8.0 ELECTRIC POWER

The electric power system is the source of power for station auxiliaries during normal operation and for the reactor protection system and engineered safety features during abnormal and accident conditions. This chapter provides information on the functional adequacy of the offsite power systems and safety-related onsite electric power systems as applicable to the AP1000 passive design and ensures that these systems have adequate capacity, capability, redundancy, independence, and testability in conformance with the current criteria established by the Nuclear Regulatory Commission (NRC).

8.1 Introduction

8.1.1 Introduction

This section provides the applicant's description of the offsite power system with regard to the interrelationships between the nuclear unit, the utility grid, and the interconnecting grids.

In addition, this section includes a regulatory requirements applicability matrix that lists all design bases, criteria, regulatory guides (RGs), standards, and other documents to be implemented in the design of the electrical systems that are beyond the scope of the design certification.

8.1.2 Summary of Application

Section 8.1 of the Bellefonte (BLN) Combined License (COL) Final Safety Analysis Report (FSAR), Revision 1, incorporates by reference Section 8.1 of the AP1000 Design Control Document (DCD), Revision 17.

In addition, in BLN COL FSAR Section 8.1, the applicant provided the following:

Supplemental Information

- BLN SUP 8.1-1

The applicant provided supplemental (SUP) information in BLN COL FSAR Section 8.1, "Introduction," describing the Tennessee Valley Authority (TVA), the TVA 500 kilovolt (kV) transmission system, and the connection interface with BLN Units 3 and 4 (BLN 3 and 4) via the 500 kV switchyard at the plant site.

- BLN SUP 8.1-2

The applicant provided supplemental information in BLN COL FSAR Section 8.1 describing additional information for regulatory guidelines and standards.

8.1.3 Regulatory Basis

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

In addition, the relevant requirements of the Commission regulations for the introduction to the electric power systems, and the associated acceptance criteria, are given in Section 8.1 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," (SRP).

The applicable regulatory requirements, guidelines, and related acceptance criteria for the supplemental information items are as follows:

- 10 CFR 50.63, "Loss of All Alternating Current Power"
- RG 1.155, "Station Blackout"
- RG 1.206, "Combined License Applications for Nuclear Power Plants (light-water reactor (LWR) Edition)"

8.1.4 Technical Evaluation

The NRC staff reviewed Section 8.1 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 introduction to the electric power systems. Section 8.1 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 the introduction to the electric power systems will be documented in the staff safety evaluation report (SER) on the DC application for the AP1000 design.

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

Supplemental Information

- BLN SUP 8.1-1

The NRC staff reviewed the supplemental information related to the TVA transmission system and its connection to BLN included under BLN SUP 8.1-1. The applicant's supplement to Section 8.1.1 is summarized as follows:

The TVA grid consists of interconnected hydro, fossil fueled, combustion turbine, and nuclear plants supplying electric energy over a transmission system consisting of various voltages up through 500 kV. The BLN is connected into TVA's 500 kV transmission grid through a 500 kV switchyard at the plant site. The 500 kV switchyard is a double bus, double breaker arrangement. There are four 500 kV transmission lines connected in the 500 kV switchyard.

The NRC staff finds that the applicant has adequately described the BLN 3 and 4 connections to the utility grid and the information provided is in accordance with the recommendations of RG 1.206 and the guidance in Section 8.1 of NUREG-0800.

- BLN SUP 8.1-2

[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 design certification (DC).

The NRC staff also reviewed supplemental information included under BLN SUP 8.1-2, related to regulatory guidelines and industry standards and found it to be consistent with Section 8.1 of NUREG-0800 with the exception of the information discussed below.

BLN COL FSAR Table 8.1-201, 1b indicated that RG 1.155 is not applicable to BLN. In request for additional information (RAI) 8.1-2, the staff requested that the applicant identify local power sources and transmission paths that could be made available to resupply power to the plant following a loss of grid or station blackout (SBO). The RAI also asked the applicant to describe the procedures and training provided to the plant operators for an SBO event of the specified duration and recovery there from as recommended in the guide. In addition, the applicant was requested to provide the SBO procedures that include severe weather guidelines established for BLN. In a letter dated June 24, 2008, the applicant stated that AP1000 design meets the requirements of 10 CFR 50.63 for 72 hours and, therefore, no specific procedures or training specific to SBO are necessary. The NRC staff found the above response to be inconsistent with the recommendations of RG 1.155 and, thereby, 10 CFR 50.63. The staff recognizes that the passive systems can maintain safe-shutdown conditions after design-basis events for 72 hours, without operator action, following a loss of both onsite and offsite ac power sources. However, the applicant needs to establish SBO procedures and training for operators to include actions necessary to restore offsite power after 72 hours by addressing ac power restoration (e.g., coordination with transmission system load dispatcher), and severe weather guidance (e.g., identification of site-specific actions to prepare for the onset of severe weather such as an impending tornado) in accordance with RG 1.155, Positions C.2 and C.3.4.

Several discussions were held between the NRC staff and the applicant regarding this issue. Subsequently, in a letter dated April 15, 2009, the applicant stated that the training and procedures to support mitigation of a SBO event will be implemented in accordance with BLN COL FSAR Sections 13.2 and 13.5, respectively. As recommended by NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," the loss of all ac power event mitigation procedures will address response (e.g., restoration of onsite power sources), ac power restoration (e.g., coordination with transmission system load dispatcher), and severe weather guidance (e.g., identification of actions to prepare for the onset of severe weather such as an impending tornado), as applicable. In addition, the applicant stated that there are no nearby large power sources, such as a gas turbine or black start fossil fuel plant that can directly connect to the station to mitigate the event. Based on the above, the NRC staff concludes that the implementation of training and procedures to support mitigation of an SBO event satisfies RG 1.155, Positions C.2 and C.3.4 and is acceptable subject to the verification that the BLN COL FSAR has been updated to include portions of the response. This is identified as **Confirmatory Item 8.1-1**.

8.1.5 Post Combined License Activities

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

8.1.6 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 introduction to the electric power systems, 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 8.1 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 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 8.1 of this SER to reflect the final disposition of the DC application.

In addition, the staff has compared the additional COL-specific supplemental information within the application to the relevant NRC regulations; guidance in NUREG-0800, Section 8.1, and other NRC regulatory guides and concludes that the applicant is in compliance with the NRC regulations subject to the verification of the confirmatory item discussed above. The staff based its conclusion on the following:

- BLN SUP 8.1-1, the applicant provided sufficient information regarding the TVA transmission system and its connection to BLN in accordance with the recommendations of RG 1.206

- BLN SUP 8.1-2, COL-specific regulatory guidelines and industry standards and additional new regulatory guidelines, are adequately addressed by the applicant. In conclusion, the applicant has provided sufficient information for satisfying the recommendations of RG 1.206 and RG 1.155 subject to the verification of the confirmatory item discussed above.

8.2 Offsite Power System

8.2.1 Introduction

The offsite power system is referred to in industry standards and RGs as the "preferred power system." It includes two or more physically independent circuits capable of operating independently of the onsite standby power sources and encompasses the grid, transmission lines (overhead or underground), transmission line towers, transformers and other switchyard components.

The BLN 3 and 4 passive reactor plant design supports an exemption, in accordance with 10 CFR 52, Appendix D, paragraph V.B.3, to the requirement of GDC 17 to have only one, not two, physically independent offsite circuits by providing safety-related passive systems for core cooling and containment integrity, and multiple non-safety-related onsite and offsite electric power sources for other functions. Therefore, the single offsite power source provided from the transmission network is reviewed below to assure that it satisfies the requirements of GDC 17 with respect to its capacity and capability.

8.2.2 Summary of Application

Section 8.2 of the BLN COL FSAR incorporates by reference Section 8.2 of the AP1000 DCD, Revision 17.

In addition, in BLN COL FSAR Section 8.2, the applicant provided the following:

Tier 2 Departures

- BLN DEP 8.2-1

In Part 7 of the BLN COL application, the applicant proposed the following Tier 2 departure from the AP1000 DCD. In Revision 1 of the BLN FSAR the transformer area was rearranged to simplify the design. The transformer area contains the main stepup transformers, the unit auxiliary transformers, and the reserve auxiliary transformers. This rearrangement is implemented for BLN Unit 4; however, it is not implemented for BLN Unit 3.

