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 V.C. Summer Nuclear Station (VCSNS) combined license (COL) Final Safety Analysis Report (FSAR), Revision 2, incorporates by reference Section 8.1 of the AP1000 Design Control Document (DCD), Revision 17.

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

Supplemental Information

- VCS SUP 8.1-1

The applicant provided supplemental (SUP) information in VCSNS COL FSAR Section 8.1, "Introduction," describing VCSNS's connections to South Carolina Electric and Gas (SCE&G), Santee Cooper and Duke Energy transmission systems via the 230 kilovolt (kV) switchyard at the plant site.

- VCS SUP 8.1-2

The applicant provided supplemental information in VCSNS COL FSAR Section 8.1 describing additional information pertaining to regulatory guides and Institute of Electrical and Electronics Engineers (IEEE) standards identified in AP1000 DCD Table 8.1-1 and to other applicable regulatory guides as indicated in VCSNS COL FSAR Table 8.1-201.

8.1.3 Regulatory Basis

The regulatory basis for the information incorporated by reference is addressed in NUREG-1793, "Final Safety Evaluation Report [FSER] 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 [SRP] for the Review of Safety Analysis Reports for Nuclear Power Plants."

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 VCSNS 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 VCSNS COL application are documented in NUREG-1793 and its supplements.

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

Supplemental Information

- VCS SUP 8.1-1

The NRC staff reviewed the supplemental information related to VCSNS's connections to the SCE&G, Santee Cooper and Duke Energy transmission systems via the 230kV switchyard at the plant site.

The NRC staff reviewed the resolution to the supplemental information VCS SUP 8.1-1 related to VCSNS's connections to various transmission systems. The staff determined that additional information was needed to complete the technical evaluation of this item. In request for

[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 design certification (DC).

additional information (RAI) 8.1-1, the staff asked the applicant to provide a description of the utility grid including transmission owner(s), transmission operator(s) and the North American Electric Reliability Corporation (NERC), including existing reactors at the site and their respective connections to the transmission grid. In a letter dated February 10, 2009, the applicant provided such description as follows:

> The VCSNS site consists of the existing VCSNS Unit 1 and the new VCSNS Units 2 and 3 reactors. VCSNS Unit 1 connects to the 115kV and 230kV SCE&G transmission systems via an existing 230kV switchyard and a 115kV transmission line. VCSNS Units 2 and 3 will connect to the 230kV SCE&G transmission system via a new 230kV switchyard. The SCE&G transmission system operator (TSO) is responsible for the safe and reliable operation of the electrical transmission system. The SCE&G transmission system consists of interconnected hydro plants, fossil-fueled plants, combustion turbine units and nuclear plants supplying energy to the service area at various voltages up to 230kV. The transmission system is interconnected with neighboring utilities, and together, they form the Virginia-Carolina (VACAR) Sub region of the Southeastern Electric Reliability Council (SERC). As of January 2009, interconnected systems at 115kV and 230kV include Santee Cooper, Duke Energy, Progress Energy (East), Southeastern Power Administration (SEPA), and Southern Company.

The applicant committed to revise the FSAR to show the information presented above.

Subsequently, in Revision 2 to the FSAR the applicant provided the information requested by the staff. The NRC staff finds that the applicant has adequately described the VCSNS Units 2 and 3 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.

The NRC staff has verified that VCSNS has updated the FSAR to include the above-mentioned items and therefore, this item is resolved.

- VCS SUP 8.1-2

The NRC staff also reviewed supplemental information included in VCS 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.

VCS COL FSAR Table 8.1-201, 1b indicated that RG 1.155 is not applicable to VCSNS. This item was deemed as standard among COL applications being discussed in Bellefonte's (BLN) response to RAI 8.1-2. In a letter dated May 12, 2009, VCSNS stated that the standard response to RAI 8.1-2 applies to the VCSNS COL application.

The standard response submitted by BLN in a letter dated June 24, 2008, is summarized as follows. BLN stated that the AP1000 design meets the requirements of 10 CFR 50.63 for 72 hours and, therefore, no specific procedures or training specific to station blackout (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 after 72 hours by addressing ac power restoration (e.g., coordination with transmission system load dispatcher), and severe weather guidance (e.g., identification of site-specific actions to prepare for the onset of severe weather such as an impending tornado) in accordance with RG 1.155, Positions C.2 and C.3.4.

Several discussions were held between the NRC staff and the applicant regarding this issue. Subsequently, in a letter dated April 15, 2009, the 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 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.

