15.0 ACCIDENT ANALYSIS

The evaluation of the safety of a nuclear power plant includes analyses of the plant's responses to postulated disturbances in process variables and postulated equipment failures or malfunctions. Such safety analyses provide a significant contribution to the selection of limiting conditions for operation, limiting safety system settings, and design specifications for components and systems from the standpoint of public health and safety. These analyses are a focal point of the combined license (COL) reviews. In Chapter 15 of the Final Safety Analysis Report (FSAR), the COL applicant discussed the applicable transient and accident analyses to justify its conformance to the applicable regulations.

The Nuclear Regulatory Commission (NRC) staff's review of Bellefonte (BLN) COL FSAR Chapter 15 follows the format contained in BLN Chapter 15, with the exception that the staff's review of the bounding radiological consequence assessments for the Chapter 15 design basis accidents (DBAs) is presented in Section 15.9 of this safety evaluation report (SER). The radiological consequence assessment evaluated in SER Section 15.9 encompasses all the Chapter 15 DBAs, as well as the radiological habitability evaluations for the Technical Support Center (TSC) and the control room.

15.0 Accident Analysis (Related to Regulatory Guide (RG) 1.206, Section C.III.1, Chapter 15, C.I.15.1, "Transient and Accident Classification," C.I.15.2, "Frequency of Occurrence," C.I.15.3, "Plant Characteristics Considered in the Safety Evaluation," C.I.15.4, "Assumed Protection System Actions," and C.I.15.5, "Evaluation of Individual Initiating Events")

15.0.1 Introduction

Design basis transient and accident analyses are required as a part of an evaluation of the safety of a nuclear power plant by analyzing the plant's responses to postulated disturbances in process variables and postulated equipment failures or malfunctions. The safety analyses provide a significant contribution to the determination of limiting conditions for operation, limiting safety system settings, and design specifications for plant components and systems to protect public health and safety.

15.0.2 Summary of Application

Section 15.0 of the BLN COL FSAR, Revision 1, incorporates by reference Section 15.0 of the AP1000 Design Control Document (DCD), Revision 17.

AP1000 COL Information Item

- COL 15.0-1

This COL information item was provided in a response to a request for additional information (RAI) related to the AP1000 design certification amendment review. Specifically, in its response dated May 6, 2009, (Agencywide Documents Access and Management System (ADAMS) Accession Number ML091310260) to NRC RAI AP1000 DCD RAI-SRP15.0-SRSB-02, Westinghouse proposed COL Information Item 15.0-1 to provide documentation of the plant calorimetric uncertainty methodology. It should be noted that the BLN applicant has not yet

proposed this item. RAI-SRP15.0-SRSB-02 noted that the AP1000 DCD assumes a 2 percent power uncertainty for the initial condition for most accidents that are not departure from nucleate boiling limited. However, a 1 percent power uncertainty is assumed for the initial reactor power for the large-break loss-of-coolant accident (LOCA) in DCD Section 15.6.5.4A, as well as the mass and energy release calculation in DCD Sections 6.2.1.3 and 6.2.1.4. In response to this RAI, Westinghouse proposed a new COL information item to be included in the AP1000 DCD Section 15.0.15 (Revision 18). COL Information Item 15.0-1 states that:

> Following selection of the actual plant operating instrumentation and calculation of the instrumentation uncertainties of the operating plant parameters prior to fuel load, the Combined License holder will calculate the primary power calorimetric uncertainty. The calculations will be completed using an NRC acceptable method and confirm that the safety analysis primary power calorimetric uncertainty bounds the calculated values.

Tier 2 Departure

The applicant proposed the following Tier 2 departure (DEP) from the AP1000 DCD:

- BLN DEP 2.3-1

In its February 2, 2009, response to RAI 15.00.3-1, Tennessee Valley Authority (TVA) proposed BLN DEP 2.3-1 associated with the exclusion area boundary (EAB) atmospheric dispersion value. In this departure and associated exemption request, TVA notes that Revision 17 of the AP1000 DCD changed the EAB atmospheric dispersion (χ/Q) value to 5.1E-04 sec/m^3. Since the site specific χ/Q site parameter at the EAB of 5.85E-04 is greater than the AP1000 DCD value, a plant-specific dose consequence analysis is necessary to determine the doses at the EAB. The departure and exemption request included a reduction in some conservatisms associated with the dose consequence analysis. The conservatisms that were removed include:

- a reduction of the calorimetric power uncertainty to 1 percent (from 2 percent previously used in the dose analysis)

- removal of the excess conservatism for fuel cycle variations resulting in an approximate 4 percent reduction in the source term

- the containment leak rate used in the LOCA analysis was reduced from 0.10 wt. percent/day to 0.09 wt. percent/day

The NRC staff evaluation of the reduction of the calorimetric power uncertainty to 1 percent is contained in Section 15.0.4 of this report. The evaluation of the other conservatisms and the departure and exemption associated with the request can be found in Section 15.9 of this report.

15.0.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the "Final Safety Evaluation Report [FSER] Related to Certification of the AP1000 Standard Design," related to the DCD (NUREG-1793).

The need to address the calorimetric power uncertainty is found in Section 15.0 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” (SRP). Specifically, Section I.3 of SRP 15.0, “Plant Characteristics in the Safety Evaluation,” states in part “the reviewer also ensures that the application specifies the permitted fluctuations and uncertainties associated with reactor system parameters and assumes the appropriate conditions, within the operating band, as initial conditions for transient analysis.” For the LOCA analysis, Appendix K to 10 CFR Part 50 specifies that an assumed power level lower than 1.02 times the licensed power level may be used provided the proposed alternative value has been demonstrated to account for uncertainties due to power level instrumentation error.

15.0.4 Technical Evaluation

The NRC staff reviewed Section 15.0 of the BLN 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 the application and incorporated by reference addresses the required information relating to accident analysis. Section 15.0 of the AP1000 DCD is being reviewed by the staff under Docket Number 52-006. The NRC staff’s technical evaluation of the information incorporated by reference related to accident analysis will be documented in the staff SER on the design certification (DC) amendment application for the AP1000 design.

