporated by reference in the North Anna 3 COL FSAR will be documented in the

staff's SER on the design certification (DC) application for the ESBWR. The SER on the ESBWR is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Chapter 15 of this SER to reflect the final disposition of the DC application.