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 U.S. 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 (DC).

8.1.2 Summary of Application

Section 8.1 of the Vogtle Electric Generating Plant (VEGP) combined license (COL) Final Safety Analysis Report (FSAR), Revision 5, incorporates by reference Section 8.1 of the AP1000 Design Control Document (DCD), Revision 19.

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

Supplemental Information

- VEGP SUP 8.1-1

The applicant provided supplemental (SUP) information in VEGP COL FSAR Section 8.1, "Introduction," describing the Southern Nuclear Operating Company (SNC), the Southern Balancing Authority Area (SBAA) transmission grid, and the connection interfaces with VEGP Unit 3 via the Units 1, 2, and 3, 230/500 kilovolt (kV) switchyard and with VEGP Unit 4 via the Unit 4, 500kV switchyard at the plant site.

- VEGP SUP 8.1-2

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

8.1.3 Regulatory Basis

The regulatory basis for the information incorporated by reference is addressed in NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," and its supplements.

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

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

- Title 10 of the *Code of Federal Regulations* (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 VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the introduction to the electric power systems. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the following information in the VEGP COL FSAR:

Supplemental Information

- VEGP SUP 8.1-1

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

> VEGP is interconnected to the SBAA transmission grid operated by Southern Company Transmission (SCT). The SBAA transmission grid interconnects hydro plants, fossil-fueled plants, and nuclear plants supplying electric energy over a transmission grid consisting of various voltages up to 500 kV. VEGP Units 1 and 2 and Plant Wilson, a six-unit oil-fueled combustion turbine facility owned by Georgia Power Company (GPC), are located on the VEGP site. VEGP Units 1 and 2 are two Westinghouse Electric Company, LLC (Westinghouse) pressurized water reactors (PWRs) that have been in commercial operation since 1987 and 1989, respectively. VEGP Units 3 and 4 are adjacent to and west of VEGP Units 1 and 2. SNC is the licensed operator of the

[1] See Section 1.2.2 for a discussion of the staff's review related to verification of the scope of information to be included in a COL application that references a DC.

nuclear facilities at the VEGP site, with control of the nuclear facilities, including complete authority to regulate any and all access and activity within the plant exclusion area boundary.

VEGP Unit 3 is connected to the Units 1, 2 and 3, 230/500 kV switchyard at the 230 kV level. The 230 kV and 500 kV levels of the Units 1, 2 and 3, 230/500 kV switchyard are arranged in a breaker-and-a-half configuration and are interconnected through two, 230/500 kV autotransformers. VEGP Unit 4 is connected to the Unit 4, 500 kV switchyard. This switchyard is also arranged in a breaker-and-a-half configuration. The Unit 4, 500 kV switchyard is connected to the 500 kV section of the Units 1, 2 and 3, 230/500 kV switchyard by overhead lines. Five, 230 kV and three, 500 kV transmission lines connect the VEGP high voltage switchyards to the remainder of the SBAA transmission grid.

The NRC staff finds that the applicant has adequately described the VEGP Units 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.

- VEGP SUP 8.1-2

The NRC staff also reviewed supplemental information included in VEGP 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.

VEGP COL FSAR Table 8.1-201, 1b indicated that RG 1.155 is not applicable to VEGP. This item was deemed as standard among COL applications being discussed in Bellefonte's (BLN) response to request for additional information (RAI) 8.1-2. In this RAI, 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 a SBO event of the specified duration and recovery therefrom 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 May 15, 2009, SNC stated that the BLN standard response to RAI 8.1-2 applies to the VEGP COL application with a clarification.

The standard response submitted for BLN in a letter dated June 24, 2008, is summarized as follows. The BLN 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 the requirements of 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 alternating current (ac) power sources. However, the applicant needs to establish SBO procedures and training for operators to include actions necessary to restore offsite power 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 BLN applicant regarding this issue. Subsequently, in a letter dated April 15, 2009, the BLN applicant stated that the training and procedures to support mitigation of an SBO event would 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," which is endorsed by RG 1.155, 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 BLN 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. This response was found acceptable by the NRC staff.

The clarification submitted along with the acceptance of the standard response is presented as follows. The last sentence of the third paragraph of the RAI response for BLN states: "In addition, 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," was not incorporated for VEGP because the VEGP site has a black start fossil fuel plant nearby. Plant Wilson is a six-unit combustion turbine electric generating facility with black start capability, located approximately 1 mile east of the VEGP site. Plant Wilson could be made available to re-supply power to Units 3 or 4 following a loss of the grid. The applicant stated that the VEGP Units 3 and 4 FSAR will incorporate the standard FSAR changes in a future revision, with the following change: The fourth sentence of the first paragraph that reads: "In addition, 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." will not be incorporated.

The NRC staff verified that VEGP COL FSAR Sections 1.9.5.1.5 and 1.9.6 have been updated to include the above-mentioned items including the identification of Plant Wilson as a local power source that could be made available to re-supply power to Units 3 and 4 following a loss of the grid in accordance with NUMARC-87-00. Also, the staff finds 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. Based on the above, the NRC staff finds this item resolved.

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 VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

In addition, the staff has compared the additional COL-specific supplemental information in 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. The staff based its conclusion on the following:

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

- VEGP 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 requirements of 10 CFR 50.63 and the guidance in RG 1.155.

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 AP1000 design includes an exemption, in 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants," Appendix D, "Design Certification Rule for the AP1000 Design," paragraph V.B.3, to the requirement of General Design Criterion (GDC) 17, "Electric Power Systems," to have only one (not two) physically independent offsite circuit to provide for safety-related passive systems for core cooling and containment integrity. Therefore, for VEGP Units 3 and 4, 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 VEGP COL FSAR, Revision 5, incorporates by reference Section 8.2 of the AP1000 DCD, Revision 19.

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

AP1000 COL Information Items

- VEGP COL 8.2-1

The applicant provided additional information in VEGP 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) to address the design of the ac power transmission system and its testing and inspection plan. The information describes: 1) the designs of the three plant site high voltage switchyards, the five 230 kV transmission lines connecting the Units 1, 2, and 3, 230/500 kV switchyard to various substations throughout the transmission grid, the three 500 kV transmission lines connecting the Units 1, 2 and 3, 230/500 kV switchyard and the Unit 4, 500 kV switchyard to other substations throughout the SBAA transmission grid; 2) the connections of the generator step-up (GSU) transformers and the reserve auxiliary transformers (RATs) to the switchyards; 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 for each of the high voltage switchyards; 7) the administrative

control of the switchyard and transmission lines circuit breakers, 8) the switchyard and transmission lines testing and inspection plan, and 9) voltage operating range, frequency decay rate, and preservation of grid connection. VEGP COL 8.2-1 is addressed in VEGP COL FSAR Sections 8.2.1, 8.2.1.1, 8.2.1.2, 8.2.1.3, and 8.2.1.4.