In a letter dated January 20, 2010, VCSNS endorsed BLN's revised response.

The NRC staff has verified that VCSNS has updated Sections 1.9.5.1.5 and 1.9.6 of the VCSNS COL FSAR to include the above-mentioned items including the implementation of training and procedures to support mitigation of an SBO event. This 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 VCSNS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VCSNS 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:

- VCS SUP 8.1-1, the applicant provided sufficient information regarding VCSNS's connections to various transmission systems in accordance with the recommendations of RG 1.206.

- VCS 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 RGs and industry standards 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, Appendix D, 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 VCSNS Units 2 and 3, 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 VCSNS COL FSAR, Revision 2, incorporates by reference Section 8.2 of the AP1000 DCD, Revision 17.

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

AP1000 COL Information Items

- VCS COL 8.2-1

The applicant provided additional information in VCS 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 plant site 230kV switchyard, and the twelve 230kV transmission lines connecting the plant switchyard to the SCE&G, the Santee Cooper and the Duke Energy transmission systems; 2) the connections of the generator step-up (GSU) transformers and the reserve auxiliary transformers (RATs) to the switchyard; 3) the designs of the switchyard circuit breakers and disconnect switches; 4) the transformer area arrangement for each unit; 5) the designs of the GSU transformers, unit auxiliary transformers (UATs), and RATs; 6) the design of the control building in the plant site 230kV switchyard; 7) the administrative control of 230kv switchyard and transmission lines circuit breakers, ~~and~~ 8) the switchyard and transmission lines

testing and inspection plan, and 9) voltage operating range, frequency decay rate, and preservation of grid connection. VCS COL 8.2-1 is addressed in FSAR Sections 8.2.1, 8.2.1.1, 8.2.1.2, 8.2.1.3, 8.2.1.4, and 8.2.5.

- VCS COL 8.2-2

The applicant provided additional information in VCS 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 switchyards arrangement and design of the protective relaying scheme; and 2) a transmission system study performed regularly to verify grid stability, switchyard voltage, and frequency to confirm the transmission system capability to maintain reactor coolant pump (RCP) operation for three seconds following a turbine trip as specified in AP1000 DCD Section 8.2.2.

Site-Specific Information Replacing Conceptual Design Information (CDI)

- VCS 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

- VCS 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, and plant site switchyard.

- VCS SUP 8.2-2

The applicant provided supplemental information describing the formal agreement between VCSNS and its TSO, SCE&G, which sets the requirements for transmission system studies and analyses.

- VCS SUP 8.2-3

The applicant provided supplemental information describing SCE&G'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.

- VCS SUP 8.2-4

The applicant provided supplemental information describing the interconnection agreement between VCSNS and SCE&G demonstrating that protocols are in place for VCSNS to remain cognizant of grid vulnerabilities in order to make informed decisions regarding maintenance

activities critical to the electric system. It also discusses the monitoring activities of the TSO in the form of real-time and offline studies to assess system conditions.

Interface Requirements

The plant interfaces for the standard design of the AP1000 are discussed in AP1000 DCD Tier 2, Section 8.2.5, and in Items 8.1, 8.2, and 8.3 of AP1000 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 NUREG-1793 and its supplements.

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 VCS COL 8.2-1 and VCS 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 VCS COL 8.2-2, VCS SUP 8.2-2, and VCS SUP 8.2-3, the requirements of GDC 17 and the guidelines of RG 1.206.

- For VCS 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"; 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 VCS CDI, the requirements of GDC 17.

8.2.4 Technical Evaluation

The NRC staff reviewed Section 8.2 of the VCSNS 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 VCSNS 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 for the reference COL application (Vogtle Electric

Generating Plant [VEGP] Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content 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 VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Any confirmatory items in the standard content material retain the numbers assigned in the VEGP SER. Confirmatory items that are first identified in this SER section have a VCSNS designation (e.g., Confirmatory Item VCSNS 8.2-1).