AP1000 COL Information Items

- BLN COL 8.2-1

The applicant provided additional information in BLN COL 8.2-1 to address COL Information Item 8.2-1 (COL Action Items 8.2.3-1 and 8.2.3.3-1), describing: 1) the designs of the plant site 500 kV switchyard, the four 500 kV transmission lines connecting the plant switchyard to the TVA 500 kV transmission system, and the interface of the switchyard with the transmission grid; 2) the connections of the generator step-up (GSU) transformers and the reserve auxiliary transformers (RATs) to the switchyard; 3) the designs of the switchyard circuit breakers and disconnect switches; 4) the transformer area arrangement for each unit; 5) the designs of the GSU transformers, unit auxiliary transformers (UATs) and RATs; 6) the design of the control building in the plant site 500 kV switchyard; 7) the administrative control of 500 kV switchyard and transmission lines circuit breakers, and 8) the switchyard and transmission lines testing and inspection plan.

- BLN COL 8.2-2

The applicant provided additional information in BLN COL 8.2-2 to address COL Information Item 8.2-2 (COL Action Items 8.2.3.1-1, 8.2.3.1-2, and 8.2.3.1-3), describing: 1) the 500 kV switchyard arrangement and design of the protective relaying scheme; and 2) a transmission system study performed regularly to verify grid stability, switchyard voltage, and frequency to confirm the transmission system capability to maintain reactor coolant pump (RCP) operation for three seconds following a turbine trip, as specified in DCD Section 8.2.2.

Site-Specific Information Replacing Conceptual Design Information (CDI)

- BLN CDI

The applicant provided site-specific information describing the transformer area located next to each unit's turbine building and containing the GSU transformer, the UATs, and the RATs. This replaced the CDI located in the DCD.

Supplemental Information

- BLN SUP 8.2-1

The applicant provided supplemental information describing details of a Failure Mode and Effects Analysis (FMEA) performed for the offsite power distribution system, plant site switchyard, and the TVA transmission system. It also provided information on the transmission system provider/operator (TSP/TSO), and the grid operating, reactive power, and configuration limits requirements to be maintained by TVA Power Systems Operations (PSO).

- BLN SUP 8.2-2

The applicant provided supplemental information describing the formal agreement between TVA Nuclear (TVAN) and TVA PSO, which is the TSP/TSO, setting the requirements for transmission system studies and analyses.

- BLN SUP 8.2-3

The applicant provided supplemental information describing the establishment of TVA PSO responsibility for maintaining area bulk transmission system reliability and demonstrating, by power system simulation studies, projections, and analyses, the current and future reliability of the system.

- BLN SUP 8.2-4

The applicant provided supplemental information describing the agreement between TVAN and PSO demonstrating that protocols are in place for BLN to remain cognizant of grid vulnerabilities in order to make informed decisions regarding maintenance activities critical to the electric system.

- BLN SUP 8.2-5

The applicant provided supplemental information describing the reliability of the four 500 kV transmission lines feeding the BLN site for the period from 1989 to 2007.

8.2.3 Regulatory Basis

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

In addition, the relevant requirements of the Commission regulations for the offsite power system, and the associated acceptance criteria, are given in Sections 8.1 and 8.2 of NUREG-0800.

The regulatory bases for acceptance of the COL information and supplementary information items are established in:

- For BLN COL 8.2-1, and BLN SUP 8.2-1, the requirements of 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 17, “Electric Power Systems,” GDC 18, “Inspection and Testing of Electrical Power Systems,” and the guidelines of RG 1.206

- For BLN COL 8.2-2, and BLN SUP 8.2-2, BLN SUP 8.2-3, and BLN SUP 8.2-5, the requirements of GDC 17 and the guidelines of RG 1.206

- For BLN SUP 8.2-4, the requirements of GDC 17, GDC 18, and 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," and the guidelines of RG 1.206

- For BLN CDI, the requirements of GDC 17

Tier 2 departures that do not require prior NRC approval

In addition, in accordance with Section VIII, Processes for Changes and Departures, of Appendix D to 10 CFR Part 52--Design Certification Rule for the AP1000 Design, the applicant identified a Tier 2 departure (BLN DEP 8.2-1) that does not require prior Commission approval.

8.2.4 Technical Evaluation

The NRC staff reviewed Section 8.2 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 offsite power system. Section 8.2 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 the offsite power system will be documented in the staff SER on the DC application for the AP1000 design.

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

Tier 2 departures that do not require prior NRC approval

The applicant identified the following Tier 2 departure:

- BLN DEP 8.2-1: Transformer area arrangement

In Revision 1 of the BLN COL FSAR the transformer area was rearranged to simplify the design. This rearrangement is implemented for BLN Unit 4; however, it is not implemented for BLN Unit 3. BLN Unit 3 retains the transformer area arrangement as presented in Revision 17 of the DCD. With these transformer area arrangements, the layout of the incoming and outgoing power lines between the switchyard and the units does not require crossing of the lines for either unit. Retention of the transformer area arrangement as presented in Revision 17 of the DCD is a departure for BLN Unit 3 only.

The applicant's evaluation in accordance with Item B.5 of Section VIII of Appendix D to 10 CFR Part 52 determined that this departure did not require prior NRC approval The applicant's process for evaluating departures and other changes to the DCD are subject to NRC inspections.

AP1000 COL Information Item

- BLN COL 8.2-1

COL Information Item 8.2-1 states:

> Combined License applicants referencing the AP1000 certified design will address the design of the ac power transmission system and its testing and inspection plan (DCD Section 8.2.5).

The commitment was also captured as COL Action Items 8.2.3-1 and 8.2.3.3-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

> The operating voltage for the high side of the AP1000 transformer and transmission switchyard, as well as the frequency decay rate are site specific and, therefore, will be addressed in the COL application. The COL applicant will provide analysis of these matters, including transient stability, voltage operating range, and preservation of the grid connections, in the COL application. (COL Action Item 8.2.3-1)
>
> Combined License applicants referencing the AP1000 certified design will address the design of the ac power transmission system and its testing and inspection plan (COL Action Item 8.2.3.3-1).

The NRC staff reviewed the resolution to COL information item, BLN COL 8.2-1, related to the transmission system design, testing, and inspection addressed in Section 8.2 of the BLN COL FSAR. The NRC staff's evaluation is described below.

BLN is served by a 500 kV switchyard, modified to meet the requirements for BLN 3 and 4. The applicant described the connection of the RATs to the 500 kV to 230 kV transformers in the 500 kV switchyard. The configuration of the 500 kV and 230 kV lines and location of the GSUs and RATs for BLN 3 and 4 are shown in Figure 8.2-202 of the BLN COL FSAR. The normal power supply to the main ac power system is provided from the main generator. The 500 kV line is the preferred power supply and is the recognized GDC 17 offsite power source for BLN 3 and 4. When either the normal power or the preferred power supply is available, the RATs serve as a source of maintenance power. Thus, when in use, the 230 kV line becomes the recognized GDC 17 offsite power source. The NRC staff's review of BLN COL FSAR Figure 8.2-202 showed that the 230 kV and 500 kV lines run parallel for BLN Unit 3, but cross each other for BLN Unit 4 in the vicinity of the plant. The staff was concerned that during adverse weather conditions, the high winds could cause the loss of both the 500 kV and 230 kV lines to supply offsite power to BLN Unit 4.

In RAI 8.2-9, the NRC staff requested that the applicant address this vulnerability in the offsite power system design. In a letter dated December 19, 2008, the applicant stated that BLN COL FSAR Chapter 8, Figure 8.2-202 and Chapter 1, Figure 1.1-202 will be revised to re-orient GSU transformers and RATs to resolve the crossing of transmission lines on BLN Unit 4 and that combined license application (COLA) Part 7, Departures and Exemptions, will be revised to add BLN DEP 8.2-1 in the next revision to the FSAR. Subsequently, in Revision 1 to the BLN COL FSAR, the applicant revised Figure 8.2-202 and Chapter 1, Figure 1.1-202 and proposed BLN DEP 8.2-1. The staff has verified that the applicant has re-oriented the GSU transformers and the RATs so that the transformer area arrangement eliminates the need to cross the

incoming and out going power lines between BLN Unit 4 and the switchyard. Based on the above, the NRC staff concludes that the above changes eliminate the potential for loss of both transmission lines during adverse conditions due to line crossing, and therefore, resolves this issue.