- VEGP COL 8.2-2

The applicant provided additional information in VEGP 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 switchyard arrangement and design of the protective relaying scheme; and 2) a transmission system study performed 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 AP1000 DCD Section 8.2.2. VEGP COL 8.2-2 is addressed in VEGP COL FSAR Sections 8.2.1.2.1 and 8.2.2.

Site-Specific Information Replacing Conceptual Design Information (CDI)

- VEGP 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 AP1000 DCD.

Supplemental Information

- VEGP 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 switchyards, and the transmission system. It also provided information on the transmission system operator (TSO), and the detailed voltage and other requirements to be maintained by the TSO.

- VEGP SUP 8.2-2

The applicant provided supplemental information describing the agreement between VEGP and SCT, which is the TSO, setting the requirements for transmission system studies and analyses.

- VEGP SUP 8.2-3

The applicant provided supplemental information describing SCT's 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. The applicant provided information on conducting planning studies on an ongoing basis, including information on updating the studies to assess future system performance.

- VEGP SUP 8.2-4

The applicant provided supplemental information describing the agreement between VEGP and SCT demonstrating that protocols are in place for VEGP to remain cognizant of grid

vulnerabilities in order to make informed decisions regarding maintenance activities critical to the electric system. It also provided grid stability analysis results for events in addition to the turbine trip.

- VEGP SUP 8.2-5

The applicant provided supplemental information describing the reliability of the 230 kV and 500 kV transmission lines feeding the VEGP site for the period from January 1, 1992 to November 30, 2007.

- VEGP SUP 8.2-6

The applicant provided supplemental information stating that the protective devices controlling the switchyard breakers are set with consideration given to preserving the plant grid connection following a turbine trip.

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.

8.2.3 Regulatory Basis

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the offsite power system 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 VEGP COL 8.2-1 and VEGP SUP 8.2-1, the requirements of 10 CFR Part 50, Appendix A, GDC 17; GDC 18, "Inspection and Testing of Electrical Power Systems"; and the guidelines of RG 1.206.

- For VEGP COL 8.2-2, VEGP SUP 8.2-2, VEGP SUP 8.2-3, VEGP SUP 8.2-5 and VEGP SUP 8.2-6, the requirements of GDC 17 and the guidelines of RG 1.206.

- For VEGP 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 Generic Letter (GL) 2006-2, "Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power," and RG 1.206.

- For VEGP CDI, the requirements of GDC 17.

8.2.4 Technical Evaluation

The NRC staff reviewed Section 8.2 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the offsite power system. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Items

- VEGP COL 8.2-1

The applicant provided additional information in VEGP COL 8.2-1 to resolve COL Information Item 8.2-1, which 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 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 VEGP COL 8.2-1, related to the transmission system design, testing, and inspection addressed in Section 8.2 of the VEGP COL FSAR. The NRC staff's evaluation is described below.

VEGP Units 3 and 4 are served via three high-voltage switchyards located north of the facility. The three high-voltage switchyards are defined as follows:

- Units 1, 2 and 3, 230/500 kV switchyard
- Unit 4, 500 kV switchyard
- Units 3 and 4, RAT supply, 230 kV switchyard

The interconnection of the three switchyards, including the location of the GSUs and RATs, and the 230 kV and 500 kV transmission lines are described in Section 8.2.1 of the VEGP COL

FSAR. VEGP Unit 3 is tied into the 230 kV transmission grid via the Units 1, 2 and 3, 230/500 kV switchyard. Unit 4 is tied into the 500 kV transmission grid via the Unit 4, 500 kV switchyard. The Units 3 and 4 RAT supply 230 kV switchyard consists of 4 breakers installed in a ring bus configuration.

VEGP Units 3 and 4 are supplied with offsite power from the SBAA 230 kV and 500 kV grid via two separate switchyard buses and backfed through the GSUs. The VEGP switchyards are connected to eight transmission lines. No single transmission line is designated as the preferred circuit, but analysis shows that with any one of these transmission lines out of service, the transmission grid can supply the switchyard with sufficient power for the safety-related systems and other auxiliary loads for Units 3 and 4 during normal, abnormal, and accident conditions.

VEGP COL FSAR Figure 8.2-202 shows several line crossings in the vicinity of the plant. The NRC staff was concerned that during adverse weather conditions high winds could cause the loss of both the 500 kV and 230 kV lines to supply offsite power to Units 3 and 4. In RAI 8.2-13, the staff asked the applicant to perform an analysis of each crossing of lines and demonstrate that this vulnerability is acceptable for VEGP offsite power system designs for Units 3 and 4. In a letter dated January 7, 2010, the applicant provided the analysis of transmission line crossings within the area of the VEGP site. The applicant reported that:

> Sixteen line crossing locations were evaluated to demonstrate that offsite power would be available to both Unit 3 and Unit 4 from at least one of the three available offsite power supplies to each unit and to confirm that Units 1 and 2 would not be affected. A non-mechanistic failure was assumed for each of the 16 transmission lines (a line is considered to be any one of the three phases) allowing it to fall on the line or lines immediately below it, resulting in a fault on each of the associated lines. In three cases, the falling line was assumed to contact two lines below. In all, 13 separate cases of falling transmission lines were evaluated. No single failures of protective relaying or breakers were assumed in this evaluation. The evaluation demonstrated that, in each case, at least one offsite power supply remained available to both Unit 3 and Unit 4. In addition, there were no adverse effects to Unit 1 or Unit 2.

Attachments with supporting information were also provided. The applicant also committed to include a proposed revision of the FSAR. The NRC staff has reviewed the response and the proposed revision and concludes that the applicant's analysis demonstrates that at least one offsite power source will be available to both Units 3 and 4 under the above contingencies. The above satisfies the requirements of GDC 17 as it applies to AP1000 design; therefore the staff finds this issue is resolved subject to the verification that the FSAR has been updated to include the proposed revision. This is **Confirmatory Item 8.2-1**.

<u>Resolution of VEGP Site-Specific Confirmatory Item 8.2-1</u>

Confirmatory Item 8.2-1 is an applicant commitment to revise its FSAR Section 8.2.1.1 to reflect the applicant's analysis demonstrates that at least one offsite power source will be available to both Units 3 and 4 under adverse weather conditions. The staff verified that the VEGP COL FSAR was appropriately revised. As a result, Confirmatory Item 8.2-1 is now closed.

With regard to the maintenance and testing of the offsite power circuits, in RAI 8.2-7, the staff asked the applicant to clarify the extent of the word "observes" and to clarify if VEGP would follow North American Electric Reliability Corporation (NERC) reliability standards.