The staff reviewed the information in the VCSNS COL FSAR:

AP1000 COL Information Item

- VCS COL 8.2-1

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

The VCSNS Units 2 and 3 switchyard is tied to the SCE&G, Santee Cooper, and Duke Energy 230kV transmission systems. There are 12 overhead transmission lines connecting the new 230kV switchyard to other substations. (Eight lines, including three new lines and five re-terminated lines, are required for Unit 2 and four additional lines are required for Unit 3. These include the 230kV lines that originate at Units 2 and 3, as well as three tie lines to VCSNS Unit 1.) Each line connected to the switchyard has the capacity to feed the design house loads for both units under all design conditions without relying on the other unit's generator. Three of these lines are short tie-lines, running in an easterly direction, connecting to the Unit 1 switchyard. (Two lines are required for Unit 2 and the third line is required for Unit 3.) Each is approximately one mile long with a thermal rating of 950 megavolt ampere (MVA). The remaining nine 230kV lines originate at the Units 2 and 3, switchyard and connect to various substations. The layout of transmission lines to the new and existing substations minimizes the crossing of transmission lines to the extent possible. All structures for these transmission lines are designed to meet the National Electrical Safety Code clearance requirements and SCE&G and Santee Cooper engineering standards. Each phase is designed using a conductor bundle comprised of two aluminum conductor, steel reinforced conductors. All structures are grounded with either ground rods or a counterpoise system and have provisions for two overhead ground wires. The NRC staff has reviewed the layout of transmission lines to the new and existing substations and concludes that at least one offsite power source will be available to both Units 2 and 3. The above satisfies the requirements of GDC 17 as it applies to AP1000 design.

With regard to the maintenance and testing of the offsite power circuits, in RAI 8.2-8, the staff asked the applicant to clarify the extent of the word "observes" and to clarify if VCSNS would follow NERC reliability standards.

In a letter dated February 17, 2009, the applicant stated that this statement was intended to indicate that SCE&G follows the applicable NERC Reliability Standards associated with switchyard maintenance and testing. The applicant stated that it will revise the FSAR as follows, for purposes of clarity:

> For performance of maintenance, testing, calibration, and inspection, TSO follows its own field test manuals, vendor manuals and drawings, and industry's maintenance practices to comply with NERC reliability standards.

The NRC staff has verified that VCSNS has updated the FSAR to include the above-mentioned revised paragraph. The NRC staff concludes that since the applicant will follow the NERC standard for switchyard maintenance and testing, this information satisfies the requirements of GDC 18 related to testing and is acceptable and therefore, the staff finds this item resolved.

Additionally, the applicant provided the site-specific voltage and frequency variations expected at the VCSNS Units 2 and 3 switchyard during transient and steady state operating conditions and the site-specific frequency decay rate to satisfy VCS COL 8.2-1.

- VCS COL 8.2-2

The applicant provided additional information in VCS 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 under "Interface Requirements" in this section of the 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, VCS 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 VCSNS COL FSAR. The NRC staff's evaluation follows.

VCS COL 8.2-2 was provided by the applicant describing details of: 1) the switchyards arrangement and design of the protective relaying scheme; and 2) a transmission system study performed regularly to verify grid stability, switchyard voltage, and frequency to confirm the transmission system capability to maintain RCP operation for three seconds following a turbine trip as specified in AP1000 DCD Section 8.2.2. VCS COL 8.2-2 is addressed in VCSNS COL FSAR Sections 8.2.1.2.2 and 8.2.2.

The switchyards are designed to provide high speed fault clearing while also maintaining high reliability and operational flexibility. The protective devices controlling the switchyard breakers are set with consideration given to preserving the plant grid connection following a turbine trip.

Under normal operating conditions, all 230kV breakers and disconnect switches are closed. The protective relay schemes are designed to provide redundancy such that adequate protection is provided given a failure of any single component of the system. Primary protective relays are supplied with current transformer inputs, potential transformer inputs, and direct current (dc) supplies that are independent of the same inputs to backup relays. The primary and backup relays trip 230kV circuit breakers via two independent trip coils supplied from two separate dc sources. All 230kV circuit breakers are provided with a breaker failure scheme to

rapidly clear faults due to a failed breaker. Each 230kV transmission line is protected by two independent high-speed relaying schemes, each scheme using a different type of protection. The short 230kV tie-lines to Unit 1 and the tie-lines to the GSU and RAT circuit breakers also use two independent high-speed protection schemes, but each scheme may be of the same or similar type.