In RAI 8.2-8, the NRC staff questioned the statement made in Section 8.2.1.4 of the BLN COL FSAR that states "PSO also observes Federal Energy Regulatory Commission (FERC) requirements and NERC reliability standards," and requested that the applicant explain whether the statement is intended to indicate that TVA will follow the FERC and the North American Electric Reliability Corporation (NERC) standards for switchyard maintenance and testing. In a letter dated July 9, 2008, the applicant stated that this statement was intended to indicate that TVA follows the applicable NERC reliability standards associated with switchyard maintenance and testing and that the confusing paragraph of the BLN COL FSAR will be revised. Subsequently, in Revision 1 to the BLN COL FSAR, the applicant revised Section 8.2.1.4 to clarify what was meant by the word observed. The staff has confirmed that these changes are incorporated in BLN COL FSAR Revision 1 and hence, COL Information Item 8.2-1 is resolved.

- BLN COL 8.2-2

COL Information Item 8.2-2 states:

> The Combined License applicant will address the technical interfaces for this non-safety-related system listed in Table 1.8-1 and Section 8.2.2. These technical interfaces include those for ac power requirements from offsite and the analysis of the offsite transmission system and the setting of protective devices.

The commitment was also captured as COL Action Items 8.2.3.1-1, 8.2.3.1-2, and 8.2.3.1-3 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

> The COL applicant will perform a site-specific grid stability analysis to show that, with no electrical system failures, the grid will remain stable and the reactor coolant pump bus voltage will remain above the voltage necessary to maintain the flow assumed in the Chapter 15 analyses for a minimum of 3 seconds following a turbine trip. (COL Action Items 8.2.3.1-1 and 8.2.3.1-3)
>
> The COL applicant will set the protective devices controlling the switchyard breakers in such a way as to preserve the grid connection following a turbine trip. (COL Action Item 8.2.3.1-2)

The NRC staff reviewed the resolution to COL information item, BLN COL 8.2-2, related to the transmission system stability analysis and switchyard circuit breaker protective device settings included under Section 8.2 of the BLN COL FSAR. The NRC staff's evaluation follows.

The BLN switchyard is designed as a double-breaker arrangement for reliability and flexibility. This arrangement allows for isolation of components and buses, while preserving the BLN's connection to the grid. Each of the 500 kV lines is protected by two independent pilot systems to achieve high-speed clearing for a fault anywhere on the line. The breaker failure relays operate through a timing relay and should a breaker fail to trip within the time setting of its timing relay, the associated breaker failure trip relay will trip and lock out breakers on the bus side plus the other breaker in that bay. Also, the applicant states that the protective devices controlling the switchyard breakers are set with consideration given to preserving the plant grid connection

following turbine trip. The NRC staff finds that the switchyard breaker arrangement, the protection of lines by two independent pilot systems, and the breaker scheme would preserve the BLN's connection to the grid. This satisfies COL Action Item 8.2.3.1-2.

The applicant stated that the BLN grid stability analysis confirms that the grid will remain stable and the RCP bus voltage will remain above the voltage necessary to maintain the flow assumed in the Chapter 15 analyses for a minimum of 3 seconds following a turbine trip, as specified in DCD Section 8.2.2 (COL Action Items 8.2.3.1-1 and 8.2.3.1-3). Also, the grid stability analysis has confirmed that the interface requirements for steady state load, inrush kilovolt amps (kVA) for motors, nominal voltage, allowable voltage regulation, nominal frequency allowable frequency fluctuation, maximum frequency decay rate and limiting under frequency value for RCP have been met.

The NRC staff was concerned that at BLN the grid voltage could drop up to 15 percent on the high side of the GSU and RATs from the pre-trip steady-state voltage and that this drop could damage auxiliary and safety-related equipment. In RAI 8.2-1, the NRC staff requested that the applicant clarify: a) if the 15 percent voltage drop was based on the worst expected switchyard voltage; b) if the 15 percent voltage drop criteria is consistent with NERC criteria (or those of a local reliability council); c) how the isophase bus steady state voltage would be maintained within 0.95 - 1.05 per unit (pu) if the switchyard voltage is allowed to drop 15 percent; and d) what effect this voltage drop will have on the operation of the onsite auxiliary power system equipment including the Class 1E battery chargers and uninterruptible power supplies.

In a letter dated July 9, 2008, the applicant stated that the Westinghouse acceptance criteria is to maintain the voltage at the RCP to ≥ 80 percent of 6900V (or 5520V) for at least 3 seconds following a turbine trip of the unit, to maintain the reactor coolant flow assumed in the Chapter 15 analyses. The acceptance criteria defining the maximum voltage drop (0.15 pu) allowed during the 3 second period from the minimum steady state value (0.95 pu) was also provided. This transient voltage drop from minimum steady state defines the maximum allowable voltage drop at the high side of the transformer being used for bus supply in order for Westinghouse design analyses to demonstrate that the RCP will remain above the 80 percent voltage required to maintain the flow assumed in the Chapter 15 analyses for a minimum of 3 seconds following a turbine trip.

In addition, the applicant stated that TSP/TSO also maintains switchyard voltage such that steady state voltage on the 26 kV isophase bus is within 0.95 - 1.05 pu of its nominal value. There were several different pre-trip steady state voltages considered in the grid study. The all-ties-closed area switchyard voltage for BLN is 515 kV or 1.03 pu (27.02 kV at the generator terminals). This voltage was used for the base case with all lines and generators in service. Many scenarios were then studied to simulate different possible grid contingencies. A series of different pre-trip voltages was studied (corresponding to each different pre-contingency grid configuration). The worst case pre-trip steady-state voltage (26.24 kV at the generator terminals) occurred when only one BLN unit was operating and the BLN-Madison 500-kV Transmission Line was out of service. This corresponds to the worst expected switchyard voltage for the contingencies studied. The applicant stated that the contingency list used in the grid study is considered to be sufficiently extensive and at an appropriate severity level to bound the reasonably expected voltages. Because BLN is close to the TVA area boundary, the list of "outaged" transmission lines included both TVA and other nearby facilities. The list of "outaged" generators also included units in both TVA and other nearby facilities.

With regard to item b), the applicant stated that the TVA Bulk Electric System is designed to meet NERC reliability standards. The NERC standards do not give specific voltage or voltage drop criteria, but require that the system remain stable and consistent with the voltage requirements of the control area. However, maintaining "switchyard voltage such that steady state voltage on the 26 kV isophase bus is within 0.95 - 1.05 pu of its nominal value" would be considered to be consistent with the NERC criteria. Additionally, the 0.15 pu voltage drop criteria for BLN are consistent with TVA's practices for nuclear plants, and their applicable grid studies which are designed to meet NERC criteria.

With regard to item c), the applicant stated that the "0.95 to 1.05 per unit" is the steady state condition. A 0.15 pu drop from the lowest point of that range (0.95-0.15 = 0.8) for 3 seconds is the requirement to allow for flow before the RCP begins coast down. This is a methodology (95 percent-15 percent = 80 percent) of verifying that 80 percent is available at the RCPs. The 0.95-1.05 and the 0.15 pu drop from that point is a deterministic evaluation of RCP voltage. The 0.95 pu is the base from which 0.15 pu is allocated for voltage drop in order to verify adequate RCP voltage. The grid stability analyses indicate that the expected voltage drop is much less than 0.15 pu.