In a letter dated April 28, 2010, the applicant stated that this statement was intended to indicate that SCT follows the NERC standards for switchyard maintenance and testing. The NRC staff concludes that since the applicant would follow the NERC standard for switchyard maintenance and testing, this information satisfies the requirements of GDC 18 related to testing and is acceptable. This issue is considered resolved subject to the verification that the FSAR has been updated to include the proposed clarification. This is **Confirmatory Item 8.2-2**.

Resolution of VEGP Site-Specific Confirmatory Item 8.2-2

Confirmatory Item 8.2-2 is an applicant commitment to revise its FSAR Section 8.2.1.4 to reflect the applicant's plans for switchyard maintenance and testing in accordance with the NERC standards. The staff verified that the VEGP COL FSAR was appropriately revised. As a result, Confirmatory Item 8.2-2 is now closed.

Additionally, the applicant provided the site-specific voltage and frequency variations expected at all VEGP switchyards during transient and steady state operating conditions and the site-specific frequency decay rate to satisfy VEGP COL 8.2-1.

- VEGP COL 8.2-2

The applicant provided additional information in VEGP COL 8.2-2 to resolve COL Information Item 8.2-2, which states:

> The Combined License applicant will address the technical interfaces 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 NRC staff's evaluation of the technical interfaces is addressed in the "Interface Requirements" section of this safety evaluation report (SER).

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 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, VEGP 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 VEGP COL FSAR. The NRC staff's evaluation follows.

VEGP COL FSAR Section 8.2.1.2.1 states that the switchyards are designed to provide high speed fault clearing while also maintaining high reliability and operational flexibility. The arrangement of the switchyards allows for isolation of components and buses, while preserving VEGP's connection to the grid. Under normal operating conditions all 230 kV and 500 kV circuit breakers and all bus sectionalizing motor operated disconnect switches are closed and all bus sections are energized. Each 230 kV and 500 kV transmission line is protected by two independent protection schemes (primary and secondary) to achieve high speed clearing for a fault anywhere on the line and to provide remote back-up protection for remote faults. Each scheme has a pilot protection package and a stand alone step distance line protection package. The breaker failure scheme is initiated by either of the primary or secondary protection schemes and operates 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 all necessary breakers to isolate the faulted area. Based on the above, the staff concludes that the switchyard breaker arrangements, the protection of lines by two independent protection schemes, and the breaker failure scheme would preserve the VEGP's connection to the grid to satisfy the requirements of GDC 17. This satisfies COL Action Item 8.2.3.1-2.

With regard to the transmission system stability analysis, the applicant stated that the VEGP grid stability analysis confirms that 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 as specified in DCD Section 8.2.2 (COL Action Item 8.2.3.1-3). The staff determined that additional information was needed to conclude the technical evaluation of this item. In RAI 8.2-1, the staff asked the applicant to confirm that the single offsite power circuit complied with the requirements of GDC 17 to provide voltage and frequency variations at all switchyards. The applicant was also asked to confirm that these voltage and frequency limits are acceptable for auxiliary power system equipment operation and Class 1E battery chargers during different 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; and motor starting with minimum and maximum grid voltage conditions. A separate set of calculations should be performed for each available connection to an offsite power supply. In addition, the applicant was asked to discuss how the results of the calculations will be verified before fuel loading.

In a letter dated January 16, 2009, the applicant stated that the results of grid stability studies performed for each available connection to an offsite power supply demonstrate the offsite power source capacity and capability to power plant components during normal, shutdown, startup and turbine trip conditions.

The applicant also stated that the 500 kV switchyard voltage was set to 517 kV (1.03 per unit [p.u.]) and the 230 kV voltage was set at 235 kV (1.02 p.u.). This is the anticipated voltage and is consistent with standard practice for grid studies at VEGP. 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 reactives (MVARs) to support this voltage, and, therefore, the generator bus voltage remains relatively stable.

In addition, the applicant stated that the grid voltage evaluation results provided in the response are verified during the preoperational testing identified in AP1000 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)

In a revised response, dated October 23, 2009, the applicant stated that the conclusion that the voltage and frequency variations expected at all VEGP switchyards are acceptable for auxiliary power system equipment operation during steady-state and transient operating conditions is based on stability studies, which include the most critical contingencies, such as simulation of turbine trip events, loss of the most critical transmission line, loss of the largest load and loss of the largest unit in the area.

The NRC staff has reviewed the above information 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. The NRC staff finds that the applicant has satisfied the portion of COL Information Item 8.2-2 to maintain the voltage at the RCP to ≥ 80 percent for at least 3 seconds following a turbine trip, to maintain the reactor coolant flow assumed in the Chapter 15 analyses.

In a public meeting with the Nustart Consortium on April 7, 2009, there was an agreement that portions of VEGP RAI 8.2-1 were not within the scope of the VEGP COL, but rather within the scope of the AP1000 DC. This is considered a standard item applicable to all COL applications including VEGP. Therefore, the staff finds that the relevant portions of RAI 8.2-1 are resolved.

In RAI 8.2-2, the staff asked the applicant to provide a discussion as to how a single offsite power circuit complied with GDCs 2, 4, 5, 17 and 18, as well as with guidance in NUREG-0800, Section 8.2.II, and how SNC intends to meet the requirements of 10 CFR 50.65.

In a letter dated January 16, 2009, the applicant stated that there is no portion of the single offsite circuit required to conform with GDC 2, 4, 5, and 18 and that these GDCs are for structures, systems, and components important to safety. The staff agrees that GDC 2 and 4 do not apply to the AP1000 design. However, based on the information provided in the applicant's letter of April 28, 2010, the NRC staff notes that the environmental effects are considered in the design of the offsite power circuit for VEGP. For example, conductors are designed to withstand a particular high temperature (normally 100°C) before violating sag clearances, and transmission lines are designed for high winds, typically 100 miles per hour (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 this information is consistent with the recommendation of RG 1.206 with respect to the design of the switchyard components to withstand environmental conditions at the VEGP site.

With respect to GDC 5, the NRC staff concludes that because the offsite power system for VEGP Units 3 and 4 UATs is not shared among the units, the requirements of GDC 5 do not apply.

With respect to GDC 17, the NRC staff finds that 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. Therefore, the NRC staff

concludes that the VEGP design meets the requirements of GDC 17, as it is applicable to the AP1000 design, and this item is resolved.

With regard to GDC 18, NUREG-1793, Section 8.2.3.2 identifies COL Action Item 8.2.3.3-1 to demonstrate that the testing and inspection capability of the offsite power system is in conformance with GDC 18; therefore, this interface item must also be satisfied by the applicant.

In a letter dated November 20, 2009, the applicant endorsed the standard content response provided in BLN RAI 8.2-10. The staff has verified that VEGP FSAR Section 8.3.1.4 has been 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. The above satisfies the requirements of GDC 18 and is, therefore, acceptable.

Based on the above, the staff considers the issue of applicability of GDC 5, 17, and 18 resolved.