The staff reviewed the information contained in the BLN COL FSAR:

AP1000 COL Information Item

- COL 15.0-1

Although Westinghouse has proposed COL Information Item 15.0-1, the BLN application does not address this item. Therefore, the staff cannot complete its evaluation until this information is provided. This is **Open Item 15.0-1.**

[1] See Section 1.2.2 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 DC.

Tier 2 Departure

- BLN DEP 2.3-1

The applicant's response to RAI 15.00.03-1 does not describe the instrumentation or methodology to support the 1 percent power uncertainty. To resolve this issue the staff needs the following information:

a. A description of the mechanism, such as the AP1000 DCD and inspections, tests, analyses, and acceptance criteria (ITAAC) or a COL information item, by which the information will be provided to support the claimed 1 percent power measurement.

b. The following information should be provided to support the claimed 1 percent power measurement uncertainty:

   (1) A description of the instrumentation and methodology used for the main feedwater flow measurement and calorimetric power measurement.

   (2) Either of the following:

      A. A reference to the NRC approval of the main feedwater and power measurement methodology, instrumentation, and associated uncertainties.

      Or

      B. A detailed description of the analyses of the main feedwater flow measurement and power measurement uncertainties, respectively. The description should include information such as:

         1) the parameters measured, e.g., feedwater flow rate, pressure, and inlet and outlet temperatures;

         2) the instrument string, including applicable sensors or transducers, process rack, analog/digital converter, process computer, and readout devices, etc., for each parameter measured;

         3) the accuracy of allowance associated with each instrument component, such as sensor reference, calibration, and measurement accuracies, respectively; rack calibration and measurement accuracies; sensor pressure and temperature effects; rack pressure and temperature effects; drift; process measurement accuracy; instrument range, span, and operating limits, etc.;

4) the methodology for combining uncertainties, allowances, or errors of the instrument components associated with each parameter to arrive at the overall uncertainty of each measured parameter; and

5) the methodology used to arrive at the total uncertainties for the main feedwater flow rate and reactor thermal power, respectively.

This is **Open Item 15.0-2.**

15.0.5 Post Combined License Activities

There is potentially a post-COL activity associated with Westinghouse proposed COL Information Item 15.0-1. This section will be updated following the resolution of this issue.

15.0.6 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 accident analysis and there is no outstanding information expected to be addressed in the BLN COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.0 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to accident analysis incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.0 of this SER to reflect the final disposition of the DC amendment application.

However, as a result of Open Items 15.0-1 and 15.0-2 noted above, the staff is unable to finalize its conclusions related to accident analysis.

15.1 Increase in Heat Removal from the Primary System (Related to RG 1.206, Section C.III.1, Chapter 15, C.I.15.6, "Event Evaluation")

Analyses focused on the increase in heat removal from the primary system address anticipated operational occurrences (AOOs) and accidents that increase the heat removal by the secondary system, which could result in a decrease in reactor coolant temperature. Increased heat removal can be caused by:

- Feedwater system malfunctions causing a reduction in feedwater temperature
- Feedwater system malfunctions causing an increase in feedwater flow
- Excessive increase in secondary steam flow
- Inadvertent opening of a steam generator relief or safety valve
- Steam system piping failure
- Inadvertent operation of the passive residual heat removal heat exchanger

Section 15.1 of the BLN COL FSAR incorporates by reference, with no departures or supplements, Section 15.1, "Increase in Heat Removal from the Primary System," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.1 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to increase in heat removal from the primary system events incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.1 of this SER to reflect the final disposition of the DC amendment application.

15.2 Decrease in Heat Removal By the Secondary System

Analyses focused on the decrease in heat removal by the secondary system address AOOs and accidents that could result in a reduction of the capacity of the secondary system to remove heat generated in the reactor coolant system (RCS). Decreased heat removal can be caused by:

- Steam pressure regulator malfunction or failure that results in decreasing steam flow
- Loss of external electrical load
- Turbine trip
- Inadvertent closure of main steam isolation valves
- Loss of condenser vacuum and other events resulting in turbine trip
- Loss of alternating current (ac) power to station auxiliaries
- Loss of normal feedwater flow
- Feedwater system pipe break

Section 15.2 of the BLN COL FSAR incorporates by reference, with no departures or supplements, Section 15.2, "Decrease in Heat Removal by the Secondary System," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.2 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to decrease in heat removal by the secondary system events incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.2 of this SER to reflect the final disposition of the DC amendment application.

15.3 Decrease in Reactor Coolant System Flow Rate

Analyses focused on the decrease in RCS flow rate address AOOs and accidents that could result in a decrease in the RCS flow rate. Decreased flow rate can be caused by:

- Partial loss of forced reactor coolant flow
- Complete loss of forced reactor coolant flow
- Reactor coolant pump (RCP) shaft seizure (locked motor)
- RCP shaft break

Section 15.3 of the BLN COL FSAR incorporates by reference, with no departures or supplements, Section 15.3, "Decrease in Reactor Coolant System Flow Rate," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.3 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to decrease in the reactor coolant flow rate events incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.3 of this SER to reflect the final disposition of the DC amendment application.

15.4 Reactivity and Power Distribution Anomalies

15.4.1 Introduction

Analyses focused on reactivity and power distribution anomalies address AOOs and accidents that could result in anomalies in the reactivity or power distribution in the reactor core. Reactivity and power distribution anomalies can be caused by:

- Uncontrolled rod cluster control assembly (RCCA) bank withdrawal from a subcritical or low-power startup condition
- Uncontrolled RCCA bank withdrawal at power
- RCCA misalignment
- Startup of an inactive RCP at an incorrect temperature
- Chemical and volume control system malfunction that results in a decrease in the boron concentration in the reactor coolant
- Inadvertent loading and operation of a fuel assembly in an improper position
- Spectrum of RCCA ejection accidents

15.4.2 Summary of Application

Section 15.4 of the BLN COL FSAR, Revision 1, incorporates by reference Section 15.4 of the AP1000 DCD, Revision 17.