The staff determined that additional information was needed to conclude the technical evaluation of this item. In RAI 8.2-6, the staff asked the applicant to provide voltage variations in the switchyard and to describe the effect of voltage variations on the onsite auxiliary power system equipment and Class 1E battery chargers and regulating transformers. In a letter dated February 17, 2009, the applicant provided the assumptions taken into consideration for the studies performed, which are:

> The studies for the turbine trip event were conservatively performed to account for worst case voltage conditions by establishing the following initial conditions:
>
> – Studies were modeled using peak summer case loads.
>
> – Studies assumed the transmission line whose outage produced the most reactive output for the AP1000 unit was placed out of service. For Unit 2 studies, this line is the Santee Cooper Newberry line and for Unit 3 studies the line is the Denny Terrace line.
>
> – Studies assumed that the system generator, which produced the most reactive output for the AP1000 unit was placed out of service. For Unit 2 studies, this generator is VCSNS Unit 1 and for Unit 3 studies the generator is VCSNS Unit 2.
>
> During the three seconds following a turbine trip, only a small order of voltage fluctuation of approximately 0.01 per unit is seen, and this would not be expected to vary based on initial voltage.
>
> The grid voltage study of VCSNS Units 2 and 3 offsite power system confirms that offsite power system voltage remains within the normal operating limits of the AP1000 (0.95-1.05 per unit as defined by the AP1000 DCD) for three seconds following a turbine trip. Since there is no anticipated over or under-voltage condition following a turbine trip event, there are no anticipated effects from the event on the Class 1E battery chargers and regulating transformers.

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 VCSNS'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 VCS 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 February 17, 2009, the applicant stated that:

> The grid stability analysis confirms that the VCSNS Units 2 and 3 switchyard voltage remains between 0.95-1.05 per unit and that frequency remains between 60.5 Hertz (Hz) and 59.5 Hz for normal steady state operation, normal shutdown, unit start-up and for at least three seconds following a turbine trip event. Motor starting, utilizing the single largest motor, which is a main feedwater pump, with minimum and maximum grid voltage conditions, has been analyzed and found to have a negligible effect on the offsite system voltage. These ranges of voltage and frequency are considered normal and acceptable ranges for the AP1000, and are acceptable for the auxiliary power system equipment operation and Class 1E battery chargers.
>
> As part of the Federal Energy Regulatory Commission (FERC) large generator interconnection procedure, the transmission provider is required to perform a series of studies to identify the feasibility, impact and required system upgrades to support the addition of a large generator (> 20 megawatt [MW]) to the transmission system. The studies that were performed for VCSNS Units 2 and 3 include the Interconnection Feasibility Study, the Interconnection System Impact Study and the Interconnection Facilities Study. These studies include system power flow analysis, short circuit analysis and stability analysis to identify any required system upgrades or new equipment to support the added generation. Each of the Unit 2 studies were an input for the applicable Unit 3 study as each generator represents a separate and independent connection to the grid. These studies have been performed in accordance with the FERC and SCE&G transmission planning procedures, and are the basis for the required offsite power system facilities, including the VCSNS Units 2 and 3, switchyard to support the reliable connection of VCSNS Units 2 and 3 to the transmission system.

In addition, the applicant stated that the above grid voltage evaluation results will be verified during the preoperational testing identified in AP1000 DCD Section 14.2.10, which includes the following tests:

- 100 Percent Load Rejection (AP1000 DCD Section 14.2.10.4.21)
- Plant Trip from 100% Power (AP1000 DCD Section 14.2.10.4.24)
- Loss of Offsite Power (AP1000 DCD Section 14.2.10.4.26)

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 BLN RAI 8.2-3 (VCS 8.2-1) were not within the scope of the BLN COL but rather within the scope of the AP1000 DC. This is considered a standard item applicable to all COL applications including VCSNS. Therefore, the staff finds that the relevant portions of RAI 8.2-1 are resolved for VCSNS.

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

In a letter dated February 17, 2009, the applicant stated that in AP1000 DCD Section 8.1.4, the single offsite circuit does not perform a safety-related function for the AP1000 and that the required offsite circuit interface with the safety-related batteries is through the Class 1E battery chargers.

With regard to GDC 5, VCSNS provided the following information.

> VCSNS Units 2 and 3 will share a common switchyard. GSU connections for Units 2 and 3 are connected to the switchyard in a double bus/double breaker configuration. The remaining connections to the switchyard are connected in a breaker-and-a-half configuration. The grid stability study and the switchyard failures analysis show that this is a highly robust and reliable offsite power system. Events such as line faults, loss of system generating units, loss of largest system load, and turbine trip of Units 2 or 3 have been analyzed and shown to not affect the ability of the offsite power system to reliably provide sufficient power for house loads to each AP1000 unit during normal and abnormal conditions. The switchyard is not shared with any additional generating units beyond Units 2 and 3.