With regard to 10 CFR 50.65, the applicant stated that VEGP COL FSAR Section 17.6 describes implementation of the requirements of 10 CFR 50.65. As indicated therein, implementation of the Nuclear Energy Institute (NEI) 07-02A, "Generic FSAR Template Guidance for Maintenance Rule Program Description for Plants Licensed Under 10 CFR Part 52," program description will determine the applicability of the maintenance requirements for the offsite power circuit. NEI 07-02A provides a template for presenting this information that has also been endorsed by the staff in a letter to NEI, dated January 24, 2008. The NRC staff verified that the reference to this topical report is in VEGP COL FSAR Table 1.6-201. Since the scope of structures, systems, and components (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 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 VEGP 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 this item resolved.

In RAI 8.2-9, the staff asked the applicant that since the voltage at the high side of the GSU, and RAT cannot drop more than 15 percent from the pre-trip steady-state voltage as specified in Section 8.2.2 of the FSAR, describe if a voltage drop of 15 percent is the worst expected switchyard voltage.

In a letter dated January 16, 2009, the applicant stated that the worst expected voltage would be a 15 percent drop from the pre-trip steady-state voltage. However, the applicant's response to RAI 8.2-5 stated that after the loss of the largest unit in the area, the voltage would recover to a value well-within the Westinghouse requirement of +/- 20 percent for a transient event. The NRC staff concluded that the applicant needed to clarify what the actual worst expected switchyard voltage would be under any operating condition.

In a letter dated October 23, 2009, the applicant provided the required additional clarification. The applicant indicated that the steady-state and transient voltage requirements were provided by Westinghouse and these requirements are satisfied as follows:

- Under steady-state conditions (no line faults, load losses, transients, or unit trips), the minimum pre-trip scheduled switchyard voltages at the VEGP 230 kV and 500 kV switchyards are 235 kV and 517 kV. While maintaining the scheduled voltage, the steady-state generator bus voltage is maintained within the Westinghouse requirement of 0.95 p.u. to 1.05 p.u.

- To ensure adequate voltage is maintained to the RCPs for 3 seconds following a turbine trip event, Westinghouse also requires that the voltage at the high side of the GSU transformer and RATs not drop more than 15 percent from the pre-trip steady-state voltage. A grid stability study for VEGP Units 3 and 4 was performed, which concluded that during a turbine trip event, the voltage at the high side of the GSU and RATs would drop a maximum of 5 percent on a transient basis and recover to an acceptable post-trip steady-state value. Therefore, the turbine trip event is well within the Westinghouse requirement.

- During transients, such as a loss of the most critical transmission line or fault on a transmission line, the Westinghouse requirement is to maintain the generator bus voltage within +/- 20 percent. The most significant transient was determined to be a fault on the West McIntosh 500 kV line. During this transient, after the fault clears (within approximately 6 cycles), generator bus voltage recovers to within 0.8 p.u. and returns to the pre-transient voltage within seconds, thereby reaching an acceptable steady state voltage level.

In summary, the applicant stated that only during short-term transient conditions does the generator bus voltage or switchyard voltage drop below the steady-state voltage stated above.

The NRC staff has reviewed the above information and finds that the applicant has satisfied the Westinghouse acceptance criteria to maintain the voltage at the RCP to ≥ 80 percent 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 8.2-9 are resolved. This satisfies COL Action Items 8.2.3.1-1 and 8.2.3.1-3.

Therefore, VEGP COL Information Item 8.2-2 is satisfied.

Submerged/Inaccessible Electrical Cables

In RAI 8.2-14, the staff asked the applicant to describe the inspection, testing and monitoring program to detect degradation of inaccessible or underground control and power cables that support equipment and other systems that are within the scope of 10 CFR 50.65. The description should include the frequency of testing and inspection. Guidance on the selection of electric cable condition monitoring can be found in Sections 3 and 4.5 of NUREG/CR-7000, "Essential Elements of an Electric Cable Condition Monitoring Program."

In a letter dated May 6, 2010, the applicant stated that the Maintenance Rule (MR) program will not be implemented until prior to fuel load; as such, specific information necessary to determine appropriate inspections, tests and monitoring is not available at this time. In order to determine

the method and frequency, a review of detailed design and procurement information is needed. The applicant also stated that the latest industry experience and other available information, including NUREG/CR-7000, will be followed in developing a cable condition monitoring program as part of the MR program. The applicant also committed to revise its FSAR to include condition monitoring of underground or inaccessible cables in its MR program. The commitment will be reflected in the COL application Part 2, FSAR Chapter 17, Section 17.6 as shown below.

> Condition monitoring of underground or inaccessible cables is incorporated into the maintenance rule program. The cable condition monitoring program incorporates lessons learned from industry operating experience, addresses regulatory guidance, and utilizes information from detailed design and procurement documents to determine the appropriate inspections, tests and monitoring criteria for underground and inaccessible cables within the scope of the maintenance rule (i.e., 10 CFR 50.65). The program takes into consideration Generic Letter 2007-01.

Based on the above, the staff concludes that the applicant's condition monitoring program for underground or inaccessible cables satisfies the recommendations of GL 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients," and the guidance in NUREG/CR-7000 and NUREG-0800 Section 8.2.III.1.L. Therefore, this item is resolved subject to the verification that the VEGP COL FSAR has been updated to include applicable portions of the RAI response. This is identified as **Confirmatory Item 8.2-3**.

Resolution of Standard Content Confirmatory Item 8.2-3

Confirmatory Item 8.2-3 is an applicant commitment to revise its FSAR Section 17.6 to address condition monitoring of underground or inaccessible cables. The staff verified that the VEGP COL FSAR was appropriately revised. As a result, Confirmatory Item 8.2-3 is now closed.

Supplemental Information

- VEGP SUP 8.2-1

VEGP 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 SBAA transmission system. The NRC staff reviewed the applicant's FMEA and determined that a detailed description of each event evaluated in the FMEA is necessary to evaluate and determine that the offsite power to each unit is not lost. In RAI 8.2-4, the NRC staff asked the applicant to provide such detailed analysis for evaluation. In a letter dated January 16, 2009, the applicant provided details of the FMEA performed based on the design of the switchyard and the interconnecting transmission line. The staff evaluated the FMEA of the VEGP 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, or 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 VEGP Units 3 or 4 via the GSU. Based on the above, the NRC staff concludes that the information provided by the applicant satisfies the requirements of GDC 17 and the recommendation of RG 1.206. Therefore, this issue is resolved.