In addition, in Section 1.9 of the BLN COL FSAR, the applicant provided the following:

Generic Letter 85-05, Inadvertent Boron Dilution

The applicant provided additional information in Standard (STD) COL 1.9-2 to address Bulletins and Generic Letters (GLs). The Bulletins and GLs provided in this AP1000 COL information item included GL 85-05, "Inadvertent Boron Dilution Events." In Revision 0 of the BLN COL FSAR, Table 1.9-204 stated that additional information regarding GL 85-05 was contained in FSAR Section 5.2.4.9. In Revision 1 of the BLN COL FSAR, the applicant removed the reference to GL 85-05 in FSAR Table 1.9-204. The applicant noted in a January 27, 2009, letter (ADAMS Accession Number ML090290127) that the basis for removal of the information was that the DCD evaluation was sufficient.

15.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the DCD (NUREG-1793).

15.4.4 Technical Evaluation

The NRC staff reviewed Section 15.4 of the BLN 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 the application and incorporated by reference addresses the required information relating to reactivity and power distribution anomalies. Section 15.4 of the AP1000 DCD is being reviewed by the staff under Docket Number 52-006. The NRC staff's technical evaluation of the information incorporated by reference related to reactivity and power distribution anomalies will be documented in the staff SER on the DC amendment application for the AP1000 design.

The staff reviewed the information contained in the BLN COL FSAR:

Generic Letter 85-05

GL 85-05, "Inadvertent Boron Dilution Events," informed each PWR licensee of the NRC staff position resulting from the evaluation of Generic Issue 22, "Inadvertent Boron Dilution Events," and urges each licensee to ensure that its plants have adequate protection against boron dilution events. GL 85-05 was evaluated as a part of the AP1000 DCD review, and the evaluation was documented in NUREG-1793, Chapter 20. GL 85-05 was resolved based on the analyses of inadvertent boron dilution events described in AP1000 DCD Section 15.4.6, which show that in all modes of operation the inadvertent boron dilution is prevented or responded to by automatic functions, or sufficient time is available for operator action to terminate the transient. The staff also stated that COL applicants should develop plant-specific emergency operating procedures (EOPs) that address the boron dilution events. The development of EOPs is identified as COL Information Item 13.5-1, Plant Procedures, which is

addressed in BLN FSAR Section 13.5. Therefore, based on the above, the applicant needs to reinsert a reference to GL 85-05 in FSAR Table 1.9-204 and provide a cross reference to COL Information Item 13.5-1. This is **Open Item 15.4-1.**

15.4.5 Post Combined License Activities

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

15.4.6 Conclusion

The NRC staff reviewed the application and checked the referenced DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to reactivity and power distribution anomalies, and there is no outstanding information expected to be addressed in the BLN COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.4 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.4 of this SER to reflect the final disposition of the application to amend the DC.

However, as a result of Open Item 15.4-1 noted above, the staff is unable to finalize its conclusions related to reactivity and power distribution anomalies.

15.5 Increase in Reactor Coolant Inventory

Analyses focused on the increase in reactor coolant inventory address AOOs that could result in an increase in RCS inventory. Increased inventory can be caused by:

- Inadvertent operation of the core makeup tanks during power operation
- Chemical and volume control system malfunctions that increases reactor coolant inventory

Section 15.5 of the BLN COL FSAR incorporates by reference, with no departures or supplements, Section 15.5, "Increase in Reactor Coolant Inventory," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.5 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to increase in reactor coolant inventory events incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.5 of this SER to reflect the final disposition of the DC amendment application.

15.6 Decrease in Reactor Coolant Inventory

Analyses focused on the decrease in reactor coolant inventory address AOOs and accidents that could result in a decrease in RCS inventory. Decreased inventory can be caused by the following:

- Inadvertent opening of a pressurizer safety valve or inadvertent operation of the automatic depressurization system
- Failure of small lines carrying primary coolant outside containment
- Steam generator tube failure
- LOCA resulting from a spectrum of postulated piping breaks within the RCPB

Section 15.6 of the BLN COL FSAR contains one supplemental item, BLN COL 2.3-4, related to site-specific χ/Q values. In addition, the applicant has proposed in its February 2, 2009, letter to add a departure, BLN DEP 2.3-1, to FSAR Section 15.6. BLN COL 2.3-4 is addressed in Section 15.9 of this SER and proposed BLN DEP 2.3-1 is addressed in Sections 15.0 and 15.9 of this SER.

With the exception of the items noted above, Section 15.6 of the BLN COL FSAR incorporates by reference Section 15.6, "Decrease in Reactor Coolant Inventory," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.6 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to decrease in reactor coolant inventory events incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.6 of this SER to reflect the final disposition of the DC amendment application.

15.7 Radioactive Release From a Subsystem or Component

15.7.1 Introduction

The group of events considered includes the following:

- Gas waste management system leak or failure
- Liquid waste management system leak or failure (atmospheric release)
- Release of radioactivity to the environment via liquid pathways
- Fuel handling accident
- Spent fuel cask drop accident

15.7.2 Summary of Application

Section 15.7 of the BLN COL FSAR, Revision 1, incorporates by reference Section 15.7 of the AP1000 DCD, Revision 17.

In addition, in BLN COL FSAR Section 15.7, the applicant provided the following:

AP1000 COL Information Item

- BLN COL 15.7-1

The applicant provided additional information in BLN COL 15.7-1 to address COL Information Item 15.7-1, "Consequences of Tank Failures," described in Section 15.7.6 of the AP1000 DCD. The applicant added the following paragraph at the end of DCD Section 15.7.6:

> This COL item is addressed in Section 2.4.13.

15.7.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the DCD (NUREG-1793).

In addition, the regulatory basis for acceptance of the supplementary information on consequences of a tank failure is established in 10 CFR 20.1301; Table 2 of Appendix B to 10 CFR Part 20; 10 CFR 20.1406; 10 CFR 50.34a; 10 CFR 50.36a; Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 60 and 61; 10 CFR 52.80(a); the codes and standards listed in Table 1 of RG 1.143; Regulatory Position C.1.1 of RG 1.143; RG 1.109; RG 1.113; and RG 4.21. The applicable acceptance criteria are identified in Section 11.2, including Branch Technical Position (BTP) 11-6, of NUREG-0800, and NUREG-0800 Section 2.4.13, Acceptance Criterion No. 5.