With regard to item d), the applicant stated that a transient of 0.15 pu from the steady state condition of 0.95 to 1.05 pu has no adverse affect on plant auxiliary equipment. This transient is less severe than the motor starting transient described in National Electrical Manufacturers Association (NEMA) MG1 for which the plant equipment is designed. As the NEMA MG1 transient bounds the turbine trip 3 second transient, the undervoltage relay scheme settings are designed not to trip during the turbine trip 3 second voltage transient. Regarding the UPS and the battery chargers, the applicant stated that the UPS is isolated from the grid voltage by the battery charger and the battery, and therefore, are unaffected by this voltage transient. The battery charger is designed to allow the battery to support the dc loads during times of ac input undervoltage. This could occur during the 3 second turbine trip transient during which the RCP must remain above 80 percent stall voltage.

The NRC staff agrees with the applicant that the 15 percent voltage transient is less severe than the motor starting transient described in NEMA MG1 which allows up to 80 percent of the voltage drop. Therefore, the 15 percent voltage drop would have no adverse affect on plant auxiliary equipment. Also, since the battery chargers are qualified isolation devices, they are unaffected by this voltage transient.

The NRC staff finds that the applicant has satisfied the Westinghouse acceptance criteria to maintain the voltage at the RCP to ≥ 80 percent of 6900V for at least 3 seconds following a turbine trip, to maintain the reactor coolant flow assumed in the Chapter 15 analyses. Therefore, the NRC staff finds the issues in RAI 8.2-1 are resolved.

In RAI 8.2-3, the NRC staff stated that in order to confirm that the single offsite power circuit provided from the transmission network satisfies the requirements of GDC 17, the applicant should provide the voltage and frequency variations expected at the 500 kV switchyard and confirm that these voltage and frequency limits are acceptable for auxiliary power system equipment operation during all operating conditions. The confirmation should include the following calculations: load flow analysis (bus and load terminal voltages of the station auxiliary system); short circuit analysis; equipment sizing studies; protective relay setting and coordination; motor starting with minimum and maximum grid voltage conditions. A separate set of calculations should be performed for each available connection to the offsite power

supply. In addition, the NRC asked the applicant to discuss how the results of the calculations will be verified before fuel load.

In a letter dated July 9, 2008, the applicant stated that the 500 kV switchyard voltage was set to 515 kV (1.03 pu). This is the anticipated voltage schedule to be set by TVA Operations, and is consistent with standard practice for grid studies at TVA. For an AP1000 turbine trip event, adequate grid voltage is required for 3 seconds. The unit's electric generator will motor immediately following a turbine trip, providing mega volt amp reactive (MVAR) to support this voltage, and therefore, the generator bus voltage remains relatively stable. The applicant stated that the above grid voltage evaluation results are verified during the preoperational testing identified in DCD Section 14.2.10, which includes the following tests:

- 100 Percent Load Rejection (DCD Section 14.2.10.4.21)
- Plant Trip from 100 Percent Power (DCD Section 14.2.10.4.24)
- Loss of Offsite Power (DCD Section 14.2.10.4.26)

The NRC staff has reviewed the applicant's responses to RAIs 8.2-1 and 8.2-3 and concludes that this information is sufficient to demonstrate that the grid will remain stable to maintain RCP operation for 3 seconds following a turbine trip.

In a teleconference with the applicant on April 7, 2009, there was an agreement that portions of RAI 8.2-3 were not within the scope of the BLN COL but rather within the scope of the AP1000 DC. Therefore, the staff finds that the relevant portions of RAI 8.2-3 are resolved for BLN and COL Information Item 8.2-2 is satisfied.

Supplemental Information

BLN SUP 8.2-1 was provided by the applicant describing details of a FMEA performed for the offsite power distribution system, plant site switchyard, and the TVA transmission system. The NRC staff has reviewed the FMEA of the BLN switchyard and agrees with the applicant that a single initiating event, such as a breaker not operating during a fault condition; a fault on a switchyard bus; a spurious relay trip; and a loss of control power supply would not cause failure of more than one single offsite transmission line, or a loss of offsite power to either BLN 3 or 4 via the GSU. Therefore, BLN SUP 8.2-1 is acceptable.

With regard to BLN SUP 8.2-2, 8.2-3, and 8.2-4 the applicant provided the following information:

> The voltage requirements and plant loading are provided by the BLN to the transmission operator, which then studies various system configurations. The studies consider transmission system outages including transmission lines, transformers, nearby generation, and other transmission devices that could affect the capability of the grid. The transmission operators maintain awareness of the qualification status of offsite power and promptly communicate any changes to the BLN. If a condition arises where the grid cannot supply qualified offsite power, plant operators are notified and appropriate actions are taken.
>
> The formal agreement between TVAN and TVA PSO, which is the TSP/TSO, sets the requirements for transmission system studies and analyses. These analyses demonstrate the capability of the offsite provider of supporting plant start up and normal shutdown. TVA PSO is the approving grid organization for reliability studies performed on the area bulk electric system. TVA conducts

> planning studies of the transmission grid on an ongoing basis. Model data used to perform simulation studies of projected future conditions is maintained and updated as load forecasts and future generation/transmission changes evolve. Studies are performed annually to assess future system performance in accordance with North American Electric Reliability Corporation (NERC) Reliability Standards. These studies form a basis for identifying future transmission expansion needs.

The NRC staff has reviewed the information provided by the applicant on the functions of the PSO/TSO that establishes a voltage schedule for the BLN 500 kV switchyard and also maintains switchyard voltage such that steady state voltage on the 26 kV isophase bus is within 0.95–1.05 pu of its nominal value. Based on the information provided by the applicant on the functions of TSP/TSO, the NRC staff concludes that the applicant has demonstrated that protocols are in place for BLN to remain cognizant of grid vulnerabilities in order to make informed decisions regarding maintenance activities critical to the electric system. This is consistent with Generic Letter (GL) 2006-2, "Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power," of which one of the provisions is to reduce the likelihood of losing offsite power.

In RAI 8.2-2, dated May 23, 2008, the NRC staff requested that the applicant describe, in accordance with RG 1.206, how the single designated offsite power circuit from the transmission network conforms to the requirements of GDC 2, 4, 5, 17 and 18, and how the applicant intends to meet the requirements of 10 CFR 50.65,. In its response, dated July 9, 2008, the applicant stated that there is no portion of the single required offsite circuit required to conform with GDC 2, 4, 5, and 18 and that these GDCs are for structures, systems and components (SSCs) important to safety.

In RAI 8.2-10, which was a supplement to RAI 8.2-2, the NRC staff stated the following:

> The applicant's response to RAI 8.2-2 is inadequate in the following areas:
>
> a) The applicant stated that the offsite power circuit conductors are designed to withstand a high temperature (normally 120 degrees C) before violating sag clearances, and transmission lines are designed for high winds, typically 110 [miles per hour] mph, and for appropriate levels of snow and ice. Specify the levels of snow and ice that these structures and systems may be subjected to during operation based on worst case environmental conditions at the Bellefonte site. Also, describe how structures, systems, and components associated with offsite power system are protected from the effects of missiles that may result from equipment failures (breakers, insulators, etc., that could fail and damage adjacent equipment) in the switchyard area.
>
> b) With regard to maintenance and testing of the offsite power, the staff notes that the test to verify (automatic and manual) transfer of AC power sources from the normal offsite circuit to an alternate offsite circuit is not included. Include this test in your testing program for switchyard components or provide your justification for not including this test.
>
> c) With regard to meeting the requirements of 10 CFR 50.65, the applicant referred to FSAR Section 17.6, which incorporates by reference technical report [Nuclear Energy Institute] NEI 07-02, "Generic FSAR Template Guidance for Maintenance

Rule Program Description for Plants Licensed Under 10 CFR Part 52," for implementation of 10 CFR 50.65. The applicant stated that the program description of this report will determine the applicability of the maintenance requirements for the offsite power system and that this document is currently under review by the NRC staff. It appears from the above statement that the offsite power system and its components will be evaluated for inclusion in to the maintenance rule program based on the outcome of the Staff's review of NEI 07-02. The staff requests that the applicant confirm the applicability of the maintenance rule to switchyard components, discuss actions to be taken to limit the risk associated with transmission system degradation and discuss actions required before performing grid-risk-sensitive maintenance activities of switchyard components.

d) BLN Units 3 and 4 share a common switchyard, please demonstrate that such sharing will not significantly impair the ability of the switchyard components to perform their functions and that the capacity and capability of incoming lines for each required circuit and other switchyard components will be adequately sized.