With regard to the information on the transmission system operator (TSO), the applicant provided the following:

SCT is the TSO within the SBAA and is responsible for the safe and reliable operation of the SBAA transmission grid. SCT and VEGP have an agreement and protocols in place to provide safe and reliable operation of the transmission grid and equipment at VEGP Units 3 and 4. Elements of this agreement are implemented in accordance with the procedures of both parties. The TSO establishes a voltage schedule for the 230 kV and 500 kV switchyards. VEGP Units 3 and 4, while generating, are expected to supply or absorb reactive power to help regulate voltage in the 230 kV and 500 kV switchyards in accordance with TSO voltage schedule criteria. VEGP maintains switchyard voltage such that steady state voltage on the 26 kV generator terminals is within 0.95–1.05 p.u. of its nominal value. VEGP provides the TSO with a nuclear plant interface agreement that specifies the detailed voltage and other requirements necessary to ensure safe and reliable operation of VEGP. The minimum and maximum switchyard voltage at VEGP is maintained in accordance with this interface agreement. These voltage levels are maintained without any reactive power support from VEGP Units 3 and 4.

The NRC staff finds the above information to be consistent with the recommendations of RG 1.206 and acceptable.

<u>VEGP SUP 8.2-2, VEGP SUP 8.2-3, and VEGP SUP 8.2-4</u>

With regard to VEGP SUP 8.2-2, the applicant provided the following information:

> An agreement between VEGP and SCT sets the requirements for transmission grid studies and analyses. These analyses demonstrate the capability of the offsite power system to support plant start up and shutdown.

The staff finds the above information to be in accordance with RG 1.206 and acceptable.

With regard to VEGP SUP 8.2-3, the applicant provided the following information:

> SCT 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 updated periodically to assess future system performance in accordance with NERC Reliability Standards. These studies form a basis for identifying future transmission expansion needs.

The NRC staff has reviewed the information on conducting planning studies of the transmission grid on an ongoing basis and concludes that the information provided by the applicant satisfies the recommendations of RG 1.206 and is acceptable.

With regard to VEGP SUP 8.2-4, the applicant provided the following information:

> The agreement between VEGP and SCT demonstrates protocols are in place for the plant to remain cognizant of grid vulnerabilities so that they can make informed decisions regarding maintenance activities critical to the electrical system. As part of its operational responsibilities, the PCC [Power Coordination Center] continuously monitors real-time power flows and assesses contingency impacts through the use of a state-estimator tool. The PCC/GCC [Georgia Transmission Control Center] continuously monitors and evaluates grid reliability

> and switchyard voltages, and informs plant operations of any potential grid instability or voltage inadequacies. They also work to maintain local voltage requirements as required by VEGP. Operational planning studies are also performed using offline power flow study tools to assess near term operating conditions under varying load, generation, and transmission topology patterns. If a condition arises where the SBAA transmission grid cannot supply adequate offsite power, plant operators are notified and appropriate actions are taken. VEGP plant operations reviews input from the GCC/PCC to make informed decisions regarding plant activities that may affect plant reliability or impacts to the transmission grid. In addition, plant operators inform the PCC/GCC of changes in generation ramp rates and notify them of any developing problems that may impact generation.

With regard to grid stability analysis results for events in addition to turbine trip, the applicant stated:

> In addition to turbine trip, the grid stability analysis also considered normally cleared three-phase faults on the transmission system and three-phase faults followed by breaker failure at the VEGP 500 kV and 230 kV switchyards. A 500 kV line out for maintenance with a normally cleared fault on another 500 kV line was also studied. The results demonstrate that the grid remains stable for the loss of the most critical transmission line, the loss of the largest load, and the loss of the largest generating unit. For these contingencies, the generator bus voltages and switchyard voltages (after fault clearing) remain well within the required limits.
>
> The grid stability analysis confirmed that the interface requirements for steady state load, 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 has reviewed the information provided by the applicant on the functions of PSO/TSO who establishes a voltage schedule for the VEGP switchyards and also maintains switchyard voltage such that steady state voltage on the generator bus is within 0.95–1.05 p.u. of its nominal value. Based on its review, the NRC staff concludes that the applicant has demonstrated that protocols are in place for the VEGP to remain cognizant of grid vulnerabilities in order to make informed decisions regarding maintenance activities critical to the electric system. This is consistent with the recommendations of RG 1.206 and 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.

- VEGP SUP 8.2-5

With regard to VEGP SUP 8.2-5 the applicant provided the average grid availability for the two transmission voltages from January 1, 1992 to November 30, 2007. The West McIntosh and Scherer 500 kV transmission lines for VEGP have an availability of 99.9 percent with 25 forced outages and the five 230 kV transmission lines for VEGP have an availability of 99.6 percent with 26 forced outages. The NRC staff finds that this information satisfies RG 1.206 and is acceptable.

- VEGP SUP 8.2-6

The applicant provided additional information in VEGP SUP 8.2-6 to resolve COL Information Item 8.2-2, which states:

> The Combined License applicant will address the technical interfaces 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 8.2.3.1-2 in Appendix F of NUREG-1793, which states:

> 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.

The NRC staff's evaluation of the resolution to COL information item, VEGP SUP 8.2-6, related to the transmission system stability analysis and switchyard circuit breaker protective device settings is addressed in the "Interface Requirements" section of this SER.

Site-Specific Information Replacing Conceptual Design Information (CDI)

- VEGP CDI

The CDI information provided by the applicant regarding the transformer area located next to each unit's turbine building is consistent with the AP1000 DCD and satisfies the applicable requirements of GDC 17

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 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.

In order to satisfy plant Interface Item 8.1 in AP1000 DCD Tier 2, Table 1.8-1, the applicant provided the design criteria, RGs, and Institute of Electrical and Electronics Engineers (IEEE) standards in Section 8.1.4.3 of the VEGP COL FSAR. The NRC staff finds the information to be consistent with Section 8.1 of NUREG-0800 and acceptable. Therefore, this interface item for offsite power system has been met.

In order to satisfy plant Interface Item 8.2 in AP1000 DCD Tier 2, Table 1.8-1, the applicant provided the steady-state load, inrush kVA for motors, nominal voltage, allowable voltage regulation, nominal frequency, allowable frequency fluctuation, maximum frequency decay rate,

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

and limiting under frequency values for RCP in Revision 2 of the VEGP COL FSAR. This information was included in Table 8.2-201, "Grid Stability Interface Evaluation," which confirms that the above interface items for RCPs have been met.

In order to satisfy plant Interface Item 8.3 in AP1000 DCD Tier 2, Table 1.8-1, the applicant did not provide a statement affirming that "the protective devices controlling the switchyard breakers are set with consideration given to preserving the plant grid connection following a turbine trip." In RAI 8.2-12, the staff asked the applicant to provide a reference to where this issue is discussed in the VEGP application, or to provide a proposed revision to the application to address the issue. In a letter dated August 31, 2009, the applicant stated that the SNC letter dated July 16, 2009, included a proposed revision to the FSAR and the addition of a new Table 1.8-205, titled "Summary of FSAR Discussions of AP1000 Plant Interfaces." Within this table, Interface Item 8.3 addresses the requirements for protective devices controlling the switchyard breakers and FSAR Sections 8.2.2 and 14.2.9.4.23 were identified as satisfying that portion of the interface. Additional changes to the FSAR were incorporated in Revision 2 as VEGP SUP 8.2-6 stating "The protective devices controlling the switchyard breakers are set with consideration given to preserving the plant grid connection following a turbine trip." The NRC staff concludes that the switchyard arrangement, the protection of lines by independent high speed relaying, and breaker failure would preserve the VEGP's connection to the grid following a turbine trip satisfying the requirements of GDC 17; therefore, the staff finds this interface has been met.