15.7.4 Technical Evaluation

The NRC staff reviewed Section 15.7 of the BLN 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 the application and incorporated by reference addresses the required information relating to the radioactive release from a subsystem or component. Section 15.7 of the AP1000 DCD is being reviewed by the staff under Docket Number 52-006. The NRC staff's technical evaluation of the information incorporated by reference related to radioactive release from a subsystem or component will be documented in the staff SER on the DC amendment application for the AP1000 design.

The staff reviewed the information contained in the BLN COL FSAR:

AP1000 COL Information Item

- BLN COL 15.7-1

The applicant addresses the consequence of a liquid waste tank failure in BLN COL FSAR Section 2.4.13. The staff's evaluation of liquid waste tank failure is contained in Sections 11.2, "Liquid Waste Management Systems," and 2.4.13, "Accidental Release of Radioactive Liquid Effluents in Ground and Surface Waters," of this report. As noted in Section 2.4 of this report, the staff stopped the hydrology review and will not restart it until after TVA satisfactorily passes an inspection and when reviewer resources are available. The resolution of hydrologic engineering issues is identified as Open Item 2.4-1. The staff cannot come to a conclusion regarding radioactive release from a subsystem or component until Open Item 2.4-1 is resolved. This is **Open Item 15.7-1.**

15.7.5 Post Combined License Activities

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

15.7.6 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 radioactive release from a subsystem or component, and there is no outstanding information expected to be addressed in the BLN COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Section 15.7 of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information incorporated by reference in the BLN COL FSAR will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.7 of this SER to reflect the final disposition of the DC amendment application.

However, as a result of Open Item 15.7-1 noted above, the staff is unable to finalize its conclusions on BLN COL 15.7-1.

15.8 Anticipated Transients Without Scram

Analyses focused on anticipated transients without scram (ATWS) address an AOO during which an automatic reactor scram is required but fails to occur due to a common mode fault in the reactor protection system.

Section 15.8 of the BLN COL FSAR incorporates by reference, with no departures or supplements, Section 15.8, "Anticipated Transients Without Scram," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

Section 15.8 of Revision 17 of the AP1000 DCD is identical to Section 15.8 of Revision 15 of the AP1000 DCD, which is incorporated by reference into 10 CFR Part 52, Appendix D. This section is not affected by the changes that Westinghouse proposed in Revision 17 to the AP1000 DCD. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix D, Section VI.B.1, all nuclear safety issues relating to ATWS events have been resolved.

15.9 Radiological Consequences of Accidents

SER Section 15.9 contains the staff's review of the bounding radiological consequence assessments for the Chapter 15 DBAs. It should be noted that there is no corresponding Section 15.9 in the BLN COL FSAR. The radiological consequence assessment evaluated in SER Section 15.9 encompasses the offsite and control room dose consequences for all the Chapter 15 DBAs, as well as the radiological habitability evaluation for the TSC.

15.9.1 Introduction

This section describes radiological consequence assessments of the DBAs for BLN Units 3 and 4 using the site-specific atmospheric dispersion factors (χ/Qs) provided in BLN FSAR, Revision 1, Table 2.3-319, "BLN Offsite Dispersion χ/Q Values"; Table 2.3-321, "BLN Control Room χ/Q Values"; Table 2.0-201, "Comparison of AP1000 DCD Site Parameters and Bellefonte Nuclear Power Units 3 & 4 Site Characteristics"; and Table 2.0-202, "Comparison of Control Room Atmospheric Dispersion Factors for Accident Analysis for AP1000 DCD and Bellefonte Nuclear Plant Units 3 & 4."

The DBA radiological consequence assessments are based on information provided in: (1) the AP1000 DCD Chapter 15, "Accident Analyses"; (2) BLN FSAR Chapter 15, "Accident Analyses"; and (3) the applicant's response dated February 2, 2009, to RAI 15.00.03-01.

This section also evaluates TSC radiological habitability during and following the DBAs. The TSC provides an area and resources for use by the applicant to provide plant management and technical support to the reactor operating personnel located in the control room in the event of an emergency. The TSC relieves the reactor operator of peripheral duties and communications not directly related to reactor operations and prevents congestion in the main control room.

The TSC radiological habitability evaluation is based on information provided in: (1) the AP1000 DCD, Revision 17, Chapter 18, "Human Factors Engineering"; (2) BLN FSAR, Revision 1, Chapter 18, "Human Factors Engineering"; (3) BLN COL Part 5, "Emergency Plan"; and (4) the applicant's response dated January 30, 2009 to RAI 13.03-25 and RAI 02.03.04-05.

In AP1000 DCD, Revision 17, Westinghouse performed radiological consequence assessments of the following seven reactor DBAs using the hypothetical set of χ/Q values provided in DCD Table 15A-5:

- LOCA (DCD Section 15.6.5)
- Main steam line break outside containment (DCD Section 15.1.5)
- RCP shaft seizure (DCD Section 15.3.3)
- RCCA ejection (DCD Section 15.4.8)
- Small line failure outside containment (DCD Section 15.6.2)
- Steam generator tube rupture (DCD Section 15.6.3)
- Fuel handling accident (DCD Section 15.7.4)

In DCD Revision 17 Chapter 15, Westinghouse concluded that the AP1000 design will provide reasonable assurance that the radiological consequence resulting from any of the above DBAs will fall within the offsite dose criterion of 0.25 Sievert (Sv) (25 roentgen equivalent man [rem]) total effective dose equivalent (TEDE), as specified in 10 CFR 52.47(a)(2)(iv), and within the control room operator dose criterion of 0.05 Sv (5 rem TEDE), as specified in GDC 19, "Control Room," of Appendix A to 10 CFR Part 50.

15.9.2 Summary of Application

In the BLN COL FSAR, Revision 1, Chapter 15, "Accident Analyses," the applicant incorporated by reference Chapter 15, "Accident Analysis," of the AP1000 DCD, Revision 17.