Based on the above, the NRC staff concludes that since Units 2 and 3 UATs and RATs are not shared among the units and the capacity of the offsite power system is large compared to the minimal safety-related loads powered by the offsite power (battery chargers and uninterruptible power supply (UPS)), the VCSNS Units 2 and 3 offsite power system design meets the requirements of GDC 5 and therefore this item is resolved.

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 VCSNS Units 2 and 3 offsite power systems design meets the requirements of GDC 17, as it is applicable to AP1000 design; therefore, 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 be in conformance with GDC 18; therefore, this interface item must also be satisfied by the applicant.

In a letter dated January 20, 2010, the applicant endorsed the standard content answer provided in BLN RAI 8.2-10. The staff has verified that VCSNS COL 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.

With regard to 10 CFR 50.65, in a letter dated January 20, 2010, the applicant endorsed the standard content answer provided in BLN RAI 8.2-10. The standard content answer to BLN RAI 8.2-10 stated that 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 VCSNS 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 will be evaluated for inclusion into the maintenance rule program in accordance with these scoping procedures during program implementation. The NRC staff notes that NEI 07-02A, Section 17.X.1.5, "Risk assessment and risk management per 10 CFR 50.65(a)(4)," addresses risk assessment and risk management from maintenance activities in accordance with 10 CFR 50.65(a)(4), and includes consideration of the issues associated with grid/offsite power system reliability as identified in NRC Generic Letter (GL) 2006-02, Items 5 and 6. Therefore, although detailed maintenance risk assessment is not anticipated in advance of the schedule defined in Table 13.4-201 of the VCSNS COL FSAR, performance of "grid-risk-sensitive" maintenance activities is 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 8.2-7, the staff asked the applicant if its grid stability analysis includes 1) the worst case disturbances; 2) station auxiliary loads for all three units and; 3) how often this study is performed. In a letter dated February 17, 2009, the applicant provided the following information:

> The analysis included the worst-case disturbances for which the grid has been analyzed to remain stable. The worst case disturbance for which the grid has

> been previously analyzed and considered stable is a three phase fault at the VCSNS switchyard (Unit 1) Bus #1 with the eight Fairfield Pumped Storage units in generating mode. The fault results in a loss of generation of VCSNS Unit 1 and the eight Fairfield units for a total loss of generation of 1584 MW following the clearing of the three phase fault. Following the clearing of the faults and loss of VCSNS Unit 1 and the Fairfield generating units, grid voltage recovers to prefault levels.
>
> Simulations included station auxiliary loads for VCSNS Units 2 and 3. The VCSNS Units' 2 and 3 switchyard is physically separated and independent from the VCSNS Unit 1 switchyard. VCSNS Unit 1 was included in the system model as a generator connected to the system, as was other system generation, but results of this study were specifically analyzed for impacts to the VCSNS Units 2 and 3 switchyard and generating units.
>
> Currently, transient stability studies are performed on a 3 year basis for VCSNS Unit 1 FSAR updates. These studies include the loss, as a result of a single event, of the largest generation capacity being supplied to the grid, removal of the largest load from the grid, or loss of the most critical transmission line. Also, SCE&G Transmission Planning performs power flow and transient stability studies annually in compliance with NERC Reliability Standards for both 1-5 year and 6-10 year planning horizons.

Based on the above, the NRC staff concludes that SCE&G's analysis demonstrates that the worst case disturbance for which the grid had been previously analyzed and considered stable is a three phase fault at the VCSNS switchyard and that following the clearing of the fault the grid voltage recovers to pre-fault levels; therefore, the issues in RAI 8.2-7 are resolved. The above, satisfies COL Action Items 8.2.3.1-1 and 8.2.3.1-3.

With regard to historical data regarding grid stability, the applicant provided the following information:

> From 1987 to 2007, the 230 kV transmission lines connecting the VCSNS site experienced 113 forced outages. The average frequency of forced line outages since 1987 is approximately 6 per year for the involved lines, with the majority being momentary outages due to lightning strikes or storm damage. The leading causes of forced outages of significant duration are equipment failures, logging and construction activities, and lightning or storm damage.

The NRC staff finds that the information regarding historical data on grid stability satisfies RG 1.206 and is acceptable.

Based on the above, VCSNS COL Information Item 8.2-2 is satisfied.