The NRC staff has reviewed the information supplied by the applicant and concludes that the applicant has adequately addressed Interface Items 8.1, 8.2, and 8.3 of AP1000 DCD Tier 2, Table 1.8-1.

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 VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the VEGP COL FSAR is acceptable and meets the requirements of GDC 17 and GDC 18. The staff based its conclusion on the following:

- VEGP 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 in accordance with the guidelines of RG 1.206.

- VEGP 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 in accordance with the guidelines of RG 1.206.

- VEGP CDI in Section 8.2.1 of the VEGP COL FSAR, the applicant provided sufficient information concerning the transformer area located next to each unit's turbine building in accordance with the guidelines of RG 1.206. VEGP SUP 8.2-1, the applicant provided sufficient information involving offsite power distribution system, plant site switchyard, and the VEGP transmission system in accordance with the guidelines of RG 1.206.

- VEGP SUP 8.2-2, the applicant provided sufficient information describing the agreement between VEGP and SCT setting the requirements for transmission system studies and analyses in accordance with the guidelines of RG 1.206.

- VEGP SUP 8.2-3, the applicant provided sufficient information describing SCT's responsibility for maintaining transmission system reliability and conducting planning studies on an ongoing basis in accordance with the guidelines of RG 1.206.

- VEGP SUP 8.2-4, describing the agreement between VEGP and SCT demonstrating that protocols are in place for VEGP to remain cognizant of grid vulnerabilities in order to make informed decisions regarding maintenance activities critical to the electric system in accordance with the guidelines of RG 1.206 and GL 2006-02.

- VEGP SUP 8.2-5, the applicant provided sufficient information regarding causes of outages of the transmission line over the past 15 years in accordance with the guidelines of RG 1.206.

- VEGP SUP 8.2-6, the applicant provided sufficient information to satisfy the interface item regarding ac power requirements and the analysis of the offsite transmission system and the setting of protective devices controlling the switchyard in accordance with the guidelines of RG 1.206.

- The applicant provided sufficient information regarding the interfaces for standard design from the generic AP1000 DCD, Table 1.8-1, Items 8.1, 8.2, and 8.3.

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 VEGP COL FSAR, Revision 5, incorporates by reference Section 14.3 of the AP1000 DCD, Revision 19.

In addition, in VEGP 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 Standard (STD) SUP 14.3-1 in VEGP COL FSAR Section 14.3.2.3.

License Condition

- License Condition 1, regarding offsite power system ITAAC

8.2.A.3 *Regulatory Basis*

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

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for ITAAC are given in Section 14.3 of NUREG-0800.

The applicable regulatory requirements for electrical SS-ITAAC are in 10 CFR 52.80(a), "Contents of applications; additional technical information."

8.2.A.4 *Technical Evaluation*

The NRC staff reviewed Section 14.3 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to SS-ITAAC for offsite power systems. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the BLN Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. There was one confirmatory item (Confirmatory Item 8.2A-1) related to the standard content in the BLN SER. Its resolution is addressed in this SER.

The following portion of this technical evaluation section is reproduced from Section 8.2.A.4 of the BLN SER:

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.*

Resolution of Standard Content Confirmatory Item 8.2A-1

The applicant proposed a license condition in Part 10 of the VEGP COL application, which will incorporate the ITAAC identified in Appendix B. Appendix B includes ITAAC for the offsite power system. The license condition's proposed text is evaluated in Chapter 1 of this SER.

Confirmatory Item 8.2A-1 required the applicant to update its FSAR to include proposed ITAAC for the offsite power system. The NRC staff verified that the VEGP COL application was appropriately updated. The ITAAC associated with the offsite power system are shown in VEGP COL Part 10, Appendix B, Table 2.6.12-1. Table 8.2A-1 of this SER reflects this table. As a result, Confirmatory Item 8.2A-1 is resolved. Therefore, the staff will include the ITAAC for the offsite power system in the license.

8.2.A.5 *Post Combined License Activities*

For the reasons discussed in the technical evaluation section above, the staff proposes to include the following ITAAC for the offsite power system:

- The licensee shall perform and satisfy the ITAAC defined in Table 8.2A-1, "Offsite Power System."

8.2.A.6 *Conclusion*

The staff concludes that the relevant information presented in the VEGP COL FSAR, including STD SUP 14.3-1, is acceptable and meets the requirements of GDC 17 and GDC 18.

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 VEGP, 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 supplies. 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 VEGP COL FSAR, Revision 5, incorporates by reference Section 8.3 of the AP1000 DCD, Revision 19. Section 8.3 of the AP1000 DCD includes Section 8.3.1.

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

AP1000 COL Information Items

- VEGP COL 8.3-1

VEGP 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 VEGP Units 3 and 4.

- STD COL 8.3-2

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

Supplemental Information

- VEGP SUP 8.3-1

VEGP SUP 8.3-1 describes the site conditions provided in Section 2.3 of the FSAR that are bounded by the standard site conditions used to rate the diesel engine and the associated generator in AP1000 DCD Section 8.3.1.1.2.3.

- VEGP SUP 8.3-2

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

- VEGP SUP 8.3-4

VEGP SUP 8.3-4 provides supplemental information regarding periodic verification of the onsite ac power system's capability to transfer between the preferred power supply and the maintenance power supply.

8.3.1.3 *Regulatory Basis*

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

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

The regulatory basis for acceptance of VEGP 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 Standard 80, "Guide for Safety in AC Substation Grounding"
- IEEE Standard 665, "Guide for Generating Station Grounding"

The bases 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 standards commonly used in the industry.

The regulatory bases 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," Revision 3

8.3.1.4 *Technical Evaluation*

The NRC staff reviewed Section 8.3.1 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the onsite ac power systems. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the BLN Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. There was one confirmatory item (Confirmatory Item 8.3.1-1) related to the standard content in the BLN SER. Its resolution is addressed in this SER.

The staff reviewed the information in the VEGP COL FSAR:

AP1000 COL Information Items

- VEGP COL 8.3-1

The NRC staff reviewed VEGP 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 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, VEGP COL 8.3-1, related to the ground grid system and lightning protection included under Section 8.3 of the VEGP 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 Standard 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. Based on the above, the staff concludes that IEEE Standard 80 provides an acceptable method for determining the right size for ground conductors; therefore, the COL information item provided by the applicant on station grounding grid is acceptable.