In addition, the applicant provided the following:

Tier 2 Departure and Exemption Request

The applicant proposed the following Tier 2 departures from the AP1000 DCD:

- BLN DEP 2.3-1

In a supplemental response to an RAI dated February 2, 2009, (ADAMS Accession Number ML090350443), the applicant requested a departure and an exemption from the AP1000 DCD, Revision 17 because the BLN site cannot meet the EAB χ/Q values in the AP1000 DCD, Revision 17. To support the departure and exemption request, TVA completed a site specific calculation to demonstrate that the NRC dose requirements were met at the EAB. This site-specific calculation took credit for a reduction in the fission product source term by applying the following two assumptions:

1. Reduction in the containment leak rate used in the LOCA analysis from 0.10 wt. percent/day to 0.09 wt. percent/day (exemption from the AP1000 generic technical specifications)

2. Reduction of the calorimetric power uncertainty to the AP1000 certified value of 1 percent (from 2 percent previously used in the dose analysis) and removal of the excess conservatism for fuel cycle variations resulting in an approximate 4 percent reduction in the core source term.

The exemption request related to the AP1000 DCD EAB χ/Q site parameter involves exemptions to the following requirements:

1. Containment leak rate technical specification.

   TVA requested an exemption from the requirement of 10 CFR Part 52, Appendix D, Subsection III.B to comply with the requirements of the Generic Technical Specifications (TS). Specifically, TVA requested an exemption from Generic TS 5.5.8.c and proposed a more stringent containment leakage rate TS of 0.09 wt. percent/day as opposed to the Generic TS limit of 0.10 wt. percent/day.

2. AP1000 DCD Tier 1 EAB χ/Q site parameter

   TVA requested an exemption from the requirement of 10 CFR Part 52, Appendix D, Subsection III.B to comply with the requirements contained in Tier 1 of the AP1000 DCD. Specifically, TVA requested an exemption from AP1000 DCD Tier 1, Table 5.0-1, Site Parameter for the Site (Exclusion Area) Boundary (0- 2 hour) atmospheric dispersion factor. In its exemption request TVA proposed a site-specific dose consequence analysis using a site-specific EAB χ/Q.

Tier 2 Departure

- BLN DEP 18.8-1

The applicant has taken the departure in the BLN FSAR, Revision 1, Chapter 18, "Human Factors Engineering," in that the BLN TSC is not located in the Control Building as identified in the AP1000 DCD, Revision 17 (BLN DEP 18.8-1). A single TSC for both BLN Units 3 and 4 is provided and located in the basement of the Maintenance Support Building sited in the northwest corner of the BLN site, just north of BLN Unit 3, within the protected area. The applicant stated in the BLN COL Part 5, "Emergency Plan" that even though the BLN TSC location is different from that provided in the AP1000 DCD, Revision 17, it includes the same functional and design requirements included for the TSC specified in the DCD. The evaluation of BLN DEP 18.8-1 in Section 15.9.4 of this report is limited to the TSC radiological habitability. Other aspects of BLN DEP 18.8-1 related to emergency planning and human factors are evaluated in Section 13.3 and 18.8 of this report, respectively.

Supplemental Information

- BLN SUP 6.4-1

In BLN FSAR Section 6.4, "Habitability Systems," the applicant provided one supplemental (SUP) information item (STD SUP 6.4-1). In this supplemental information item, the applicant evaluated the radiological impact of a postulated DBA at a single AP1000 unit to the control room at an adjacent AP1000 unit. The staff evaluated supplemental information, STD SUP 6.4-1, in Section 15.9.4, "Technical Evaluation," below.

AP1000 COL Information Item

- BLN COL 2.3-4

The applicant provided one COL information item, BLN COL 2.3-4. In its response dated February 2, 2009, to RAI 15.00.03-01, the applicant proposed to revise COL Information Item, BLN COL 2.3-4 to read:

> Site-specific χ/Q Values provided in Subsection 2.3.4 are not bounded by the values given in DCD Tables 15A-5 and 15A-6. Therefore, a site-specific dose consequence analysis was performed as discussed in Subsection 15.6.5.

The staff evaluated COL Information Item BLN COL 2.3-4 in Section 15.9.4, "Technical Evaluation," below.

15.9.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the DCD (NUREG-1793).

In addition, the relevant requirements of the Commission regulations for the accident analyses, and the associated acceptance criteria are given in Section 15.0.3 of NUREG-0800.

The applicable regulatory requirements for the information being reviewed in this section (which are consistent with those contained in Section 15.0.3 of NUREG-0800) are as follows:

- Section 52.79(a)(1)(vi) of 10 CFR Part 52 as it relates to the evaluation and analysis of the offsite radiological consequences of postulated accidents with fission product release.

- General Design Criterion (GDC) 19 of Appendix A to 10 CFR Part 50, "Control room," as it relates to maintaining the control room in a safe condition under accident conditions by providing adequate protection against radiation.

- Section 100.21 of 10 CFR Part 100, "Non-seismic siting criteria," as it relates to the evaluation and analysis of the radiological consequences of postulated accidents for the type of facility to be located at the site in support of evaluating the site atmospheric dispersion characteristics.

- Paragraph IV.E.8 of Appendix E, to 10 CFR Part 50, "Emergency Planning and Preparedness for Production and Utilization Facilities," as it relates to adequate provisions for an onsite technical support center (TSC) from which effective direction can be given and effective control can be exercised during an emergency.

The related acceptance criteria (which are consistent with those contained in Section 15.0.3 of NUREG-0800) are as follows:

- Offsite Radiological Consequences of Postulated Design Basis Accidents.

  The acceptance criteria are based on the requirements of 10 CFR 52.79(a)(1)(vi) as related to mitigating the radiological consequences of an accident. The plant design features intended to mitigate the radiological consequences of accidents, site

atmospheric dispersion characteristics and the distances to the EAB and to the low population zone (LPZ) outer boundary are acceptable if the total calculated radiological consequences for the postulated fission product release fall within the following exposure acceptance criteria specified in 10 CFR 52.79(a)(1)(vi):

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 25 rem TEDE, and

B. An individual located at any point on the outer boundary of the LPZ 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 25 rem TEDE.

- Control Room Radiological Habitability.

  The acceptance criterion is based on the requirements of GDC 19 that mandate a control room design providing adequate radiation protection to permit access and occupancy of the control room under accident conditions for the duration of the accident, without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. These requirements are incorporated into 10 CFR 52.79(a)(4).