The following portion of this technical evaluation section is reproduced from Section 8.2.4 of the VEGP SER:

> *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.*
>
> > *The 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, 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.***

Supplemental Information

- VCS SUP 8.2-1

VCS SUP 8.2-1 was provided by the applicant describing details of a FMEA performed for the offsite power distribution system, and plant site switchyard. VCS SUP 8.2-1 is addressed in

VCSNS COL FSAR Section 8.2.1.1. The staff determined that additional information was needed to conclude the technical evaluation of this item. In RAI 8.2-4, the staff asked the applicant to discuss in detail the results of the FMEA. In a letter dated February 17, 2009, the applicant provided a more detailed description of the switchyard analysis including a change in its switchyard design. The NRC staff has reviewed this information and concludes that no offsite power contingencies, including a breaker not operating during a fault on an offsite line, fault on a switchyard bus, a spurious relay trip, or a loss of control power, result in a loss of both the preferred and maintenance sources of offsite power or cause a reactor trip. The staff also verified that VCSNS COL FSAR Sections 8.2.1 and 8.2.1.1 and Figure 8.2-202 have been updated to reflect the change to the switchyard design. This issue has been adequately addressed and is resolved.

- VCS SUP 8.2-2, VCS SUP 8.2-3, and VCS SUP 8.2-4

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

> The SCE&G transmission system operator (TSO) is responsible for the safe and reliable operation of the electrical transmission system. TSO and the Operations Departments for the VCSNS nuclear plants have formal agreements and protocols to provide safe and reliable operation of the transmission system and equipment at the nuclear plants in accordance with North American Electric Reliability Corporation (NERC) Standard NUC-001-01. Elements of this agreement are implemented in accordance with the procedures of both parties. TSO continuously monitors and evaluates grid reliability and switchyard voltages, and informs the nuclear plant operators of any grid instability or voltage inadequacies. They also work to maintain local voltage requirements as required by the nuclear plant. The nuclear plant operators review the transmission system parameters and inform TSO immediately prior to initiating any plant activities that may affect grid reliability. In addition, the nuclear plant operators inform TSO of changes in generation ramp rates and notify them of any developing problems that may impact generation.

The NRC staff has reviewed the information provided by the applicant and concludes that the information provided by the applicant is consistent with the recommendations of RG 1.206 and is, therefore, acceptable.

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

> As set forth in NERC Reliability Standard NUC-001-1, the formal agreement between Nuclear Plant Generator Operators (described here as VCSNS Operations Department) and Transmission Entities (described here as SCE&G TSO) establishes the Nuclear Plant Interface Requirements, such as transmission system studies and analyses. TSO performs short-term grid analyses to support VCSNS plant startup and normal shutdown. Long-term grid studies, done at a minimum of every 36 months, are performed and coordinated with the VCSNS Operations Departments. Studies of future load growth and new generation additions are performed yearly in accordance with NERC and Virginia-Carolinas Reliability Council standards.

> New large generating units requesting to connect to the area bulk electric system are required to complete the Large Generator Interconnection Procedure. The studies performed by TSO as part of this procedure examine the generating unit (combined turbine-generator-exciter) and the main step-up transformer(s).

The staff concludes that the supplemental information provided by the applicant is consistent with the recommendations of RG 1.206 and acceptable.

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

> The agreement between TSO and the VCS Operations Departments demonstrates protocols in place for the plant to remain cognizant of grid vulnerabilities to make informed decisions regarding maintenance activities critical to the electrical system. In the operations horizon, the TSO continuously monitors real-time power flows and assesses contingency impacts through use of a state estimator tool. 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.

The staff determined that additional information was needed to conclude the technical evaluation of this item. In RAI 8.2-5, the staff asked the applicant to explain how notifications regarding changes in grid conditions are coordinated between the system operator and the operators of existing VCSNS Unit 1, and the proposed Units 2 and 3, and to explain if the interface agreement requires that the operators be notified of periods when the system operator is unable to determine if offsite power voltage and capacity is inadequate. In a letter dated February 17, 2009, the applicant provided the following information:

> Although the VCSNS generators connect to the SCE&G transmission system, the Unit 2 and 3 generators do not share a common switchyard with the existing VCSNS Unit 1. The VCSNS Unit 2 and 3 switchyard is connected to the offsite power system and VCSNS Unit 1 switchyard by transmission lines as described in FSAR Subsection 8.2.1. Per the interface agreement, it is the responsibility of the System Controllers (SCE&G Transmission System Operator or TSO) to immediately report any present or predicted grid instability or voltage inadequacy to the VCSNS control room. Per the interface agreement, the control room is required to be notified of periods when the system operator is unable to determine if offsite power voltage and capacity is inadequate.

