8.0 ELECTRIC POWER

8.0 ELECTRIC POWER

This chapter of the U.S. Nuclear Regulatory Commission's (NRC's) safety evaluation report (SER) provides information on the functional adequacy of the offsite power systems and safety related onsite electric power systems as applicable to the Economic Simplified Boiling-Water Reactor (ESBWR) design proposed for North Anna 3 Combined License (COL). 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. The NRC staff's review of the electric power systems ensures that these systems have adequate redundancy, independence, and testability in conformance with the current criteria established by the NRC.

8.1 Introduction

8.1.1 Introduction

This section of the COL final safety analysis report (FSAR) describes the transmission grid and its interconnection to the nuclear unit and other grid interconnections. It describes those onsite alternating and direct current (ac and dc) loads that are added to the certified ESBWR design and the function provided by these loads.

The section also includes a regulatory requirements applicability matrix that lists design bases, criteria, regulatory guides (RGs), standards, and other documents to be implemented in the design of the electrical systems that are site specific to the North Anna 3 station. The review of this section is coordinated closely with the reviews described in Sections 8.2, 8.3.1, and 8.3.2, and 8.4 of this SER.

8.1.2 Summary of Application

Section 8.1 of the North Anna 3 COL FSAR, Revision 8, incorporates by reference Section 8.1 of Revision 10 of the Design Control Document (DCD) for the ESBWR, referenced in Appendix E to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." In addition, in Part 7, "Departures Report," of the North Anna 3 COL application (COLA) and in FSAR Section 8.1, the applicant provided the following information:

Exemption and Tier 1 and Tier 2 Departures

- Exemption 2 — Electric Power Distribution System Functional Arrangement (Associated with NAPS DEP 8.1-1).

The applicant proposed the site-specific Tier 1 DCD departure from Figure 2.13.1-1, Sheet 1, *Electric Power Distribution System Functional Arrangement*.

In addition, the applicant has identified the following departure in FSAR Section 8.1.5.2.4 Regulatory Requirements – NRC Regulatory Guides:

- NAPS DEP 8.1-2 — Switchyard Surge Protection

The departure lists the subsections for which departures are taken from the Institute of Electrical and Electronics Engineers (IEEE) Standard (Std) C62.23, "Application Guide for Surge Protection of Electric Generating Plants" (as endorsed by RG 1.204, "Guidelines for Lightning protection of Nuclear Power Plants" issued November 2005), which is described in ESBWR DCD, Tier 2.

Supplemental Information

- NAPS SUP 8.1-1 Utility Power Grid Description

This supplemental information describes the connection of North Anna 3 to the 500/230-kilo Volt (kV) switchyard.

8.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor Standard Design," issued April 2014, and it's Supplement 1, issued September 2014. In addition, Section 8.1, "Electric Power—Introduction," of NUREG 0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), includes the relevant regulatory requirements for the electric power systems (the transmission system and its connections to the nuclear power unit) and the associated acceptance criteria.

The NRC requirements governing the COLA supplemental information are in General Design Criterion (GDC) 17, "Electric power systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities."

An applicant who seeks to depart from information in Tier 1 of a DCD for a certified standard design must request an exemption, as does an applicant who believes its proposed design need not comply with one or more NRC regulations. Exemptions are submitted pursuant to 10 CFR 52.7 and 52.93 and special circumstances as defined in 10 CFR 50.12(a) must be present.

8.1.4 Technical Evaluation

As documented in NUREG–1966, the staff reviewed and approved Section 8.1 of the certified ESBWR DCD. The staff reviewed Section 8.1 of the North Anna 3 COL FSAR, Revision 8, and checked the referenced DCD to confirm that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to the review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference includes all the information necessary for the review of this section, related to the North Anna 3 offsite power systems and safety-related onsite electric power systems.

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

The staff reviewed the following information in the COLA Part 7, "Departures Report" and FSAR:

Exemption and Tier 1 and Tier 2 Departures

The applicant proposed the following site-specific Tier 1 exemption and departure in Part 7 of its license application.

- Exemption 2: Electric Power Distribution System Functional Arrangement (Associated with NAPS DEP 8.1-1).

In the on-site power supply system specified in DCD Tier 1, Figure 2.13.1-1, Sheet 1, "Electric Power Distribution System Functional Arrangement," the applicant made a departure from the DCD to accommodate, due to special constraints on the North Anna 3 site, an intermediate switchyard that does not change the functions performed by these components as part of the on-site power supply system for the ESBWR standard plant design.

The applicant provided the following in its description of this Tier 1 Exemption to the DCD:

> The addition of the intermediate switchyard to DCD Tier 1, Figure 2.13.1-1, Sheet 1, adds details regarding the site-specific design of the switchyard for Unit 3 and is consistent with this DCD figure in that it specifies the off-site normal and alternate preferred power supplies are in the switchyard area of the plant. This change more specifically identifies that some of the off-site normal preferred power supply is located in the site-specific intermediate switchyard. Adding the intermediate switchyard to the figure does not change the functions performed by the components shown on this figure and has no effect on how the functions are performed by the components.

In the North Anna 3 COLA, Revision 8, Part 7, "Departures Report," the applicant requested an exemption from the provisions of 10 CFR Part 52, Appendix E, Section III.B, "Design Certification Rule for the ESBWR Design, Scope and Contents," which requires an applicant referencing a certified design to incorporate by reference Tier 1 information. Specifically, in North Anna Part 7, Exemption 2, the applicant proposed to revise the ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1 to accommodate site space constraints by adding an intermediate switchyard to revise the location information for the main generator circuit breaker and the two motor-operated disconnects (MOD).[2]

Regulations

- 10 CFR Part 52, Appendix E, Section VIII.A.4 states that exemptions from Tier 1 information are governed by the requirements of 10 CFR 52.63(b) and 10 CFR 52.98(f). 10 CFR Part 52, Appendix E, Section VIII.A.4 also states that the Commission will deny such a request if it finds that the design change will result in a significant reduction in the level of safety otherwise provided by the design.