  The radiation protection design of the control room is acceptable if the total calculated radiological consequences for the postulated fission product release fall within the exposure acceptance criteria specified in GDC 19 of 5 rem TEDE for the duration of the accident.

- Technical Support Center Radiological Habitability.

  This acceptance criterion is based on the requirement of Paragraph IV.E.8 of Appendix E to 10 CFR Part 50 to provide an onsite TSC from which effective direction can be given and effective control can be exercised during an emergency. The TSC is a required facility specified by the NRC regulation 10 CFR Part 50, Appendix E, Section IV.E.8, as it relates to providing emergency facilities and equipment for use in an emergency. 10 CFR Part 50, Appendix A, GDC 19 requires that the applicant provide equipment at appropriate locations outside the control room with a design capability for prompt hot shutdown of the reactor and with a potential capability for subsequent cold shutdown of the reactor. Its functional criteria are specified in NUREG-0696, “Functional Criteria for Emergency Response Facilities,” and the radiological acceptance criterion is specified in NUREG-0737, Supplement No. 1, “Clarification of [Three Mile Island] TMI Action Plan Requirements.”

  NUREG-0737 requires, among other things, radiological protection to assure that radiation exposure to any person working in the TSC would not exceed 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. NUREG-0800 Section 15.0.3 states that the radiation protection design of the TSC is acceptable if the total calculated radiological consequences for the postulated fission product release fall within the exposure acceptance criteria specified for the control room of 5 rem TEDE for the duration of an accident.

15.9.4 Technical Evaluation

The NRC staff reviewed Chapter 15 of the BLN 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 the application and incorporated by reference addresses the required information relating to radiological consequences of accidents. Chapter 15 of the AP1000 DCD is being reviewed by the staff under Docket Number 52-006. The NRC staff's technical evaluation of the information incorporated by reference related to radiological consequences of accidents will be documented in the staff SER on the DC amendment application for the AP1000 design.

The staff reviewed the information contained in the BLN COL FSAR:

Tier 2 Departures and Exemption Request

- BLN DEP 2.3-1, relating to EAB χ/Q site parameter

In BLN COL FSAR, Revision 0, the applicant referenced the AP1000 DCD, Revision 16. The AP1000 DCD, Revision 16 used an assumption (i.e., aerosol impaction in the containment leakage pathways) which the NRC staff found was not technically justified and, therefore, rejected in evaluating the radiological consequence analysis for the postulated LOCA. In addition, the site-specific χ/Q values for the LOCA shown in BLN FSAR, Revision 0, Table 2.0-201, exceeded the χ/Q values for the EAB referenced in the AP1000 DCD, Revisions 15 and 17 (it met the χ/Q values in Revision 16).

Consequently, in RAI 15.00.03-01, the staff requested that the applicant provide the site-specific DBA radiological consequence analysis that does not make use of the rejected assumption for the EAB, LPZ, and control room. In response to RAI 15.00.03-01, the applicant acknowledged in its submittal dated February 2, 2009, that the site-specific χ/Q values for the EAB for the LOCA shown in BLN FSAR, Revision 0, Table 2.0-201, exceeded the χ/Q values for the EAB referenced in the AP1000 DCD, Revisions 15 and 17 and, therefore, the applicant provided a new radiological consequence analysis for the EAB for the postulated LOCA to demonstrate that it meets the dose evaluation factors set forth in 10 CFR 52.79(a)(1)(vi).

In its new DBA radiological consequence analysis, the applicant proposed the following two reductions in conservatisms from the AP1000 DCD, Revision 17 to reduce the core fission product source term:

1. Containment Leak Rate

   The applicant proposed a reduction of the containment leak rate used in the radiological consequence analysis for the postulated LOCA for the EAB in the AP1000 DCD, Revision 17, Chapter 15 from 0.1 weight percent (w/o) per day to 0.09 w/o per day. NUREG-0800 Section 6.2.6, "Containment Leakage Testing," states that the minimum acceptable design containment leakage rate should not be less than 0.1 percent per day. It further stated that nuclear power plant leakage rate testing experience shows that a design leakage rate of 0.1 percent per day provides adequate margin above typically measured containment leakage rates and is compatible with current leakage rate test

methods and test acceptance criteria. Therefore, this proposal is an exception to the NUREG-0800 guidance. The staff's evaluation of the reduction in the containment leak rate can be found in Section 6.2 of this report.

2. Reactor Core Fission Product Source Term

   In the AP1000 DCD Chapter 15A, Revision 17, Westinghouse used the core source term at shutdown for an assumed three-region equilibrium cycle at end of life after continuous operation at 2 percent above (3468 megawatt thermal [MWt]) the design core power of 3400 MWt, stating that use of 2 percent power uncertainty is conservative and that the main feedwater calorimetric flow measurement supports a 1 percent calorimetric power uncertainty. The applicant proposed use of 1 percent calorimetric power uncertainty for the radiological consequence analysis for the postulated LOCA in the BLN FSAR, Chapter 15, Revision 1. The staff's evaluation of the use of a 1 percent calorimetric power uncertainty can be found in section 15.0.4 of this report.

   The applicant stated that a 4 percent conservatism was originally included in the AP1000 core design calculations to provide margin for uncertainties in the predicted core designs. The applicant stated that the core source term calculations have been revised for the first three core loadings and an equilibrium core cycle that will be utilized for BLN Units 3 and 4. The applicant further stated that it refined the site-specific core source term based on a more detailed evaluation of the first three core loadings and an equilibrium core cycle reduces the uncertainty in the core design, so that the original 4 percent design conservatism is not necessary. The applicant proposed to remove this 4 percent conservatism. The NRC staff has not yet completed its evaluation of the removal of this 4 percent conservatism. **This is Open Item 15.9-1.**

As stated above the applicant also requested an exemption from: 1) the containment leak rate technical specification contained in the AP1000 Generic TSs; and 2) the AP1000 DCD Tier 1 EAB χ/Q site parameter. The proposed reduction in core fission product source term in TVA's site-specific analysis supports this exemption request. Pursuant to 10 CFR 52.7, "Specific Exemption," the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 52. 10 CFR 52.7 further states that the Commission's consideration will be governed by 10 CFR 50.12, which states that an exemption may be granted when: (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. Special circumstances are present as specified in 10 CFR 50.12(a)(2).