Based on its review of the information provided in applicant's letter of July 9, 2008, regarding item (a) above, the NRC staff notes that the environmental effects are considered in the design of the offsite power circuit for BLN. For example, conductors are designed to withstand a particular high temperature (normally 120°C) before violating sag clearances, and transmission lines are designed for high winds, typically 110 mph, and for appropriate levels of snow and ice. Additionally, transmission lines include overhead ground wires and, in an area with a history of lightning strikes or an area of high ground resistivity, have lightning arrestors installed. Based on the above, the staff finds item (a) resolved with respect to the design of the switchyard components to withstand environmental conditions at the BLN site.

With regard to item (b) concerning the automatic and manual transfer of ac power sources from the normal offsite circuit to an alternate offsite circuit periodic testing, in a letter dated April 23, 2009, the applicant stated that BLN COL FSAR Section 8.3.1.4 will be revised to include implementation of procedures for periodic verification of proper operation of the onsite ac power system capability for automatic and manual transfer from the preferred power supply to the maintenance power supply and return from the maintenance power supply to the preferred power supply. Based on the above, the NRC finds item (b) resolved subject to the verification that the BLN COL FSAR has been updated to include portions of the RAI response. This is identified as **Confirmatory Item 8.2-1**.

With regard to item (c) concerning 10 CFR 50.65, the applicant stated that BLN COL FSAR Section 17.6 describes implementation of the requirements of 10 CFR 50.65. As indicated therein, implementation of the NEI 07-02 program description will determine the applicability of the maintenance requirements for the offsite power circuit. The NRC staff reviewed NEI 07-02 and issued its safety evaluation (SE) on January 24, 2008. NEI re-issued the report, after incorporating the NRC SE and responding to RAIs, as NEI 07-02A. The reference to this topical report in BLN COL FSAR Table 1.6-201 was updated in Revision 1 to the FSAR. Since the scope of SSCs covered by the maintenance rule program is determined using the scoping procedures defined in the maintenance rule program description in accordance with NEI 07-02A, the offsite power system and its components then will be evaluated for inclusion into the maintenance rule program in accordance with these scoping procedures during program implementation. The NRC staff notes that NEI 07-02A, Section 17.X.1.5, "Risk assessment and risk management per 10 CFR 50.65(a)(4)," addresses risk assessment and

risk management from maintenance activities in accordance with 10 CFR 50.65(a)(4), and includes consideration of the issues associated with grid/offsite power system reliability as identified in NRC Generic Letter (GL) 2006-02, Items 5 and 6. Therefore, although detailed maintenance risk assessment is not anticipated in advance of the schedule defined in Table 13.4-201 of the BLN COL FSAR, performance of "grid-risk-sensitive" maintenance activities is considered to be a necessary consideration of the program in accordance with NEI 07-02A guidance. Based on the above, the NRC staff finds item (c) resolved.

With regard to item (d) concerning GDC 5 and 17, the applicant stated that the transmission lines and switchyard are designed so the full output of the plants can be carried out to the network, and the capacity is more than sufficient for any incoming power requirements. The results of the grid stability analysis demonstrate the offsite source capacity and capability to power plant components during normal, shutdown, startup, and turbine trip conditions. The results of the failure modes and effects analysis demonstrate the reliability of the offsite source which minimizes the likelihood of its failure under normal, abnormal and accident conditions. The NRC staff concludes that because BLN Units 3 and 4 UATs and RATs are not shared among the units and the capacity of the offsite power system is large compared to the minimal safety-related loads powered by the offsite power (battery chargers and uninterruptible power supply [UPS]), the sharing of the switchyard components will not significantly impair their ability to perform their safety functions. Therefore, the BLN design meets the requirements of GDC 5 and 17 and item (d) is resolved.

Interface Requirements

The plant interfaces for the standard design of the AP1000 are discussed in DCD Tier 2, Section 8.2.5, and in Items 8.1, 8.2, and 8.3 of DCD Tier 2, Table 1.8-1, where they are identified as 'non-nuclear safety (NNS)' interfaces.

The NRC staff has reviewed the interfaces for the standard design addressed in BLN COL FSAR Sections 8.2.2 and 8.2.5, and concludes that the applicant has adequately addressed Interface Items 8.1, 8.2, and 8.3 of DCD Tier 2, Table 1.8-1.

In order to satisfy plant Interface Item 8.2 in DCD Tier 2 Table 1.8-1, the NRC staff requested in RAI 8.2-7 that the applicant provide the steady state load, inrush kVA for motors, nominal voltage, allowable voltage regulation, nominal frequency, allowable frequency fluctuation, maximum frequency decay rate, and limiting under frequency values for RCP. In letters dated July 9, 2008, and April 6, 2009, the applicant provided the above parameters for the NRC staff's review and stated that BLN COL FSAR Chapter 8 will be revised to include a new Table 8.2-201, "Grid Stability Interface Evaluation," which confirms that the above interface items for RCPs have been met. The NRC staff has reviewed this information and concludes that the information provided by the applicant satisfies Interface Items 8.1, 8.2, and 8.3 of DCD Table 1.8-1 and is acceptable subject to the verification that the BLN COL FSAR has been updated to include portions of the RAI response. This is identified as **Confirmatory Item 8.2-2**.

The applicant incorporated by reference Section 1.8 of the DCD. This section of the DCD identifies certain interfaces with the standard design that have to be addressed in accordance with 10 CFR 52.47(a)(1)(vii).[2] As required by 10 CFR 52.79(d)(2), the COL application must demonstrate how these interface items have been met. The BLN 3 and 4 application does not

[2] Following the update to 10 CFR Part 52 (72 FR 49517), this provision has changed to 10 CFR 52.47(a)(25).

explicitly identify how these interface items have been met. This is being tracked as **Open Item 1-3.**

In a letter dated September 4, 2009, the applicant indicated to the staff that it will provide a future revision to the COLA Environmental Report and FSAR Section 8.2 describing an additional 500 kV transmission line, including revisions to FSAR Figures 8.2-201 and 8.2-202. The additional 500 kV transmission line addresses transmission thermal overloads and transient stability of area generation. The staff created **Open Item 8.2-1** to track the outcome of this future revision.

8.2.5 Post Combined License Activities

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

8.2.6 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 offsite power system, and there is no outstanding information expected to be addressed in the BLN COL FSAR related to this section.

In addition, the staff concludes that the relevant information presented within the BLN COL FSAR is acceptable and meets the requirements of GDC 17 and GDC 18 pending resolution of the confirmatory items discussed above. The staff based its conclusion on the following:

- BLN COL 8.2-1, the applicant provided sufficient information involving the design details of the plant site switchyard, its interface with the local transmission grid, protective device settings, and its testing and inspection plan.

- BLN COL 8.2-2, the applicant provided sufficient information to demonstrate that the grid will remain stable to maintain RCP operation for three seconds following a turbine trip.

- BLN CDI in Section 8.2.1 of the BLN COL FSAR, the applicant provided sufficient information involving the transformer area located next to each unit's turbine building.

- BLN SUP 8.2-1, the applicant provided sufficient information involving offsite power distribution system, plant site switchyard, and the TVA transmission system.

- BLN SUP 8.2-2, the applicant provided sufficient information to demonstrate that the risk, reliability, operating limits, and administrative control of the power transmission grid is in accordance with GL 2006-2.

- BLN SUP 8.2-3, the applicant provided sufficient information to demonstrate that the risk, reliability, operating limits, and administrative control of the power transmission grid is in accordance with GL 2006-2.

- BLN SUP 8.2-4, the applicant provided sufficient information to demonstrate that the risk, reliability, operating limits, and administrative control of the power transmission grid is in accordance with GL 2006-2.

- BLN SUP 8.2-5, the applicant provided sufficient information regarding causes of outages of the transmission line over the past twenty years in accordance RG 1.206.

- The applicant provided sufficient information regarding the interfaces for standard design from the generic DCD Table 1.8-1, Items 8.1, 8.2, and 8.3.