[2] *While the applicant describes the requested exemption as being from Section III.B of 10 CFR Part 52, Appendix E, the entirety of the exemption pertains to proposed departures from Tier 1 information in the generic DCD. In the remainder of this evaluation, the NRC will refer to the exemption as an exemption from Tier 1 information to match the language of Section VIII.A.4 of 10 CFR Part 52, Appendix E, which specifically governs the granting of exemptions from Tier 1 information.*

- 10 CFR Part 52.63(b)(1) allows an applicant to request NRC approval for an exemption from one or more elements of the certification information. The Commission may only grant such a request if it determines that the request complies with the requirements of 10 CFR 52.7, which, in turn, points to the requirements listed in 10 CFR 50.12 for specific exemptions, and if the special circumstances present outweigh the potential decrease in safety due to reduced standardization. Therefore, any exemption from the Tier 1 information certified by 10 CFR Part 52, Appendix E must meet the requirements of 10 CFR 50.12, 10 CFR 52.7, and 10 CFR 52.63(b)(1).

Evaluation of Exemption

As stated in 10 CFR Part 52, Appendix E, Section VIII.A.4, an exemption from Tier 1 information is governed by the requirements of 10 CFR 52.63(b)(1) and 52.98(f). Additionally, the Commission will deny an exemption request if it finds that the requested change to Tier 1 information will result in a significant decrease in safety. Pursuant to 10 CFR 52.63(b)(1), the Commission may, upon application by an applicant or licensee referencing a certified design, grant exemptions from one or more elements of the certification information, as long as the criteria given in 10 CFR 50.12 are met and the special circumstances as defined by 10 CFR 50.12 outweigh any potential decrease in safety due to reduced standardization.

Applicable criteria for when the Commission may grant the requested specific exemption are provided in 10 CFR 50.12(a)(1) and (a)(2). 10 CFR 50.12(a)(1) provides that the requested exemption must be authorized by law, not present an undue risk to the public health and safety, and be consistent with the common defense and security. The provisions of 10 CFR 50.12(a)(2) list six special circumstances for which an exemption may be granted. It is necessary for one of these special circumstances to be present in order for NRC to consider granting an exemption request. The applicant stated that the requested exemption meets the special circumstances of 10 CFR 50.12(a)(2)(ii). That subsection defines special circumstances as when "[a]pplication of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule." The staff's analysis of each of these findings is presented below. Although the applicant requested an exemption from 10 CFR Part 52, Appendix E, Section III.B, the NRC is treating the requested exemption as one from ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1, since the applicant is seeking to depart from the information reflected on that figure.

Authorized by Law

This exemption would allow the applicant to implement approved changes to Tier 1 information. This is a permanent exemption limited in scope to particular Tier 1 information, and subsequent changes to this Tier 1 information or any other Tier 1 information would be subject to full compliance by the applicant as specified in 10 CFR Part 52, Appendix E, Section VIII.A.4. As stated above, 10 CFR 52.63(b)(1) allows the NRC to grant exemptions from one or more elements of the certification information, namely, Tier 1. The staff determined that granting of the applicant's proposed exemption will not result in a violation of the Atomic Energy Act of 1954, as amended, or NRC regulations. Therefore, as required by 10 CFR 50.12(a)(1), the exemption is authorized by law.

No Undue Risk to Public Health and Safety

The underlying purpose of ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1, is to identify the standard ESBWR switchyard layout and configuration that will function in a manner the NRC has determined satisfied NRC requirements. The addition of an intermediate switchyard supports the system's intended design functions and does not affect the offsite power system compliance with GDC 17, since the intermediate switchyard is simply an additional space used to hold the plant's output breakers from the plant generator and introduces no new failure modes. The plant-specific Tier 1 DCD will continue to reflect the approved licensing basis for the applicant and will maintain a level of detail consistent with that which is currently provided elsewhere in Tier 1 of the plant-specific DCD. The affected design description in the plant-specific Tier 1 DCD will continue to provide the detail necessary to support the performance of the associated inspection, test, analysis, and acceptance criterion (ITAAC). Therefore, the staff finds the exemption presents no undue risk to public health and safety as required by 10 CFR 50.12(a)(1).

Consistent with Common Defense and Security

The proposed exemption would allow the applicant to implement modifications to the Tier 1 information requested in the applicant's submittal. This is a permanent exemption limited in scope to particular Tier 1 information. Subsequent changes to this Tier 1 information or any other Tier 1 information would be subject to full compliance by the applicant as specified in 10 CFR Part 52, Appendix E, Section VIII.A.4. This change is not related to security issues. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that the exemption is consistent with the common defense and security.

Special Circumstances

Special circumstances, in accordance with 10 CFR 50.12(a)(2)(ii), are present whenever application of the regulation in the particular circumstances would not serve the underlying purposes of the rule or is not necessary to achieve the underlying purpose of the rule. The underlying purpose of the specific ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1, is to identify the standard ESBWR switchyard layout and configuration that will function in a manner the NRC has determined satisfies NRC requirements. This site-specific change modifies the standard design to accommodate physical space constraints on the North Anna 3 site for the switchyard. The intermediate switchyard configuration in the requested exemption will continue to perform its intended function and will, therefore, meet the underlying purpose of the rule. Accordingly, special circumstances are present because the certified design information in ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1, is not necessary to achieve the underlying purpose of the rule in view of the space constraints on the North Anna 3 switchyard. Therefore, the staff finds that special circumstances required by 10 CFR 50.12(a)(2)(ii) for the granting of an exemption from Tier 1 exist.

Special Circumstances Outweigh Reduced Standardization

This exemption would allow the applicant to change certain ESBWR DCD, Tier 1 information proposed in the North Anna 3 COLA in view of site-specific space constraints. The key design functions of the switchyard will nonetheless be maintained, based on the nature of the proposed changes to the generic ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1, and the understanding that these changes support the design function of the switchyard. However, this exemption

request and the associated changes to North Anna 3 COLA Tier 1 information demonstrate that there is a minimal change from the standard information provided in the ESBWR DCD. Consequently, the decrease in safety due to reduced standardization would also be minimal. For this reason, the staff determined that even if other ESBWR licensees and applicants do not request similar departures, the special circumstances outweigh the potential decrease in safety due to reduced standardization of the ESBWR design, as required by 10 CFR 52.63(b)(1).

No Significant Reduction in Safety

The proposed exemption would not modify the function of the North Anna 3 switchyard from that described in the ESBWR DCD. Therefore, the staff finds that granting the exemption would not result in a significant decrease in the level of safety otherwise provided by the design, as required by 10 CFR Part 52, Appendix E, Section VIII.A.4.