In its response to RAI 15.00.03-1 TVA stated that special circumstance 10 CFR 50.12(a)(2)(ii) was present since the χ/Q site parameter in Tier 1 of the DCD is not necessary to achieve the underlying purpose of the rules. TVA stated that the site-specific analysis using the assumptions crediting a reduction in the fission product source term demonstrates that the higher site-specific χ/Q does not affect the design. In addition, TVA stated that special circumstance 10 CFR 50.12(a)(2)(iii) was also present since compliance would necessitate expanding the EAB, which would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted. In its response to RAI 6.2.6-2 TVA amended the special circumstances it was citing to only reference 10 CFR 50.12(a)(2)(ii).

The NRC staff is unable to make the findings required to grant the exemption because of the following:

1. Open items associated with the reductions in conservatisms from the AP1000 DCD, Revision 17 to reduce the core fission product source term have not been resolved (e.g., Open Items 15.0-2, and 15.9-1). These issues must be resolved in order for the staff to determine that the exemption will not present an undue risk to public health and safety.

2. The staff has not completed its evaluation as to whether the special circumstances in 10 CFR 50.12(a)(2) exist.

The staff's evaluation of the EAB χ/Q exemption request in accordance with the requirements of 10 CFR 50.12 is **Open Item 15.9-2**.

Tier 2 Departure

- BLN DEP 18.8-1, addressing the radiological habitability of the location of the TSC.

In BLN COL Part 5, "Emergency Plan," the applicant stated that the TSC is provided with radiological protection and monitoring equipment necessary to control radiation exposure to any person working in the TSC below 0.05 Sv (5 rem) TEDE for the duration of an accident. However, the applicant did not provide the radiological consequence analysis for the postulated fission product release as a result of the DBAs at BLN Units 3 and 4.

Therefore, the staff issued RAI 13.03-25 and RAI 02.03.04-05. In RAI 13.03-25, the staff requested that the applicant provide the radiological consequence analysis for the personnel in the TSC for the postulated fission product release as a result of the DBAs. In RAI 02.03.04-05, the staff requested that the applicant provide a description of the methodology, inputs, assumptions, and calculated atmospheric dispersion factors (χ/Q values) for releases from various potential fission product release points to the TSC.

In its response dated January 30, 2009, to RAI 13.03-25, the applicant provided the radiological consequence analysis for the TSC personnel, complete with the parameters and assumptions used in the analysis. The applicant also provided the TSC design description document as an attachment to the response to RAI 13.03-25. The result of the applicant's analysis showed 1.42 rem TEDE, due to the fission product release from the containment shell to the TSC air intake as a result of the postulated LOCA, meeting the acceptance criterion of 5 rem TEDE. The applicant stated, and the staff agrees, that the postulated LOCA bounds all other DBAs and the calculated χ/Q values from the containment shell to the TSC air intake bound those from the plant vent to the TSC air intake for the postulated LOCA. To verify the applicant's analysis, the staff performed an independent radiological consequence assessment for the TSC. The staff finds reasonable assurance that the BLN TSC meets the acceptance criterion of 5 rem TEDE. Therefore, the staff finds the response to RAI 13.03-25 is acceptable and, thus, the RAI is closed.

Also, in its response dated January 30, 2009, to RAI 02.03.04-05, the applicant provided TSC χ/Q values for BLN Units 3 and 4. The applicant calculated TSC χ/Q values using the guidance provided in RG 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," and the NRC ARCON96 computer code.

ARCON96 computer code input files are provided in an electronic format as an attachment to the response. To verify the applicant's χ/Q values provided, the staff performed an independent calculation using the ARCON96 computer code and was able to produce the same χ/Q values as the applicant provided. Therefore, the staff finds the response to RAI 02.03.04-05 is acceptable and, thus, the RAI is closed.

AP1000 COL Information Item

- Site Specific Offsite, Control Room, and TSC Atmospheric Dispersion Factors

The DBA radiological consequences analyses in the AP1000 DCD, Revision 17 used the hypothetical set of atmospheric dispersion factors (χ/Q values), in place of site-specific values. The χ/Q values are the only input to the DBA radiological consequences analyses that are impacted by the site characteristics. 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 from that calculated generically for the AP10000 design. All other inputs and assumptions in the radiological consequence analyses 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 those required by the reactor design.

The applicant discussed the BLN site-specific offsite, TSC, and control room χ/Q values in the FSAR, Revision 1, Chapter 2, Section 2.3.4,"Short-Term Diffusion Estimates," and provided the BLN site-specific offsite and control room χ/Q values in the FSAR, Revision 1, Table 2.3-319, "BLN Offsite Dispersion χ/Q Values," and Table 2.3-321, "BLN Control Room χ/Q Values." Other than the EAB χ/Q value, the applicant demonstrated that the BLN site-specific LPZ χ/Q values for each time-averaging period are less than the design reference offsite χ/Q values used by the AP1000 DCD, Revision 17, for the radiological consequences analyses for each of the DBAs. Since the result of the radiological consequences analysis 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 BLN site-specific LPZ χ/Q values are less than the comparable AP1000 DCD, Revision 17 design reference LPZ χ/Q values for all time periods and all accidents, the BLN site-specific total LPZ dose for each DBA is less than the AP1000 DCD, Revision 17 generic total dose for each DBA.

The staff is currently evaluating the BLN site-specific offsite, TSC, and control room χ/Q values proposed by the applicant; the staff's findings and evaluation are provided in Section 2.3.4, "Short-Term Diffusion Estimates," of this SER. As noted in Section 2.3.4 of this report there are several open items associated with the review of short-term diffusion estimates. The staff can not complete its radiological review until these open items are resolved. **This is Open Item 15.9-3.**

- BLN COL 2.3-4

In its response dated February 2, 2009, to RAI 15.00.03-01, the applicant proposed to revise COL Information Item, BLN COL 2.3-4 to read:

> Site-specific χ/Q values provided in Subsection 2.3.4 are not bounded by the values given in DCD Tables 15A-5 and 15A-6 (for the Bellefonte EAB χ/Q values). Therefore, a site-specific dose consequence analysis was performed as discussed in Subsection 15.6.5.