In addition, the staff has compared the additional COL-specific supplemental information within the application to the relevant NRC regulations guidance in NUREG-0800, Section 8.2, and other NRC regulatory guides and concludes that the applicant is in compliance with the NRC regulations subject to the verification of the confirmatory items discussed above.

8.2.A Site-Specific ITAAC for Offsite Power Systems

8.2.A.1 Introduction

This section specifically addresses the site-specific inspections, tests, analyses and acceptance criteria (SS-ITAAC), that the applicant proposed related to the offsite power system that are necessary and sufficient to provide reasonable assurance that the facility has been constructed and will operate in conformance with the COL, the provisions of the Atomic Energy Act, and NRC regulations.

8.2.A.2 Summary of Application

Section 14.3 of the BLN COL FSAR, Revision 1 incorporates by reference Section 14.3 of the AP1000 DCD, Revision 17.

In addition, in BLN COL FSAR Section 14.3, the applicant provided the following:

Supplemental Information

- STD SUP 14.3-1

The applicant provided supplemental information related to the offsite power system in STD Supplement (SUP) 14.3-1 in BLN COL FSAR Section 14.3.2.3.

8.2.A.3 Regulatory Basis

Site-Specific Inspections, Tests, Analyses, and Acceptance Criteria (SS-ITTAC)

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

In addition, the relevant requirements of the Commission regulations and the associated guidance for the review of this section are given in 10 CFR 52.80(a), “Contents of applications; additional technical information,” Section 14.3 of NUREG-0800, and RG 1.206.

8.2.A.4 Technical Evaluation

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

Supplemental Information

- STD SUP 14.3-1, addressing SS-ITAACs

ITAAC Screening Summary Table 14.3-201 of the BLN FSAR identified the transmission switchyard and offsite power system as a site-specific system and selected them for ITAAC, but the table indicated "title only, no entry for COLA." Consequently, Section 2.6.12 of Part 10 of Appendix B, "License Conditions and ITTAC" of the BLN COL application (COLA) provided no ITAAC information for the transmission switchyard and offsite power system. The COL applicant must provide this site-specific ITAAC for compliance with 10 CFR 52.79(d) and 10 CFR 52.80(a). In RAI 14.3-1, the NRC staff stated that RG 1.206, CIII.7.2, Site-Specific ITAAC, recommends that applicants develop ITAAC for the site-specific systems that are designed to meet the significant interface requirements of the standard certified design, that is, the site-specific systems that are needed for operation of the plant (e.g., offsite power). Therefore, the applicant should justify why there is no ITAAC entry associated with offsite power, or revise Table 14.3-201 of the BNL FSAR to include ITAAC entries for the transmission switchyard and the offsite power system.

By letter dated June 24, 2008, the applicant stated that approved DCD Section 14.3 refers to the selection criteria and processes used for developing the AP1000 Certified Design Material (CDM) and identifies no interfaces (e.g., systems for storm drain, raw water, and closed circuit TV system, etc.) meeting this definition. Thus, according to the applicant, the CDM does not include ITAAC or a requirement for COL developed ITAAC for the offsite power interface system. The staff found the above response to be inconsistent with the requirements of 10 CFR 52.80(a), and guidance of NUREG-0800 Section 14.3 and RG 1.206.

Several discussions were held between the applicant and the NRC staff to discuss this issue. The staff pointed out that the offsite power system performs an important function in the passive designs as it provides power to the safety-related loads through battery chargers during normal, abnormal and accident conditions. It also provides power to those active systems that provide defense-in-depth capabilities for reactor coolant make-up and decay heat removal. These active systems are the first line of defense to reduce challenges to the passive systems in the event of plant transients. The above function of the offsite power system in passive designs supports the need for ITAAC for these systems so that the staff can verify that (1) the designed and installed systems, structures, or components of the offsite power systems will perform as designed and (2) the required single circuit from the transmission network satisfies the requirements of GDC 17.

Subsequently, in a letter dated May 11, 2009, the applicant revised its response to RAI 14.3-1 and provided an ITAAC for the offsite power system to verify that the as-built offsite portion of the power supply from the transmission network to the interface with the onsite ac power system will satisfy the applicable provisions of GDC 17. Specifically, the ITAAC shall verify:

(1) A minimum of one offsite circuit supplies electric power from the transmission network to the interface with the onsite portions of the ac power system.

(2) Each offsite circuit interfacing with the onsite ac power system is adequately rated to supply assumed loads during normal, abnormal and accident conditions.
(3) During steady state operation, each offsite circuit is capable of supplying required voltage to the interface with the onsite ac power system that will support operation of assumed loads during normal, abnormal and accident conditions.
(4) During steady state operation, each offsite circuit is capable of supplying required frequency to the interface with the onsite ac power system that will support operation of assumed loads during normal, abnormal and accident conditions.
(5) The fault current contribution of each offsite portion circuit is compatible with the interrupting capability of the onsite ac power system fault current interrupting devices.
(6) The reactor coolant pumps continue to receive power from either the main generator or the grid for a minimum of 3 seconds following a turbine trip.

To ensure that the requirements of GDC 17 for the adequacy of the offsite power source within the standard design scope are met, the proposed ITAAC would verify the capacity and capability of the offsite source to feed the onsite power system. The proposed ITAAC provides for the inspection of the connection of the offsite source to the onsite power system.

Additionally, the applicant identified all associated changes that will be made in a future revision of the Bellefonte FSAR. On the basis of its review, the staff finds that the applicant has adequately addressed the site-specific ITAAC for the offsite power system so that the staff can verify that the designed and installed systems, structures, or components of the offsite power system will perform as designed. Therefore, the staff concludes that the applicant meets the requirements of 10 CFR 52.79(d) and 10 CFR 52.80(a), and the guidance of SRP 14.3 and RG 1.206. The applicant will revise the BLN COL FSAR to include the proposed ITAAC for offsite power system. This is identified as **Confirmatory Item 8.2A-1**, pending NRC review and approval of the revised BLN COL FSAR.

8.2.A.5 Post Combined License Activities

The following items were identified as the responsibility of the COL holder:

License Conditions:

- Part 10, License Condition 1, “ITAAC,” addresses the offsite power system for BLN included in Table 2.6.12-1, “Offsite Power System.”

8.2.A.6 Conclusion

The staff concludes that the relevant information presented within the BLN COL FSAR is acceptable and meets the requirements of GDC 17 and GDC 18 pending resolution of the confirmatory item discussed above. The staff based its conclusion on the following:

- STD SUP 14.3-1, the applicant adequately described the site-specific ITAAC for the offsite power system.

8.3 Onsite Power Systems

8.3.1 AC Power Systems

8.3.1.1 Introduction

The onsite ac power system includes those standby power sources, distribution systems, and auxiliary supporting systems provided to supply power to safety-related equipment or equipment important to safety for all normal operating and accident conditions. In the AP1000 passive reactor design used at BLN, the onsite ac power system is a non-Class 1E system that provides reliable ac power to the various system electrical loads. It does not perform any safety-related functions. These loads enhance an orderly shutdown under emergency conditions when offsite power is not available. Additional loads for investment protection can be manually loaded on the standby power supplied. Diesel generator sets are used as the standby power source for the onsite ac power systems.

8.3.1.2 Summary of Application

Section 8.3 of the BLN COL FSAR incorporates by reference Section 8.3 of the AP1000 DCD, Revision 17.

In addition, in BLN COL FSAR Section 8.3.1, the applicant provided the following:

AP1000 COL Information Items

- BLN COL 8.3-1

BLN COL 8.3-1 describes: 1) the grounding grid system design within the plant boundary and 2) a lightning protection risk assessment for the buildings comprising BLN.

- STD COL 8.3-2

STD COL 8.3-2 describes the details of: 1) plant procedures for pre-operational testing to verify proper operation of ac power systems and 2) procedures for the periodic testing of penetration overcurrent protective devices.

Supplemental Information

- BLN SUP 8.3-1

BLN SUP 8.3-1 describes the site conditions provided in Sections 2.1 and 2.3 of the FSAR that are bounded by the standard site conditions used to rate the diesel engine and the associated generator in DCD Section 8.3.1.1.2.3.