Conclusion

For the reasons set forth above, the staff has concluded that pursuant to 10 CFR Part 52, Appendix E, Section VIII.A.4, the exemption: (1) is authorized by law; (2) presents no undue risk to the public health and safety; (3) is consistent with the common defense and security; (4) has special circumstances that outweigh the potential decrease in safety due to reduced standardization; and (5) does not significantly reduce the level of safety at the licensee's facility. Therefore, the staff finds that the applicant's request to depart from the information in ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1, is acceptable, and the applicant's request for an exemption from these Tier 1 requirements is granted.

Tier 2 Departure

- NAPS DEP 8.1-2 Switchyard Surge Protection

The applicant identified specific sections of IEEE Standard. C62.23 concerning switchyard surge protection with which the switchyard design is not in conformance. Use of this standard is one of the recommendations of RG 1.204. On August 4, 2008, in a Request for Additional Information (RAI) 08.02-61, (Agencywide Documents Access and Management System (ADAMS) Accession Number No. ML11195A365), the staff requested the specific bases for the non-conformance. In its response to RAI 08.02-61 on September, 16, 2011 (ADAMS Accession No. ML11264A130), the applicant addressed each subsection of the standard for which an exception was taken.

The staff reviewed each exception and concurred with the applicant that either the subsection did not apply or that the measures taken provided equivalent protection, as described in the following table.

IEEE Standard.C62.23 Section	Title	Staff Finding
4.3.5	Shielding	This section recommends shielding of distribution lines. The proposed design has one line (342) that fits this description. Instead of shielding the line, the proposed design provides equivalent protection by using multiple metal oxide surge arrestors at the 34.5 kV switchyard interconnection.
5.3.2	Incoming Surges	This section references a paper that discusses alternate wiring practices when redesigning a chemical plant. This provision is not applicable.
5.3.2.1	Control Systems	This section recommends circuit separation based upon voltage level in order to prevent coupling between power cables and low voltage, low energy digital and analog instrument and control (I&C) circuits. The proposed design provides equivalent protection by shielding the cables as power cable voltages in the switchyard are limited to either 120 Vac or 125 Vdc.
5.3.3.1	Control Systems	This section recommends creating a separate radial ground system for control and instrumentation circuits to minimize electrical noise. The proposed design provides equivalent protection by using grounded messenger cables in parallel with cable runs and using grounded, shielded cable in control circuits.
5.3.3.2	Communications Systems	This section recommends gathering communication circuit grounds on a communication backboard and then connecting the grouping to ground with a single insulated ground wire. The proposed design provides equivalent protection by using a non-insulated ground wire that does not touch any other circuit.
5.3.3.3	Electrostatic Discharge	This section recommends using anti-static flooring material or some other equivalent to prevent static discharge between humans and equipment. The proposed design provides equivalent protection by using concrete floors with grounded racks and equipment cabinets grounded to the racks.
5.3.4.1	Communication and Power Circuit Coupling	This section recommends methods for reducing field coupling between parallel cables. The proposed design provides equivalent protection by using shielded control cable with messenger cables from switchyard components to the control house. Within the control house, shielded cable is used and fiber optics is used from the data collectors to point's offsite.

IEEE Standard.C62.23 Section	Title	Staff Finding
5.3.4.2	Lightning-induced Voltages in Control Cables	This section recommends use of telecommunication cables with grounded sheaths and grounding of both ends of unused conductors. The proposed design provides equivalent protection by using shielded control cables with messenger cables from switchyard components and grounds both ends of the cable shields when run with the messenger cables.
5.3.5.2	Sources of Interference	This section identifies sources of noise that can radiate or be induced into switchyard cables and equipment. However, no specific recommendations are provided. The proposed design addresses this problem by the techniques discussed above by employing a combination messenger cable/shielded cable and continuously grounded open racks to minimize signals induced into the system.
5.3.5.6.2. a)	Single Point Guidelines for a Multipoint Grounding System	This subsection recommends wiring for computer equipment, communications and control systems within a control house to be connected to a multipoint ground system in only one place. The proposed design provides equivalent protection by using shielded cable run in a grounded tray with continuous grounding along the floor and ceiling and around the racks.

Therefore, the applicant has adequately addressed the provisions of IEEE Std. C62.23, and the staff finds that this issue is acceptably resolved.

Supplemental Information

- NAPS SUP 8.1-1 Utility Power Grid Description

The staff reviewed the supplemental information provided by the applicant to modify Section 8.1.2.1, "Utility Power Grid Description." The applicant provided the following supplement to Section 8.1.2.1:

> The output of Unit 3 is delivered to a main 500/230 kV switchyard through the unit main step-up transformers, and an intermediate switchyard. The main switchyard serves four 500 kV lines and one 230 kV line. The plant is connected to the main switchyard by a 500 kV normal preferred transmission line, and a 230 kV alternate preferred transmission line that supplies power to the two reserve auxiliary transformers.

The staff finds that the applicant has adequately described the North Anna 3 connection to the utility grid. In addition, the staff has determined the switchyard is connected to the grid by at least two separate circuits. Therefore, the staff finds that the connection conforms to the requirements of GDC 17.

8.1.5 Post Combined License Activities

There are no post COLA activities related to this section.

8.1.6 Conclusion

As described in detail above, the Tier 1 departure requiring an exemption as described in North Anna 3 Part 7, Exemption 2, "Electric Power Distribution System Functional Arrangement," is acceptable because pursuant to 10 CFR Part 52, Appendix E, Section VIII.A.4, the exemption: (1) is authorized by law; (2) presents no undue risk to the public health and safety; (3) is consistent with the common defense and security; (4) has special circumstances that outweigh the potential decrease in safety due to reduced standardization; and (5) does not significantly reduce the level of safety at the licensee's facility. Therefore, the staff finds that the applicant's request to depart from the information in ESBWR DCD, Tier 1, Figure 2.13.1-1, Sheet 1, is acceptable, and the applicant's request for an exemption from these Tier 1 requirements is granted.

The staff's finding related to information incorporated by reference is in NUREG–1966. The staff reviewed the application and checked the referenced DCD. The staff finds that the application includes all the information relevant to the North Anna 3 offsite power systems and safety-related onsite electric power systems, and the staff confirmed that no outstanding information related to this section remains to be addressed in the COL FSAR. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, "Design Certification Rule for the Economic Simplified Boiling-Water Reactor," Section VI.B.1, all nuclear safety issues relating to the transmission system and its connections to the nuclear power unit that were incorporated by reference are resolved.