Pending satisfactory resolution of Open Items 15.9-1 through 15.9-3, the staff will complete its independent radiological dose calculation for the postulated LOCA for the EAB to verify and confirm the revised BLN EAB dose meets the dose acceptance criteria.

Other than the EAB dose for the postulated LOCA, the staff finds (pending satisfactory resolution of Open Items 15.9-1 through 15.9-3) that the BLN site-specific DBA offsite and control room radiological consequences are less than those for the AP1000 DCD, Revision 17, and, therefore, the applicant has sufficiently shown that the DBA offsite radiological consequences meet the requirements of 10 CFR Part 100.21, 10 CFR 52.79(a)(1)(vi), and GDC 19.

Supplemental Information

- STD SUP 6.4-1

The applicant provided Section 6.4.4.1, "Dual Unit Analysis," in the BLN FSAR, Revision 1, Section 6.4, "Habitability Systems." The applicant provided the following supplementary information to address the control room operator safety:

> Credible events that could put the control room operators at risk from a dose standpoint at a single AP1000 unit have been evaluated and addressed in the DCD. The dose to the control room operators at an adjacent AP1000 due to a radiological release from another unit is bounded by the dose to control room operators on the affected unit. While it is possible that a unit may be downwind in an unfavorable location, the dose at the downwind unit would be bounded by what has already been evaluated for a single unit AP1000. Simultaneous accidents at multiple units at a common site are not considered to be a credible event.

The NRC staff reviewed the STD SUP 6.4-1 information provided by the applicant and agrees that simultaneous accidents at multiple units at a common site are not credible. Therefore, the NRC staff finds STD SUP 6.4-1 to be acceptable.

15.9.5 Post Combined License Activities

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

15.9.6 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 radiological consequences of accidents, and there is no outstanding information expected to be addressed in the BLN COL FSAR related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Chapter 15 of the AP1000 DCD (as it relates to radiological consequences of accidents), as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information incorporated by reference in the BLN COL FSAR, Revision 1, will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Section 15.9 of this SER to reflect the final disposition of the DC amendment application, as it relates to radiological consequences of accidents.

However, as a result of Open Items 15.9-1 through 15.9-3, the staff is unable to finalize its conclusions related to radiological consequences of accidents.

Appendix 15A Evaluation Models and Parameters for Analysis of Radiological Consequences of Accidents

This appendix contains the parameters and models that form the basis of the radiological consequences analyses for the various postulated accidents.

Appendix 15A of the BLN COL FSAR contains one supplemental item, BLN COL 2.3-4, related to site-specific χ/Q values. In addition, the applicant has proposed in its February 2, 2009, letter to add a departure, BLN DEP 2.3-1, to Appendix 15A. BLN COL 2.3-4 is addressed in Section 15.9 of this SER and the proposed BLN DEP 2.3-1 is addressed in Sections 15.0 and 15.9 of this SER.

With the exception of the items noted above, Appendix 15A of the BLN COL FSAR incorporates by reference Appendix 15A, "Evaluation Models and Parameters for Analysis of Radiological Consequences of Accidents," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

The Westinghouse application to amend Appendix D to 10 CFR Part 52 includes changes to Appendix 15A of the AP1000 DCD, as stated in Revision 17 of the AP1000 DCD. The staff is reviewing this information on Docket Number 52-006. The results of the NRC staff's technical evaluation of the information related to the parameters and models that form the basis of the radiological consequences analyses for the various postulated accidents, incorporated by reference in the BLN COL FSAR, will be documented in a supplement to NUREG-1793. The supplement to NUREG-1793 is not yet complete, and this is being tracked as part of Open Item 1-1. The staff will update Appendix 15A of this SER to reflect the final disposition of the DC amendment application.

Appendix 15B Removal of Airborne Activity from the Containment Atmosphere Following a LOCA

This appendix contains information related to the AP1000 design, which does not depend on active systems to remove airborne particulates or elemental iodine from the containment atmosphere following a postulated LOCA with core melt. The AP1000 applicant stated that naturally occurring passive removal processes provide significant removal capability such that airborne elemental iodine is reduced to very low levels within a few hours and the airborne particulates are reduced to extremely low levels within 12 hours.

Appendix 15B of the BLN COL FSAR incorporates by reference, with no departures or supplements, Appendix 15B, "Removal of Airborne Activity from the Containment Atmosphere Following a LOCA," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

Appendix 15B of Revision 17 of the AP1000 DCD is identical to Appendix 15B of Revision 15 of the AP1000 DCD, which is incorporated by reference into 10 CFR Part 52, Appendix D. This section is not affected by the changes that Westinghouse proposed in Revision 17 to the AP1000 DCD. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix D, Section VI.B.1, all nuclear safety issues relating to removal of airborne particulates or elemental iodine from the containment atmosphere following a postulated LOCA with core melt have been resolved.

Appendix 15B Removal of Airborne Activity from the Containment Atmosphere Following a LOCA

This appendix contains information related to the AP1000 design, which does not depend on active systems to remove airborne particulates or elemental iodine from the containment atmosphere following a postulated LOCA with core melt. The AP1000 applicant stated that naturally occurring passive removal processes provide significant removal capability such that airborne elemental iodine is reduced to very low levels within a few hours and the airborne particulates are reduced to extremely low levels within 12 hours.

Appendix 15B of the BLN COL FSAR incorporates by reference, with no departures or supplements, Appendix 15B, "Removal of Airborne Activity from the Containment Atmosphere Following a LOCA," of Revision 17 of the AP1000 DCD. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issue relating to this section remained for review.[1] The NRC staff's review confirmed that there is no outstanding issue related to this section.

Appendix 15B of Revision 17 of the AP1000 DCD is identical to Appendix 15B of Revision 15 of the AP1000 DCD, which is incorporated by reference into 10 CFR Part 52, Appendix D. This section is not affected by the changes that Westinghouse proposed in Revision 17 to the AP1000 DCD. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix D, Section VI.B.1, all nuclear safety issues relating to removal of airborne particulates or elemental iodine from the containment atmosphere following a postulated LOCA with core melt have been resolved.

PKG No.: ML091760296
Accession Number: ML092590516 *see previous concurrence

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