Based on its review, the NRC staff concludes that the applicant has demonstrated that protocols are in place for the VCSNS 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. Therefore, the staff finds this issue resolved.

Site-Specific Information Replacing Conceptual Design Information (CDI)

- VCS 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 AP1000 DCD Tier 2, Section 8.2.5, and in Items 8.1, 8.2, and 8.3 of AP1000 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 AP1000 DCD. This section of the AP1000 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 IEEE standards in Section 8.1.4.3 of the VCSNS 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 staff asked RAI 1-4. In response to this RAI, VCSNS provided the steady state load, inrush kVA for motors, nominal voltage, allowable voltage regulation, nominal frequency, allowable frequency fluctuation, maximum frequency decay rate, and limiting under frequency values for the RCP. The applicant committed to include this information in a revision to the VCSNS COL FSAR. This is **Confirmatory Item VCSNS 8.2-1.**

Regarding 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 8.2-9, the staff asked the applicant to provide a reference to where this issue is discussed in the VCSNS application, or to provide a proposed revision to the application to address the issue. In its response dated July 30, 2009, the applicant identified a proposed addition to VCSNS COL FSAR Section 8.2.1.2.2 that states "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 verified that the VCSNS COL FSAR was updated to include this change and concludes that the switchyard arrangement, the protection of lines by independent high speed relaying, and breaker failure would preserve the VCSNS connection to the grid following a turbine trip satisfying the requirements of GDC 17. Therefore, the staff finds this interface has been met.

[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).

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

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

- VCS 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.

- VCS 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.

- VCS CDI in Section 8.2.1 of the VCSNS 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.

- VCS SUP 8.2-1, the applicant provided sufficient information describing details of a failure analysis performed for the offsite power distribution system, and plant site switchyard in accordance with the guidelines of RG 1.206.

- VCS SUP 8.2-2, the applicant provided sufficient information to demonstrate that the risk, reliability, operating limits, and administrative control of the power transmission grid are in accordance with in accordance with the guidelines of RG 1.206 and GL 2006-2.

- VCS SUP 8.2-3, the applicant provided sufficient information to describe SCE&G'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 in accordance with the guidelines of RG 1.206, and GL 2006-2.

- VCS SUP 8.2-4, the applicant provided sufficient information to demonstrate that protocols are in place for VCSNS to remain cognizant of grid vulnerabilities in order to make informed decisions regarding maintenance activities critical to the electric system in accordance with in accordance with the guidelines of RG 1.206 and GL 2006-2.

- 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 VCSNS COL FSAR, Revision 2, incorporates by reference Section 14.3 of the AP1000 DCD, Revision 17.

In addition, in VCSNS 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 VCSNS COL FSAR Section 14.3.2.3.

8.2.A.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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 VCSNS 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 VCSNS 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 for the reference COL application (Vogtle Electric Generating Plant [VEGP] Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content 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 VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4, COL application.

The following portion of this technical evaluation section is reproduced from Section 8.2.A.4 of the VEGP 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 BLN 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 finds the following ITAAC proposed by the applicant acceptable:

- 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 VCSNS COL FSAR 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 VCSNS, 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 VCSNS COL FSAR, Revision 2, incorporates by reference Section 8.3 of the AP1000 DCD, Revision 17. Section 8.3 of the AP1000 DCD includes Section 8.3.1.

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

AP1000 COL Information Items

- VCS COL 8.3-1

VCS 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 VCSNS Units 2 and 3.

- STD COL 8.3-2

STD COL 8.3-2 describes the details of: 1) the bases of the recommendations in operation, inspection, and maintenance procedures for the onsite standby diesel generators; and 2) procedures for the periodic testing of penetration overcurrent protective devices.

Supplemental Information

- VCS SUP 8.3-1

VCS SUP 8.3-1 describes the site-specific switchyard and power transformer voltage.

- VCS SUP 8.3-2

VCS SUP 8.3-2 states that the site conditions provided in Table 2.0-201 and Section 2.3 of the VCSNS COL FSAR 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.

- STD SUP 8.3-4

STD 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 NUREG-1793 and its supplements.

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 VCS 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, Revision 3, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants"

8.3.1.4 Technical Evaluation

The NRC staff reviewed Section 8.3.1 of the VCSNS 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 ac power systems. The results of the NRC staff's evaluation of the information incorporated by reference in the VCSNS 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 for the reference COL application (VEGP Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3 COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs.