In addition, as set forth above, the staff compared the additional COLA supplemental information in the application to the relevant NRC regulations, the guidance in SRP Section 8.1, and other NRC RGs. For the reasons set forth above, the staff concludes that the applicant has provided sufficient information to satisfy the requirements of GDC 17 for this section.

8.2 Offsite Power System

8.2.1 Introduction

This section of the North Anna 3 FSAR describes analyses and referenced documents that include electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the offsite power system. Industry standards and RGs refer to the offsite power system as the "preferred power system." The offsite power system should include two or more physically independent circuits capable of operating independently of the onsite standby power sources. The system encompasses the grid, transmission lines (overhead or underground), transmission line towers, transformers, switchyard components and control systems, switchyard battery systems, the main generator, generator circuit breakers, disconnect switches, and other switchyard equipment, such as capacitor banks and volt amperes reactive compensators. The system supplies electric power to safety-related and other equipment.

- The ESBWR passive reactor design used at North Anna 3 minimizes the potential risk contribution of a station blackout (SBO) (loss of all ac power) by not crediting ac power sources for design-basis events for 72 hours. The plant's safety-related passive systems automatically establish and maintain safe-shutdown conditions for the plant following design-basis events, including the extended loss of ac power sources. The passive systems can maintain these safe-shutdown conditions after design-basis events for 72 hours without operator action, following loss of both onsite and offsite ac power sources. As described in the ESBWR DCD, for the standard design for off-site power systems that are not safety related, GDC 5, "Sharing of Structures, Systems, and Components" and GDC 18, "Inspection and Testing of Electric Power and Protective Systems" are not applicable; however, the nonsafety-related offsite and onsite ac systems that supply ac power to the isolation power centers are testable and meet GDC 18 requirements. In addition, the ESBWR Preferred Power Supply (PPS) complies with GDC 17 requirements for two physically independent and separate offsite power circuits, each with the capacity and capability to power equipment during design basis operating modes (plant start-up, normal operation, safe shutdown, accident, and post-accident operation).

8.2.2 Summary of Application

Section 8.2 of the North Anna 3 COL FSAR, Revision 8, incorporates by reference Section 8.2 of the ESBWR DCD, Revision 10.

In addition, in FSAR Section 8.2, the applicant provided site-specific supplemental information to resolve COL Items 8.2.4-1-A through 8.2.4-10-A. The applicant adds the following site-specific supplemental information:

COL Items

- NAPS COL 8.2.4-1-A Transmission System Description

In FSAR Section 8.2.1.1, the applicant provided detailed information on the designs of the plant site 500 kV switchyard, the four 500 kV and one 230 kV transmission lines connecting the plant switchyard to Dominion's transmission system, and the interface of the switchyard with the transmission grid. The applicant provided Figures 8.2-201 through 8.2-203, which show a one-line diagram of the electrical system from the switchyard to the onsite electrical system, physical arrangement of the offsite power source, and a map of offsite transmission lines, respectively.

- NAPS COL 8.2.4-3-A Normal Preferred Power
- NAPS COL 8.2.4-4-A Alternate Preferred Power

The applicant provided additional information in FSAR Section 8.2.1.2, "Offsite Power System," describing details of normal preferred power and alternate preferred power including an arrangement drawing (Figure 8.2-202).

- NAPS COL 8.2.4-2-A Switchyard Description
- NAPS COL 8.2.4-6-A Switchyard DC Power
- NAPS COL 8.2.4-7-A Switchyard AC Power
- NAPS COL 8.2.4-8-A Switchyard Transformer Protection
- NAPS DEP 8.1-2 Switchyard Surge Protection

The applicant provided additional information in FSAR Section 8.2.1.2.1, “Switchyard,” that described details of the switchyard, switchyard dc and ac power, switchyard transformer protection, and switchyard surge protection and included tables on capacities of switchyard components.

- NAPS COL 8.2.4-5-A Protective Relaying

The applicant provided new information in Section 8.2.1.2.2 that specifically addresses the monitoring of the unit auxiliary transformers (UAT) and reserve auxiliary transformers (RAT) for open circuit conditions as discussed in NRC Bulletin 2012-01, “Design Vulnerability in Electric Power System,” (ADAMS Accession No. ML12074A115). Section 8.2.1.2.3 describes the existing relay schemes that protect the 500 kV transmission lines, switchyard buses, generating unit tie-line, and auxiliary transformers.

[NOTE: The applicant added information concerning the subject of Bulletin 2012-01 in Section 8.2.1.2.2 and renumbered Sections 8.2.1.2.2 and 8.2.1.2.3 as 8.2.1.2.3 and 8.2.1.2.4, respectively.]

- NAPS COL 8.2.4-9-A Stability and Reliability of the Offsite Transmission Power System

- NAPS COL 8.2.4-10-A Interface Requirements

The applicant provided additional information in FSAR Section 8.2.2.1, “Reliability and Stability Analysis,” describing details of a transmission system study performed regularly to verify grid stability, switchyard voltage, and frequency. The purpose of the study was to confirm the transmission system capability and demonstrate formal agreement between the control room and the transmission operator.

Supplemental Information

- NAPS SUP 8.2-1 Bulletin 2012-01

In FSAR Section 8.2.1.2.2, the applicant provided commitments for developing procedures and training for the operations and maintenance staff in support of the transformer open circuit monitoring system.

- NAPS SUP 8.2-2 Testing and Inspection

The applicant provided FSAR Section 8.2.1.2.4, “Testing and Inspection,” which gives details of testing and inspection of the switchyard components.

- NAPS SUP 8.2-3 Failure Mode and Effects Analysis

The applicant provided FSAR Section 8.2.2.3, “Failure Modes and Effects Analysis,” which describes details of the failure modes and effect analysis of transmission system, switchyard, and intermediate switchyard components.

8.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, the final safety evaluation report (FSER) related to the ESBWR DCD and NUREG–1966, Supplement 1, FSER related to the Certification of the ESBWR Standard Design, Supplement 1. In addition, the relevant requirements of the Commission regulations for the offsite power system and the associated acceptance criteria are in SRP Section 8.2.