- BLN SUP 8.3-2

BLN SUP 8.3-2 provides supplemental information describing the site-specific switchyard and power transformer voltage.

8.3.1.3 Regulatory Basis

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

In addition, the relevant requirements of the Commission regulations for the ac power systems, and the associated acceptance criteria, are given in Section 8.3.1 of NUREG-0800.

The regulatory basis for acceptance of BLN COL 8.3-1, addressing the grounding and lightning protection systems, are the guidelines of:

- RG 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants"
- IEEE Std 80, "Guide for Safety in AC Substation Grounding"
- IEEE Std 665, "Guide for Generating Station Grounding"

The basis for acceptance of the part of STD COL 8.3-2, addressing the recommendations in operation, inspection, and maintenance procedures for the onsite standby diesel generators, are the guidelines of industry standards.

The regulatory basis for acceptance of the part of STD COL 8.3-2, addressing procedures for penetration protective device testing, are the guidelines of:

- RG 1.63, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants"

8.3.1.4 Technical Evaluation

The NRC staff reviewed Section 8.3.1 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 ac power systems. Section 8.3.1 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 ac power systems will be documented in the staff SER on the DC application for the AP1000 design.

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

AP1000 COL Information Items

- BLN COL 8.3-1

The NRC staff reviewed BLN COL 8.3-1 related to COL Information Item 8.3-1. COL Information Item 8.3-1 states:

> Combined License applicants referencing the AP1000 certified design will address the design of grounding and lightning protection.

The commitment was also captured as COL Action Item 8.3.1.6-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

> The COL applicant will provide the design of the site-specific grounding and lightning protection.

The NRC staff reviewed the resolution to COL information item, BLN COL 8.3-1, related to the ground grid system and lightning protection included under Section 8.3 of the BLN COL FSAR. The NRC staff's evaluation is described below.

The applicant states that a grounding grid system design within the plant boundary includes step and touch potentials near equipment that are within the acceptable limit for personnel safety. Actual resistivity measurements from soil samples taken at the plant site were analyzed to create a soil model. The ground grid conductor size was then determined using the methodology outlined in IEEE 80 and a grid configuration for the site was created. The grid configuration was modeled in conjunction with the soil model. The resulting step and touch potentials are within the acceptable limits for personnel safety. Therefore, the staff concludes that IEEE 80 provides an acceptable method for determining the right size of ground conductors. The COL action item provided by the applicant on station grounding grid is consistent with the recommendations of RG 1.206 and acceptable.

With regard to lightning protection, the applicant stated that in accordance with IEEE 665, a lightning protection risk assessment for the buildings was performed based on the methodology in National Fire Protection Association (NFPA) 780. The tolerable lightning frequency for each of the buildings was determined to be less than the expected lightning frequency; therefore, lightning protection is required for the BLN buildings based on the design in accordance with NFPA 780. The zone of protection is based on the elevations and geometry of the structures. It includes the space covered by a rolling sphere having a radius sufficient enough to cover the building to be protected. The zone of protection method is based on the use of ground masts, air terminals and shield wires. Either copper or aluminum is used for lightning protection. Lightning protection grounding is interconnected with the station or switchyard grounding system. Based on the above, the staff concludes that IEEE 665 and NFPA 780 provide acceptable methods for lighting protection. Therefore, the supplemental information provided by the applicant on lightning protection is consistent with the recommendations of RG 1.206 and RG 1.204 making it acceptable.

- STD COL 8.3-2

The NRC staff reviewed STD COL 8.3-2 related to COL Information Item 8.3-2. COL Information Item 8.3-2 states (in part):

> The Combined License applicant will establish plant procedures as required for:
>
> - Periodic testing of penetration protective devices
>
> - Diesel generator operation, inspection and maintenance in accordance with manufacturers' recommendations

The commitment was also captured as COL Action Items 8.3.1.2-1 and 8.4.1-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which state:

> The COL applicant will establish plant procedures for preoperational testing to verify proper operation of the ac power system. (COL Action Item 8.3.1.2-1)
>
> The COL applicant will establish plant procedures for periodic testing of penetration protective devices. (COL Action Item 8.4.1-1)

A part of standard information item, STD COL 8.3-2, was provided by the applicant describing the bases of the recommendations in operation, inspection, and maintenance procedures for the onsite standby diesel generators. This part of STD COL 8.3-2 is addressed in BLN COL FSAR Section 8.3.1.1.2.4.

A part of standard information item, STD COL 8.3-2, was provided by the applicant describing procedures for the testing of penetration protective devices. This portion of STD COL 8.3-2 is addressed in BLN COL FSAR Section 8.3.1.1.6.

The NRC staff reviewed the resolution to COL information item, STD COL 8.3-2, related to testing procedures for standby diesel generators and electrical penetrations included under Section 8.3 of the BLN COL FSAR. The NRC staff's evaluation follows.

For the operation, inspection and maintenance for diesel generators, the applicant's procedures will consider both the diesel generator manufacturer and industry diesel working group recommendations.

In RAI 8.3.1-2, the NRC staff stated that COL Action Item 8.3.1.2-1 in the NRC's FSER for the AP1000 DCD (NUREG-1793), contains the following discussion:

> Preoperational tests are conducted to verify proper operation of the ac power system. The preoperational tests include operational testing of the diesel load sequencer and diesel generator capacity testing. The diesel generators are not safety-related and will be maintained in accordance with the requirements of the overall plant maintenance program. This program will cover the preventive, corrective, and predictive maintenance activities of the plant systems and equipment and will be presented in the COL application. This COL information is discussed in DCD Tier 2, Section 8.3.3, "Combined License Information for Onsite Electrical Power."

In RAI 8.3.1-2, the applicant was asked to provide a reference to where the preoperational testing program and the preventive, corrective, and predictive maintenance activities for the diesel generators are discussed in the application, or provide a proposed revision to the application to address this issue.

In a letter dated April 6, 2009, the applicant stated that COL Action Item 8.3.1.2-1 in Appendix F of the FSER does not indicate that "pre-operational testing" of the diesel generators has been addressed in the DCD. Pre-operational testing of the ac power system is described in FSER Section 14, DCD Section 14, and BLN COL FSAR Chapter 14. Specifically, DCD Sections 14.2.9.2.15 and 14.2.9.2.17 address the onsite ac power system and diesel generator testing, including diesel generator capacity and sequencer tests. BLN COL FSAR Section 14.2.9.4.23 describes testing of the offsite power system. The NRC staff agrees that

pre-operational testing of the diesel generators is addressed in DCD Section 14.2.9.2.17 and was found acceptable by the staff as indicated in FSER NUREG-1793 Section 14.2.9. Based on the above, the NRC staff finds that the applicant's response to the portion of the RAI regarding COL areas of responsibility is acceptable.

In addition, the applicant stated that BLN COL FSAR Section 8.3.1.1.2.4 will be revised to include inspection and maintenance (including preventive, corrective, and predictive maintenance) procedures considering both the diesel generator manufacturer's recommendations and industry diesel working group recommendations.

The NRC staff concludes that following the manufacturer and industry diesel generator working group recommendations for onsite standby diesel generator inspection and maintenance including preventive, corrective, and predictive maintenance provides reasonable assurance that the diesel generators will be adequately maintained. Therefore, DCD COL Information, Item 8.3-2 and FSER COL Action Item 8.3.1.2-1 are resolved subject to the verification that the BLN COL FSAR has been updated to include applicable portions of the RAI response. This is identified as **Confirmatory Item 8.3.1-1**.

With regard to establishing plant procedures for periodic testing of protective devices that provide penetration overcurrent protection, the applicant will implement procedures to periodically test a sample of each different type of overcurrent device. Testing includes:

- Verification of thermal and instantaneous trip characteristics of molded case circuit breakers

- Verification of long time, short time, and instantaneous trips of medium voltage air circuit breakers

- Verification of long time, short time, and instantaneous trips of low voltage air circuit breakers

Because the above testing is consistent with the recommendation of RG 1.63, the NRC staff concludes that the above information satisfies COL Information Item 8.3-2 and FSER COL Action Item 8.3.1.6-1, and that these items are resolved.