With regard to lightning protection, the applicant stated that in accordance with IEEE Standard 665, a lightning protection risk assessment for the buildings was performed based on the methodology in National Fire Protection Association (NFPA) 780, "Standard for the Installation of Lightening Protection." "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 VEGP Units 3 and 4 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 Standard 665 and NFPA 780 provide an acceptable method for lightning protection; therefore, the supplemental information provided by the applicant on lightning protection is acceptable.

The following portion of this technical evaluation section is reproduced from Section 8.3.1.4 of the BLN SER:

- *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.

Resolution of Standard Content Confirmatory Item 8.3.1-1

Confirmatory Item 8.3.1-1 required the applicant to update its FSAR to specify that onsite standby diesel generator inspection and maintenance (including preventive, corrective, and predictive maintenance) procedures will consider both the diesel generator manufacturer's recommendations and industry diesel working group recommendations. The NRC staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 8.3.1-1 is resolved.

Supplemental Information

- VEGP SUP 8.3-1

The applicant stated in VEGP SUP 8.3-1 that its site conditions provided in Section 2.3 were bounded by the standard site conditions in AP1000 DCD Section 8.3.1.1.2.3 used to rate the diesel generators. The staff agrees that the VEGP site conditions are bounded by the standard site conditions used to determine the rating.

- VEGP SUP 8.3-2

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

- VEGP SUP 8.3-4

For evaluation of the subject of this item, see the evaluation of VEGP COL 8.2-2 regarding conformance to GDC 18.

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 onsite ac power systems, and there is no outstanding information expected to be addressed in the VEGP

COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

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 in 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. The staff based its conclusion on the following:

- VEGP 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.

- VEGP 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.

- VEGP SUP 8.3-4, the applicant will implement procedures for periodic verification of offsite power system capacity for automatic and manual transfer from the preferred power supply to maintenance power supply and vice-versa to satisfy the requirements of GDC 18.

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 an uninterruptible power supply (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 VEGP COL FSAR, Revision 5, incorporates by reference Section 8.3 of the AP1000 DCD, Revision 19. Section 8.3 of the AP1000 DCD includes Section 8.3.2. The advanced safety evaluation (ASE) with confirmatory items for Section 8.3.2 was based on the VEGP COL FSAR, Revision 2 and DCD Revision 17. After submitting DCD Revision 17 to the NRC, Westinghouse revised the COL Information Item (COL 8.3-2) and the applicant took a

departure (STD DEP 8.3-1) to address the revised COL information item. This COL information item has been incorporated into Revision 18 of the DCD; however, the discussion of the COL information item below did not change.

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

Tier 2 Departure

- STD DEP 8.3-1

In a letter dated October 15, 2010, the applicant proposed the following Tier 2 departure related to a proposed revision to AP1000 DCD Section 8.3.2.2. In that letter, the applicant stated that the Class 1E battery chargers are designed to limit the input (ac) current to an acceptable value under faulted conditions on the output side; however, the voltage regulating transformers do not have active components to limit current; therefore, the Class 1E voltage regulating transformer maximum current is determined by the impedance of the transformer. The voltage regulating transformer in combination with fuses and/or breakers will interrupt the input or output (ac) current under faulted conditions on the output side. Since AP1000 DCD Section 8.3.2.2 states that the Class 1E voltage regulating transformers are designed to limit the input (ac) current to an acceptable value under faulted conditions on the output side, the use of the breakers/fuses for the regulating transformers for isolation function, in lieu of current limiting characteristics as presented in the AP1000 DCD, is a departure for VEGP.

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. In a letter dated October 15, 2010, the applicant proposed to revise STD COL 8.3-2 by adding information related to periodic testing for the battery chargers and voltage regulating transformers.

Supplemental Information

- STD SUP 8.3-3

The applicant provided supplemental information stating that there is 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 in the FSER related to the DCD.

In addition, the acceptance criteria associated with the relevant requirements of the Commission regulations for the dc power systems 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 8.3-3 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," Revision 2
- IEEE Standard 450, "Recommended Practice for the Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications"
- RG 1.75, "Physical Independence of Electrical Systems," Revision 3

8.3.2.4 *Technical Evaluation*

The NRC staff reviewed Section 8.3.2 of the VEGP COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the COL application represents the complete scope of information relating to this review topic.[1] The NRC staff's review confirmed that the information in the application and incorporated by reference addresses the required information relating to the dc power systems. The results of the NRC staff's evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

Section 1.2.3 of this SER provides a discussion of the strategy used by the NRC to perform one technical review for each standard issue outside the scope of the DC and use this review in evaluating subsequent COL applications. To ensure that the staff's findings on standard content that were documented in the SER with open items issued for the BLN Units 3 and 4 COL application were equally applicable to the VEGP Units 3 and 4 COL application, the staff undertook the following reviews:

- The staff compared the BLN COL FSAR, Revision 1, to the VEGP COL FSAR. In performing this comparison, the staff considered changes made to the VEGP COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs and open and confirmatory items identified in the BLN SER with open items.
- The staff confirmed that all responses to RAIs identified in the corresponding standard content (the BLN SER) evaluation were endorsed.
- The staff verified that the site-specific differences were not relevant.

The staff has completed its review and found the evaluation performed for the standard content to be directly applicable to the VEGP COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. There was one confirmatory item (Confirmatory Item 8.3.2-1) related to the standard content in the BLN SER. Its resolution is addressed in this SER.

Although the staff concluded that the evaluation performed for the standard content is directly applicable to the VEGP COL application, there were differences in the response provided by the VEGP applicant from that provided by the BLN applicant regarding the standard COL and supplemental information items. These differences are evaluated by the staff below, following the standard content material.

The following portion of this technical evaluation section is reproduced from Section 8.3.2.4 of the BLN SER:

> *<u>AP1000 COL Information Item</u>*
>
> - *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****.*

Resolution of Standard Content Confirmatory Item 8.3.2-1

Confirmatory Item 8.3.2-1 required the applicant to update its FSAR to provide for the testing of Class 1E and non-Class 1E dc penetration overload protection devices. The NRC staff verified that the VEGP COL FSAR was appropriately updated. As a result, Confirmatory Item 8.3.2-1 is resolved.

Evaluation of Tier 2 Departure STD DEP 8.3-1 and Revised STD COL 8.3-2

In a letter dated June 18, 2010, Westinghouse provided a response to Open Item OI-SRP8.3.2-EEB-09, Revision 3, related to the periodic testing of battery chargers and voltage regulating transformers. The response included a COL information item to be added to AP1000 DCD Section 8.3.3 to ensure that periodic testing is performed on the battery chargers and voltage regulating transformers. Specifically, this section will be revised to include the following COL information item:

> The Combined License applicant will establish plant procedures as required for:
>
> > Combined License applicants referencing the AP1000 certified design will ensure that periodic testing is performed on the battery chargers and voltage regulating transformers.