- The staff confirmed that all responses to RAIs identified in the corresponding standard content 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 VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4 COL application.

The staff reviewed the information in the VCSNS COL FSAR:

AP1000 COL Information Items

- VCS COL 8.3-1

The NRC staff reviewed VCS 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, VCS COL 8.3-1, related to the ground grid system and lightning protection included under Section 8.3 of the VCSNS 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. 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 VCSNS Units 2 and 3 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 spherehaving 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 VEGP 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

- VCS SUP 8.3-1

The applicant provided information in VCS SUP 8.3-1 describing the site-specific switchyard and transformer voltage. The staff found this statement of fact acceptable; therefore, no evaluation is required.

- VCS SUP 8.3-2

The applicant stated in VCS SUP 8.3-2 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 engine and the associated generator. The staff agrees that the VCS site conditions are bounded by the standard site conditions used to determine the rating.

STD SUP 8.3-4

For evaluation of the subject of this item, see the evaluation of VCS 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 VCSNS COL FSAR related to this section. The results of the NRC staff's technical evaluation of the information incorporated by reference in the VCSNS 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:

- VCS 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.

- VCS SUP 8.3-1, the applicant provided sufficient information related to the site-specific switchyard and power transformer voltage.

- VCS SUP 8.3-2, the applicant demonstrated its site-specific conditions are bounded by the standard site conditions in the AP1000 DCD for rating the diesel generator.

- STD 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 a UPS that furnishes a continuous, highly reliable source of ac supply.

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

8.3.2.2 Summary of Application

Section 8.3 of the VCSNS COL FSAR, Revision 2, incorporates by reference Section 8.3 of the AP1000 DCD, Revision 17. Section 8.3 of the AP1000 DCD includes Section 8.3.2.

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

Tier 2 Departure

- STD DEP 8.3-1

In a letter dated October 20, 2010, the applicant endorsed a Southern Nuclear letter dated October 15, 2010, for the VEGP application that proposed the following Tier 2 standard departure related to a proposed revision to AP1000 DCD Section 8.3.2.2. In the October 15, 2010, Southern Nuclear letter, Southern 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. Because the issue is identified as a standard item it is also a departure for VCSNS.

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 20, 2010, the applicant endorsed a Southern Nuclear letter dated October 15, 2010, for the VEGP application that 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 are no site-specific non-Class 1E dc loads connected to the Class 1E dc system.

8.3.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in NUREG-1793 and its supplements.

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, Revision 2, "Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants"
- 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 VCSNS 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 VCSNS 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 for the reference COL application (VEGP Units 3 and 4) were equally applicable to the VCSNS Units 2 and 3, COL application, the staff undertook the following reviews:

- The staff compared the VEGP COL FSAR, Revision 2, to the VCSNS COL FSAR. In performing this comparison, the staff considered changes made to the VCSNS COL FSAR (and other parts of the COL application, as applicable) resulting from RAIs.
- The staff confirmed that all responses to RAIs identified in the corresponding standard content 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 VCSNS COL application. This standard content material is identified in this SER by use of italicized, double-indented formatting. Section 1.2.3 of this SER provides an explanation of why the standard content material from the SER for the reference COL application (VEGP) contains evaluation material from the SER for the BLN Units 3 and 4, COL application.

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

AP1000 COL Information Item

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

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

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

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

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

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

With regard to periodic testing of electrical penetration protective devices (COL Action Item 8.4.1-1) for dc systems, the applicant has not addressed periodic testing of the penetration over load protective devices related to dc systems. In RAI 8.3.1-1, the staff requested that the applicant address the periodic testing of the electrical penetration primary and backup protective devices protecting

Class 1E and non-Class 1E dc circuits. In a letter dated January 2, 2009, the applicant stated that the BLN COL FSAR will be revised in the next COLA submittal to include periodic testing of the electrical penetration primary and backup protective devices protecting Class 1E and non-Class 1E dc circuits, as well as control of protective devices. The staff has reviewed the information in the applicant's response, which provided for the testing of Class 1E and non-Class 1E dc penetration overload protection devices. The staff also reviewed the proposed change to BLN COL FSAR Section 8.3.1.1.6 and concludes that COL Action Item 8.4.1-1 is resolved subject to the verification that the BLN COL FSAR has been updated to include portions of the RAI response. This is identified as ***Confirmatory Item 8.3.2-1****.*

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****.*

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

In addition, pending resolution of the confirmatory items discussed above, the staff concludes that the relevant information presented in the VCSNS 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.