Supplemental Information

- BLN SUP 8.3-1

The applicant stated in BLN SUP 8.3-1 that their site conditions were bounded by the standard site conditions in DCD Section 8.3.1.1.2.3 used to rate the diesel generators. The staff agrees that the BLN site conditions are bounded by the standard site conditions used to determine the rating.

- BLN SUP 8.3-2

The applicant provided information in BLN SUP 8.3-2 describing the site-specific switchyard and power transformer voltage. The staff found this statement of fact acceptable; no evaluation is required.

8.3.1.5 Post Combined License Activities

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

8.3.1.6 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 ac power systems, 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 8.3.1 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 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 8.3.1 of this SER to reflect the final disposition of the DC application.

In addition, the staff has compared the COL information items, the supplemental information, the interfaces for standard design, and the proposed design changes and corrections within the application to the relevant NRC regulations, guidance in NUREG-0800, Section 8.3.1, and other NRC regulatory guides and concludes that the applicant is in compliance with the NRC regulations pending resolution of the confirmatory item discussed above. The staff based its conclusion on the following:

- BLN COL 8.3-1, the applicant provided sufficient information related to the grounding grid system design and lightning protection consistent with the recommendations of RGs 1.206 and 1.204.

- STD COL 8.3-2, the applicant provided sufficient information related to preoperational testing of the diesel generators and periodic testing of the penetration overcurrent protective devices consistent with industry standards and the recommendations of RG 1.63.

- BLN SUP 8.3-1, the applicant demonstrated its site-specific conditions are bounded by the standard site conditions in the AP1000 DCD for rating the diesel generator.

8.3.2 DC Power Systems

8.3.2.1 Introduction

The direct current (dc) power systems include those dc power sources and their distribution systems provided to supply motive or control power to safety-related equipment. Batteries and battery chargers serve as the power sources for the dc power system and inverters convert dc from the dc distribution system to ac instrumentation and control power, as required. These three components, when combined, provide a UPS that furnishes a continuous, highly reliable source of ac supply.

The AP1000 dc power system is comprised of independent Class 1E and non-Class 1E dc power systems. Each system consists of ungrounded stationary batteries, dc distribution equipment, and UPS.

8.3.2.2 Summary of Application

Section 8.3 of the BLN COL FSAR incorporates by reference Section 8.3 of the AP1000 DCD, Revision 17. Section 8.3 of the AP1000 DCD includes Section 8.3.2.

In addition, in BLN COL FSAR Section 8.3.2, the applicant provided the following:

AP1000 COL Information Item

- STD COL 8.3-2

STD COL 8.3-2 describes the details of: 1) procedures for inspection, maintenance, and testing of Class 1E batteries; and 2) the clearing of ground faults on the Class 1E dc power system.

Supplemental Information

- STD SUP 8.3-1

The applicant provided supplemental information stating that there are no site-specific non-Class 1E dc loads connected to the Class 1E dc system.

8.3.2.3 Regulatory Basis

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

In addition, the relevant requirements of the Commission regulations for the dc power systems, and the associated acceptance criteria, are given in Section 8.3.2 of NUREG-0800.

The regulatory basis for acceptance of COL information item, STD COL 8.3-2 and STD SUP 8.3-1, is established in:

- GDC 17
- GDC 18
- RG 1.206
- RG 1.129, “Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants”
- IEEE Std 450, “Recommended Practice for the Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications”

8.3.2.4 Technical Evaluation

The NRC staff reviewed Section 8.3.2 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 dc power systems. Section 8.3.2 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 dc power systems will be documented in the staff SER on the DC application for the AP1000 design.

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

AP1000 COL Information Item

- STD COL 8.3-2, involving the inspection, maintenance, and testing of Class 1E batteries and clearing of ground faults on the Class 1E dc system.

The NRC staff reviewed STD COL 8.3-2 related to COL Information Item 8.3-2. COL Information Item 8.3-2 states (in part):

> The Combined License applicant will establish plant procedures as required for:
>
> - Clearing ground fault on the Class 1E dc system
>
> - Checking sulfated battery plates or other anomalous conditions through periodic inspections
>
> - Battery maintenance and surveillance (for battery surveillance requirements, refer to DCD Chapter 16, Section 3.8)

The commitment was also captured as COL Action Item 8.4.1-1 in Appendix F of the NRC staff's FSER for the AP1000 DCD (NUREG-1793), which states:

> The COL applicant will establish plant procedures for periodic testing of penetration protective devices. (COL Action Item 8.4.1-1)

The Class 1E 125 volts direct current (Vdc) system components undergo periodic maintenance tests to determine the condition of the system. The applicant has established procedures for inspection and maintenance of Class 1E batteries and non-Class 1E batteries. Class 1E battery maintenance and service testing is performed in conformance with RG 1.129. Batteries are inspected periodically to verify proper electrolyte levels, specific gravity, cell temperature and battery float voltage. Cells are inspected in conformance with IEEE 450 and vendor recommendations. In addition, the applicant has established procedures for clearing of ground faults on the Class 1E dc system. The battery testing procedures are written in conformance with IEEE 450 and the Technical Specifications. The NRC staff concludes that the applicant has established procedures for inspection and maintenance of Class 1E and non-Class 1E batteries to satisfy COL Information Item 8.3-2; therefore, this item is resolved.

With regard to periodic testing of electrical penetration protective devices (COL Action Item 8.4.1-1) for dc systems, the applicant has not addressed periodic testing of the penetration over load protective devices related to dc systems. In RAI 8.3.1-1, the staff requested that the applicant address the periodic testing of the electrical penetration primary and backup protective devices protecting Class 1E and non-Class 1E dc circuits. In a letter dated January 2, 2009, the applicant stated that the BLN COL FSAR will be revised in the next COLA submittal to include periodic testing of the electrical penetration primary and backup protective devices protecting Class 1E and non-Class 1E dc circuits, as well as control of protective devices. The staff has

reviewed the information in the applicant's response, which provided for the testing of Class 1E and non-Class 1E dc penetration overload protection devices. The staff also reviewed the proposed change to BLN COL FSAR Section 8.3.1.1.6 and concludes that COL Action Item 8.4.1-1 is resolved subject to the verification that the BLN COL FSAR has been updated to include portions of the RAI response. This is identified as **Confirmatory Item 8.3.2-1**.

Supplemental Information

- STD SUP 8.3-1

STD SUP 8.3-1 was provided by the applicant indicating that there are no site-specific non-Class 1E dc loads connected to the Class 1E dc system. The staff finds this acceptable because it is consistent with the guidance in RG 1.206.

8.3.2.5 Post Combined License Activities

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

8.3.2.6 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 dc power systems, 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 8.3.2 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 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 8.3.2 of this SER to reflect the final disposition of the DC application.

In addition, the staff concludes that the relevant information presented within the BLN COL FSAR is acceptable and meets the relevant NRC regulations, guidance in NUREG-0800, Section 8.3.2, and other NRC regulatory guides and concludes that the applicant is in compliance with the NRC regulations provided the confirmatory item discussed above is resolved. The staff based its conclusion on the following:

- STD COL 8.3-2, the applicant provided sufficient information involving the inspection, maintenance, and testing of Class 1E batteries and clearing of ground faults on the Class 1E dc system.

- STD SUP 8.3-1, the applicant made a commitment that there are no site-specific non-Class 1E dc loads connected to the Class 1E dc system.

8.3.2.7 Post Combined License Activities

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

8.3.2.8 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 dc power systems, 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 8.3.2 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 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 8.3.2 of this SER to reflect the final disposition of the DC application.

In addition, the staff concludes that the relevant information presented within the BLN COL FSAR is acceptable and meets the relevant NRC regulations, guidance in NUREG-0800, Section 8.3.2, and other NRC regulatory guides and concludes that the applicant is in compliance with the NRC regulations provided the confirmatory item discussed above is resolved. The staff based its conclusion on the following:

- STD COL 8.3-2, the applicant provided sufficient information involving the inspection, maintenance, and testing of Class 1E batteries and clearing of ground faults on the Class 1E dc system.

- STD SUP 8.3-1, the applicant made a commitment that there are no site-specific non-Class 1E dc loads connected to the Class 1E dc system.

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