The NRC requirements governing the COL supplemental information are in GDC 17 of Appendix A to 10 CFR Part 50, and specifically, as follows:

- for NAPS COL 8.2.4-1-A, the requirements of GDC 17
- for NAPS COL 8.2.4-3-A and 8.2.4-4-A, the requirements of GDC 17
- For NAPS COL 8.2.4-2-A, 8.2.4-6-A, and 8.2.4-7-A, the requirements of GDC 17 and GDC 5
- for NAPS COL 8.2.4-5-A and 8.2.4-8-A, the requirements of GDC 17
- for NAPS COL 8.2.4-9-A and 8.2.4-10-A, the requirements of GDC 17
- For NAPS SUP 8.2-1, the requirements of GDC 17
- for NAPS SUP 8.2-2, the requirements of GDC 18

The guidance and specific acceptance criteria that apply to the supplemental information are as follows:

- For NAPS COL 8.2.4-9-A and 8.2.4-10-A, the guidelines of RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)”; Branch Technical Position (BTP) 8-3, “Stability of Offsite Power Systems”; BTP 8-6, “Adequacy of Station Electric Distribution System Voltages”; RG 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants”
- For NAPS SUP 8.2-2, the guidelines of RG 1.118, “Periodic Testing of Electric Power and Protection Systems”
- For NAPS SUP 8.2-3, the guidelines of RG 1.206

8.2.4 Technical Evaluation

As documented in NUREG–1966 and NUREG–1966, Supplement 1, the staff reviewed and approved Section 8.2 of the ESBWR DCD. The staff reviewed Section 8.2 of the North Anna 3 COL FSAR, Revision 8, and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1]

The staff's review confirmed that the information in the application and the information incorporated by reference include all the information relevant to the offsite power system.

The staff reviewed the following information in the COL FSAR:

COL Items

- NAPS COL 8.2.4-1-A Transmission System Description

The applicant provided additional information in NAPS COL 8.2.4-1-A to address COL Item 8.2.4-1-A. The applicant stated that the following replaces DCD Section 8.2.1.1:

> NAPS, that is, Units 1, 2, and 3, is connected to the Dominion transmission system by four 500 kV lines and one 230 kV line. The lines are designed and located to minimize the likelihood of simultaneous failure. The Unit 3 main generator feeds electric power through a 27 kV isolated phase bus to a bank of three single phase transformers, stepping the generator voltage up to the transmission voltage of 500 kV. Figure 8.2-201 provides a one-line diagram of the electric system from the switchyard to the onsite system. The transmission lines and towers connecting the switchyard to the transmission system are as follows:
>
> - Two 500 kV overhead lines to the Ladysmith substation (approximately 15 miles)
> - A 500 kV overhead line to the Midlothian substation (approximately 41 miles)
> - A 500 kV overhead line to the Morrisville substation (approximately 33 miles)
> - A 230 kV overhead line to the Gordonsville substation (approximately 31 miles)
>
> Two Ladysmith lines utilize a common right-of-way. Each of the other lines utilizes separate right-of-way. The 230 kV Gordonsville line crosses under the 500 kV Ladysmith and Morrisville lines near the switchyard.

The applicant stated that transmission tower separation, line installation, and clearances are consistent with the National Electric Safety Code (NESC) and Dominion transmission line standards. Adequate clearance exists between wire galloping ellipses to minimize conductor or structural damage.

The staff's review of FSAR Chapter 8, Figure 8.2-201, indicated a discrepancy with the corresponding DCD Revision 4, Figure 8.1-1. Figure 8.1-1 showed the main generator circuit breaker as part of the onsite power system, while Figure 8.2-201 showed the same breaker as being in the intermediate switchyard. Also, in Figure 8.1-1, the main transformer and UATs are connected at the high-voltage side of the main transformer; however, in Figure 8.2-201, UATs high-side voltage is 230 kV, and the main transformer's high-side voltage is 500 kV. It was not clear how the connection can be made with different voltages. On June 13, 2008, the staff

issued RAI 08.02-1 (ADAMS Accession No. ML081650433), the staff asked the applicant to clarify the apparent discrepancies. In the response letter dated July 28, 2008, to RAI 08.2-1 (ADAMS Accession No. ML082170400), the applicant stated that the main generator circuit breaker is physically located in the NAPS intermediate switchyard. The applicant stated that it will revise FSAR Figure 8.2-201 to remove the main generator circuit breaker symbol from the figure and will add a note to clarify the interface between DCD Figure 8.1-1 and FSAR Figure 8.2-201. The applicant stated that at North Anna 3, the high-voltage side of the UATs and RATs will be at 230 kV and generator step-up transformers will be at 500 kV on the high side. Because of this, a 500/230 kV transformer bank will be located in the intermediate switchyard to step down 500 kV to 230 kV for use by the UATs, as depicted in FSAR Figure 8.2-201. The applicant added a note to FSAR Figure 8.2-201 to clarify that equipment on the offsite power portion of FSAR Figure 8.2-201 replaces equipment on the offsite power portion of DCD Figure 8.1-1. This Tier 1 departure was evaluated as an exemption above and was determined to be acceptable to the staff. Therefore as described in Section 8.1.6 of this SER, the staff finds that the applicant has adequately addressed the staff's question. The staff confirmed that these changes are incorporated in FSAR Revision 8, and the note to the figure was removed and the issue is resolved.

The staff finds that the information the applicant provided in response to COL Item 8.2-4-1-A conforms to the requirements of GDC 17.

- NAPS COL 8.2.4-3-A Normal Preferred Power
- NAPS COL 8.2.4-4-A Alternate Preferred Power

The applicant provided additional information in North Anna 3 COL 8.2.4-3-A and 8.2.4-4-A to address COL Items 8.2.4-3-A and 8.2.4-4-A. The applicant stated that it has replaced the first and second paragraph of DCD Section 8.2.1.2 with the following:

> The offsite power system is a non-safety-related system. Power is supplied to the plant from multiple independent and physically separate offsite power sources.
>
> The normal preferred power source is any one of the four 500 kV lines, and the alternate preferred power source is any one of the other three 500 kV lines.
>
> The normal preferred power source is supplied to the UATs through the intermediate transformer, MODs [motor operated disconnect] and isolation circuit breakers. The normal preferred power interface with offsite power system occurs at the high voltage terminals of the main generator circuit breaker MOD and UAT MODs. The MOD feeding a faulted UAT will be opened after the UAT high voltage breaker opens.