In a letter dated October 15, 2010, the applicant submitted its response to address the above identified AP1000 DCD revision to the Section 8.3.3 COL information item regarding battery charger and voltage regulating transformer testing. The applicant stated that procedures are established for periodic testing of the Class 1E battery chargers and the Class 1E regulating transformers in accordance with the manufacturer recommendations. The battery chargers and regulating transformers are tested periodically in accordance with manufacturer recommendations. Circuit breakers in the Class 1E battery chargers and Class 1E voltage regulating transformers that are credited for an isolation function are tested through the use of breaker test equipment. This verification confirms the ability of the circuit to perform the designed coordination and corresponding isolation function between Class 1E and non-Class 1E components. Circuit breaker testing is done as part of the MR program and testing frequency is determined by that program. Fuses/fuse holders that are included in the

isolation circuit are visually inspected. Class 1E battery chargers are tested to verify current limiting characteristic utilizing manufacturer recommendation and industry practices. Testing frequency is in accordance with that of the associated battery.

The applicant clarified that the voltage regulating transformers do not have active components to limit current and, therefore, the voltage regulating transformer in combination with fuses and/or breakers will interrupt the input or output (ac) current under faulted conditions on the output side. The NRC staff finds this to be inconsistent with AP1000 DCD Section 8.3.2.2, which states that Class 1E voltage regulating transformers are designed to limit the input (ac) current to an acceptable value under faulted conditions on the output side. As such the use of the breakers/fuses for regulating transformers for isolation function in lieu of current limiting characteristics as presented in the AP1000 DCD is a departure for VEGP. The applicant stated that Part 7 of the COL application will be revised to include a departure from AP1000 DCD Section 8.3.2.2 clarifying the current limiting feature of voltage regulating transformers. The applicant has included, in its response, the appropriate changes related to the above departure that will be included in VEGP COL FSAR Sections 8.3.2.1.4 and 8.3.2.2, in Chapter 1, Table 1.8-201 and in Part 7 of the VEGP COL application. These changes will be included in a future revision to the VEGP COL application.

The NRC staff has reviewed the proposed changes to the VEGP COL application and concludes that the applicant has provided sufficient information regarding the isolation function and the periodic inspection and testing of the isolating devices for the Class 1E battery chargers and Class 1E voltage regulating transformers. In addition, the staff finds that, although the use of the breakers/fuses for regulating transformers isolation function in lieu of current limiting characteristics as presented in the AP1000 DCD is a departure for VEGP, the departure is acceptable because the use of the breakers/fuses for regulating transformers for isolation function is consistent with the recommendations in IEEE-384, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," endorsed by RG 1.75. Therefore, AP1000 COL Information Item STD DEP 8.3-1 and the revised STD COL 8.3-2 are resolved subject to NRC staff verification of the revision to the VEGP COL FSAR sections discussed above. This is being tracked as **Confirmatory Item 8.3.2-2**.

Resolution of Standard Content Confirmatory Item 8.3.2-2

Confirmatory Item 8.3.2-2 is an applicant commitment to revise its FSAR Table 1.8-201 and Section 8 3.2.1.4 to address COL Information Item STD COL 8.3-2 and a departure, STD DEP 8.3-1. The staff verified that the VEGP COL FSAR was appropriately revised. As a result, Confirmatory Item 8.3.2-2 is now closed.

The following portion of this technical evaluation section is reproduced from Section 8.3.2.4 of the BLN SER:

> *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.*

Evaluation of Site-specific Response to Standard Content

In VEGP COL FSAR, Revision 2, the VEGP applicant changed the number of the supplemental information item from STD SUP 8.3-1 to STD SUP 8.3-3. The associated VEGP COL FSAR, Revision 2 text, which is identical to the BLN COL FSAR, Revision 1 text accepted by the staff, was not changed. Therefore, the staff concludes that this difference is not relevant and that the staff's evaluation of STD SUP 8.3-1 for BLN applies to STD SUP 8.3-3 for VEGP.

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 VEGP COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VEGP COL application are documented in NUREG-1793 and its supplements.

In addition, the staff concludes that the relevant information presented in the VEGP 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. 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, the clearing of ground faults on the Class 1E dc system, and periodic testing of the battery chargers and voltage regulating transformers.

- STD SUP 8.3-3, the applicant made a commitment that there are no site-specific non-Class 1E dc loads connected to the Class 1E dc system.

- STD DEP 8.3-1, the applicant provided sufficient information involving the use of breakers/fuses for regulating transformers for isolation function that is consistent with IEEE-384, endorsed by RG 1.75.

Table 8.2A-1. Offsite Power System

Design Commitment	Inspections, Tests, and Analyses	Acceptance Criteria
1. A minimum of one offsite circuit supplies electric power from the transmission network to the interface with the onsite ac power system.	Inspections of the as-built offsite circuit will be performed.	At least one offsite circuit is provided from the transmission switchyard interface to the interface with the onsite ac power system.
2. Each offsite power circuit interfacing with the onsite ac power system is adequately rated to supply assumed loads during normal, abnormal and accident conditions.	Analyses of the offsite power system will be performed to evaluate the as-built ratings of each offsite circuit interfacing with the onsite ac power system against the load assumptions.	A report exists and concludes that each as-built offsite circuit is rated to supply the load assumptions during normal, abnormal and accident conditions.
3. During steady state operation, each offsite power source 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.	Analyses of the as-built offsite circuit will be performed to evaluate the capability of each offsite circuit to supply the voltage requirements at the interface with the onsite ac power system.	A report exists and concludes that during steady state operation each as-built offsite circuit is capable of supplying the voltage at 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.	Analyses of the as-built offsite circuit will be performed to evaluate the capability of each offsite circuit to supply the frequency requirements at the interface with the onsite ac power system.	A report exists and concludes that during steady state operation each as-built offsite circuit is capable of supplying the frequency at the interface with 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 circuit is compatible with the interrupting capability of the onsite short circuit interrupting devices.	Analyses of the as-built offsite circuit will be performed to evaluate the fault current contribution of each offsite circuit at the interface with the onsite ac power system.	A report exists and concludes the short circuit contribution of each as-built offsite circuit at the interface with the onsite ac power system is compatible with the interrupting capability of the onsite 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.	Analyses of the as-built offsite power system will be performed to confirm that power will be available to the reactor coolant pumps for a minimum of 3 seconds following a turbine trip when the buses powering the reactor coolant pumps are aligned to either the UATs or the RATs.	A report exists and concludes that voltage at the high-side of the GSU, and the RATs, does not drop more than 0.15 pu from the pre-trip steady-state voltage for a minimum of 3 seconds following a turbine trip when the buses powering the reactor coolant pumps are aligned to either the UATs or the RATs.