On June 13, 2008, the staff issued RAI 08.02-2 (ADAMS Accession No. ML081650433), requesting the applicant provide a discussion of the routing of control and instrumentation cables, and miscellaneous power cables associated with normal and alternate preferred circuits, between the switchyard and the power block. In the response letter dated July 28, 2008, to RAI 08.02-2 (ADAMS Accession No. ML082170400), the applicant stated that adequate separation is ensured either by routing cables associated with the normal preferred circuit in a duct bank separate from cables associated with the alternate preferred circuit, or by routing these cables in separate conduits within the same duct bank. The applicant revised FSAR Section 8.2.1.2 to add a description of the routing of control, instrumentation, and miscellaneous

power cables. Because normal I&C cables and power cables associated with those I&C circuits will be in duct banks separate from those for the alternate circuits, or will be in separate conduits in the same duct bank, the staff finds that the applicant has adequately addressed the issue of cable separation. The staff confirmed that these changes are incorporated in FSAR Revision 8, and the issue is resolved.

Since underground cables are susceptible to moisture, on June 13, 2008, the staff issued RAI 08.02-4 (ADAMS Accession No. ML081650433), requesting the applicant identify the design features and/or in situ monitoring programs that it will use to monitor the degradation of the cable from the effects of moisture. In the response letter dated July 28, 2008, to RAI 08.02-4 (ADAMS Accession No. ML082170400), the applicant stated that the normal preferred power supply and alternate preferred power supply both use 230 kV underground cable. The applicant stated further that it would periodically monitor cable insulation for underground medium-voltage and high-voltage cable to detect potential cable degradation from moisture intrusion using one of the following methods or an equivalent: partial discharge testing, time domain reflectometry, dissipation factor testing, or very-low-frequency ac testing. On the basis of its review, the staff determined that the applicant did not address the testing frequency. Additionally, the staff determined that testing alone is not sufficient.

The manholes should be inspected every 6 months for water accumulation, and adequate corrective actions (increased inspection frequency) should be taken if water accumulation is found, as required by the maintenance rule 10 CFR 50.65 and as recommended by RG 1.160. Furthermore, the staff needed technical justification for using one of the testing methods indicated above to detect potential high-voltage (230 kV) cable degradation.

On October 16, 2008, the staff issued RAI 08.02-29 (ADAMS Accession No. ML082900201), requesting the applicant to address these issues. In the response letter dated December 1, 2008, to RAI 08.02-29 (ADAMS Accession No. ML083390401), the applicant stated that these 230 kV underground cables in duct banks have a metallic sheath to prevent moisture ingress into the cable insulation. The applicant indicated that it would inspect manholes associated with these duct banks every 6 months for excessive accumulation of water, and would take corrective actions (such as increased inspection frequency), as required by the maintenance rule, 10 CFR 50.65, if excessive water accumulation is found. Duct bank inspection on a 6-month frequency allows for the evaluation of performance and condition monitoring activities every refueling outage, as required by 10 CFR 50.65(a)(3). Accordingly, the applicant has adequately addressed this issue. The staff confirmed that the applicant has revised COL FSAR Section 8.2.1.2 to add manhole inspections for water accumulation in Revision 8 of the FSAR.

Since these 230 kV underground cables are part of the design that satisfies the GDC 17 requirement for having two circuits from the transmission network to the onsite power distribution system, these circuits fall under the requirements of 10 CFR 50.65(a)(1) of the maintenance rule. The staff confirmed that COL FSAR Section 17.6.4 provides the following statement:

> 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 procurement documents to determine the appropriate inspections, tests and monitoring criteria for underground and inaccessible cables within the scope of the maintenance rule (10 CFR 50.65).

Given that 10 CFR 50.65, "Maintenance Rule," applies for these cables, and the applicant's Maintenance Rule Program is adequate as described in Section 17.6.4 of this SER, further response is not needed for this review. On this basis, the staff finds that the 230 kV underground cables will be included as required by the maintenance rule in a cable condition monitoring program, the cables are monitored for degradation and subsequent action can be taken, if necessary. Accordingly, the issue is resolved.

The FSAR Section 8.2.1.2.1 notes that the 500 kV transmission line rated current is 3,954 amps and the 500 kV bus is rated as 3,891 amps. On June 13, 2008, the staff issued RAI 08.02-5 (ADAMS Accession No. ML081650433), requesting the applicant to explain why the bus rating is less than the transmission line rating and clarify the actual loading of the line and bus. In the response letter dated July 28, 2008, to RAI 08.02-5 (ADAMS Accession No. ML082170400), the applicant stated that transmission line loading (normal loading and emergency loading) is well below the bus rating. Additionally, both Dominion and the Pennsylvania, New Jersey, and Maryland Interconnection (PJM) perform periodic studies to verify that bus work and transmission lines can be operated within their rating. Since transmission line loading (normal loading and emergency loading) is below the bus rating in the switchyard, the staff finds the applicant's response adequate, and this issue is resolved.

Since all North Anna units share the same switchyard, the offsite power system provided for the site should have sufficient capacity and capability to safely shut down all units. As documented in NRC generic communications (e.g., NRC Generic Letter (GL) 07-01, "Inaccessible or Underground Power Cable Failures That Disable Accident Mitigation Systems or Cause Plant Transients," dated February 7, 2007; NRC Information Notice (IN) 98-07, "Offsite Power Reliability Challenges from Industry Deregulation," dated February 27, 1998; and NRC IN 95-37, "Inadequate Offsite Power Voltages During Design-Basis Events," dated September 7, 1995), operational experience has shown the need to demonstrate that the offsite power system operation supports equipment important to safety and avoids plant transients. In addition, NRC GL 06-02, "Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power," dated February 1, 2006, states that, "For nuclear plants licensed in accordance with the GDC in Appendix A to 10 CFR Part 50, the design criteria for onsite and offsite electrical power systems are provided in GDC 17…which requires, among other things, that an offsite electric power system be provided to permit the functioning of certain structures systems and components (SSCs) important to safety in the event of anticipated operational occurrences."

On July 9, 2008, the staff issued RAI 08.02-28 (ADAMS Accession No. ML081910316), requesting that the applicant discuss the capacity and capability of the offsite system (i.e., the 500 kV lines and associated switchyard equipment) to mitigate the consequences of anticipated abnormal operational occurrences associated with unit operation. In the response letter dated August 21, 2008 (ADAMS Accession No. ML083470290), the applicant deferred its technical response to within 45 days following the General Electric Hitachi Nuclear America, LLC (GEH) response to DCD RAI 14.3-394, to ensure that the response was consistent and complete.

GEH submitted their responses to DCD RAI 14.3-394 on August 27, 2008 (ADAMS Accession No. ML082420291), and DCD RAI 14.3-394 S01 on December 9, 2008 (ADAMS Accession No. ML083470290). The applicant provided its subsequent response to RAI 08.02-28 on November 19, 2008 (ADAMS Accession No. ML083260325). The applicant stated in its response as follows: The switchyard for North Anna Power Station was evaluated under a system impact study (SIS) for interconnection of Unit 3 by PJM, the regional transmission operator (RTO). The SIS was performed to verify load flow capability, short-circuit capability, and system stability of the local transmission system in the vicinity of the North Anna 3 switchyard. The study was performed in accordance with North American Electric Reliability Corporation (NERC) criteria. The applicant stated that this level of detail meets the specific requirements of the RTO and ensures that the local transmission system, including the North Anna 3 switchyard, will be a reliable power source. The applicant also stated that the SIS recommended specific upgrades to the transmission system to ensure that PJM interconnection criteria are met with the interconnection of North Anna 3. In the SIS, PJM concludes that the transmission system is capable of accepting the interconnection of North Anna 3 and of operating with the transmission system contingencies evaluated. The evaluation covers NERC contingency classes A, B, and C, where class A assumes all facilities in service function normally, class B considers the loss of any single element of the grid, and class C considers events resulting in the loss of two or more grid elements. The applicant includes in Part 10, "ITAAC" Table 2.4.8-1 of the COLA specific analysis to confirm these offsite interfaces would remain current for North Anna 3 prior to plant operation. The staff reviewed the ITAAC, and finds that it specifies analyses adequate to verify that the as-built offsite interfaces continue to function properly under the NERC contingency classes.

Furthermore, the applicant notes that the DCD does not state the limits for voltage and frequency variation that need to be met by site-specific offsite power systems, as stated in the DCD, "the COL Applicant is responsible for the interface protocol requirements (COL 8.2.4-10-A)." The staff observes that this interface requirement does not set specific electrical characteristics for offsite power systems. The applicant indicated further that it would analyze the as-built onsite power system to determine the maximum load during all operating modes. The applicant stated that these analyses will, in part, specify maximum power, voltage, frequency, and interrupting capability necessary for the offsite power system to support safety-related load operation during all operating modes. These analyses will be re-evaluated as part of a site-specific ITAAC (see Section 14.3 of this SER) and will ensure that each as-built offsite circuit has sufficient capacity and capability. Because the applicants SIS evaluation and the required re-evaluation as part of the North Anna 3 ITAAC requirements in Part 10, Table 2.4.8-1 of the COLA are together sufficient to establish the electrical performance of the offsite power system described above, the staff finds that the applicant has addressed the issue adequately, and the issue is resolved.

For the reasons stated above, and since the offsite circuit interface with the onsite portions of the preferred power supply is adequately rated to supply the load credited during design basis operating modes (as described in DCD ITAAC Table 2.13.1-2, Item 9), the staff finds that the information the applicant provided in response to COL Items 8.2.4-3-A and 8.2.4-4-A conforms to the requirements of GDC 17 and is therefore acceptable.

- NAPS COL 8.2.4-2-A Switchyard Description
- NAPS COL 8.2.4-6-A Switchyard DC Power
- NAPS COL 8.2.4-7-A Switchyard AC Power

The applicant provided additional information in North Anna 3 COL 8.2.4-2-A, 8.2.4-6-A, and 8.2.4-7-A to address COL Items 8.2.4-2-A, 8.2.4-6-A, and 8.2.4-7-A. The applicant replaced the last paragraph of DCD Section 8.2.1.2.1, in part, with the following:

> The NAPS switchyard, prior to the point of interconnection with Unit 3, is a 500/230 kV, air-insulated, breaker-and-a-half bus arrangement Unit 3 is connected to this switchyard by an overhead conductor circuit.
>
> The physical location and electrical interconnection of the switchyard is shown on Figures 8.2-201 and 8.2-202.
>
> The North Anna switchyard uses surge suppressors on the high and low sides of Transformers 1, 2, 3, 5, and 6 to protect equipment from voltage surges, including lightning events. The insulation coordination and surge protective devices are applied in compliance with IEEE 1313.2 (Reference 8.2-205) and IEEE C62.22 (Reference 8.2-206). The surge protective devices are maintained according to NEMA requirements and manufacturer's recommendations.

The FSAR Revision 1, Chapter 1, Table 1.9-201, "Conformance with Standard Review Plan," for SRP Section 8.2, indicated that GDC 5 is not applicable. DCD Revision 4, Section 8.2.2.2 stated that the ESBWR reference plant is designed as a single-unit plant, and therefore, GDC 5 is not applicable. However, the staff noted that the North Anna 3 switchyard is shared with Units 1 and 2 and, therefore, on June 13, 2008, the staff issued RAI 08.02-16 (ADAMS Accession No. ML081650433), requesting the applicant to clarify the applicability of and conformance with GDC 5. In the response letter dated July 28, 2008, to RAI 08.02-16 (ADAMS Accession No. ML082170400), the applicant stated that the North Anna switchyard is not important to safety for North Anna 3, and thus, GDC 5 is not applicable. The staff agrees that GDC 5 related to sharing SSCs important to safety is not applicable and that the switchyard as well as the grid connections are not safety-related class 1E components that provide safety-related offsite electric power systems for functioning of SSCs important to safety. In addition, since the North Anna 3 switchyard and offsite power is not safety related, RG 1.32 does not apply to either the switchyard or the off-site power distribution systems. This is the conclusion in DCD Section 8.1.5.2.4, "Regulatory Requirements," and North Anna 3 did not depart from this aspect of Section 8.1.5.2.4 of the DCD.

The staff has determined that the North Anna 3 UATs and RATs are not shared with North Anna 1 and 2. Although the Unit 3 UATs and RATs are connected to the same grid as the Unit 1 and 2 transformers, the capacity of the offsite power system is large compared to the safety-related loads (battery chargers and uninterruptible power supply (UPS)) fed by these transformers, and those loads will not affect the functioning of any offsite power systems.

The ESBWR DCD, Section 8.2.3 states that a station ground grid is provided that consists of a ground mat below grade at the switchyard that is connected to the foundation embedded loop grounding system provided for the entire power block and associated buildings. On June 13, 2008, the staff issued RAI 08.02-24 (ADAMS Accession No. ML081650433), requesting the applicant to describe the station ground grid. In the response letter dated July 28, 2008, to RAI 08.02-24 (ADAMS Accession No. ML082170400), the applicant stated that a description of the station ground grid appears in Appendix 8a to DCD Section 8. However, the staff noted that the North Anna Station ground grid consists of the switchyard ground grid, the existing Unit 1 and 2 ground grid, and the new Unit 3 ground grid. On October 16, 2008 the staff issued

RAI 08.02-37 (ADAMS Accession No. ML082900201), requesting that the applicant discuss the interface and impact of station grounding resulting from the addition of the Unit 3 ground grid to the existing station ground consisting of the switchyard and the Unit 1 and 2 grounding. In addition, the staff asked the applicant to provide a summary description of the existing grounding system at North Anna and the proposed grounding of Unit 3 to achieve a single point ground at the site.

In the response letter dated December 1, 2008, to RAI 08.02-37 (ADAMS Accession No. ML083390401), the applicant provided additional information. The applicant stated as follows: The ground grids for Unit 3, the intermediate switchyard, and the existing North Anna switchyard will be interconnected. Since each of these ground grids either will provide, or is currently designed to provide, adequate grounding for the associated structures and equipment, the interconnection of all of these ground grids will serve to improve the quality of each of the ground grids. Because each structure provides adequate grounding alone in accordance with IEEE standards as provided in ESBWR DCD, Section 8A.1.2, and the capacity is increased by tying together the ground grids into a single grid for the North Anna site, the staff finds that the applicant has adequately addressed switchyard grounding, and therefore the issue is resolved.

The SRP Section 8.2 (III.1.I) identifies the need to address provisions for surge protection and lightning protection. The staff determined that Chapter 8 of the application did not address these issues. On June 13, 2008, the staff issued RAI 08.02-25 (ADAMS Accession No. ML081650433), requesting that the applicant discuss the adequacy of the surge protection and lightning protection of the offsite power system. In the response letter dated July 28, 2008, to RAI 08.02-25 (ADAMS Accession No. ML082170400), the applicant stated as follows: The North Anna switchyard uses surge suppressors on the high and low sides of transformers 1, 2, 3, 5, and 6. The insulation coordination and surge protective devices are applied in conformance with IEEE 1313.2 (2004), "IEEE Guide for the Application of Insulation Coordination," and IEEE C62.22 (2003), "IEEE Guide for Application of Metal Oxide Surge Arresters for Alternating Current Systems." The surge protective devices are maintained according to National Electrical Manufacturers Association requirements and manufacturer's recommendations. A shield wire arrangement is designed for lightning abatement in the switchyard in accordance with IEEE Standard 62.22-2003; IEEE Standard 988-2000, "Guide to Direct Lightning Shielding of Substations;" and "Insulation Coordination for Power Systems," by Andrew R. Hileman. The staff finds that the applicant has provided the appropriate surge and lightning protection in accordance with industry approved standards and such protection is acceptable, therefore this issue is resolved.

Based on the above discussion, the staff finds that the information the applicant provided in response to COL Items 8.2.4-2-A, 8.2.4-6-A, and 8.2.4-7-A conforms to the requirements of GDC 17 and GDC 5.

- NAPS COL 8.2.4-5-A Protective Relaying
- NAPS COL 8.2.4-8-A Switchyard Transformer Protection

The applicant provided additional information in NAPS COL 8.2.4-5-A and 8.2.4-8-A to address COL Items 8.2.4-5-A and 8.2.4-8-A. The applicant added the following, in part, to Section 8.2.1.2.3, "Protective Relaying:"

The 500 kV transmission lines are protected with redundant high-speed relay schemes with re-closing and communication equipment to minimize line outages. The 500 kV switchyard buses have redundant bus differential protection using separate and independent current and control circuits. Generating unit tie-lines and auxiliary transformer underground cable circuits are protected with redundant high-speed relay schemes. Transformers 1, 2, 3, 5, and 6 are protected with sudden pressure relays and differential relays.

Dominion is responsible for engineering, constructing, operating, and maintaining its electric transmission system, and for interfacing with PJM, the Regional Transmission Organization (RTO). Dominion's responsibility includes designing, maintaining, and operating all switchyard protective relaying associated with connecting Unit 3 to the North Anna switchyard. PJM studied the interconnection of Unit 3 to the North Anna switchyard and recommended no additional design requirements above those typically used by Dominion in the design of the protective relaying scheme at the switchyard.

The 500 kV circuit breakers are equipped with dual trip coils. Each redundant protection circuit that supplies a trip signal is powered from its redundant DC power load group and connected to a separate trip coil. Equipment and cabling associated with each redundant system is physically separated from its redundant counterpart. Breakers are provided with a breaker failure scheme that isolates a breaker that fails to trip due to a malfunction.

The IEEE Standard 141, "Electrical Power Distribution for Industrial Plants," and Standard 242, "Protection and Coordination of Industrial and Commercial Power System," address the provision of sudden pressure relay and ground fault protection for transformers. On June 13, 2008, the staff issued RAI 08.02-6 (ADAMS Accession No. ML081650433), requesting that the applicant discuss the provision for such transformer protection. In addition, the staff asked the applicant to discuss the monitoring schemes it implements for detection of ground faults in the system if the transformer neutrals are high-resistance grounded.

In the response letter dated July 28, 2008, to RAI 08.02-6 (ADAMS Accession No. ML082170400), the applicant stated as follows: Transformers 1, 2, 3, 5, and 6 in the North Anna switchyard are protected by sudden pressure relays. Transformers 1 and 2 have solid grounds on their 500 kV, wye connected windings. The 34.5 kV, delta connected windings have zigzag transformers connected on the bus, which creates a ground source. This ground source is monitored by relays for ground fault detection. Differential relays applied across these transformers also provide ground fault protection. Since transformers 3, 5, and 6 have no tertiary winding, differential relays provide ground fault protection. The staff finds that the applicant had provided adequate fault protection to the switchyard transformers in accordance with industry IEEE standards and Dominion Engineering controls and practices and the proposed fault protection is therefore acceptable.

In addition the staff determined that the applicant did not identify transformers 1, 2, 3, 5, and 6 in the North Anna 3 site-specific Figure 8.2-201. Therefore, on October 16, 2008, the staff issued RAI 08.02-30 (ADAMS Accession No. ML082900201), requesting the applicant to revise or supplement Figure 8.2-201 accordingly. In the response letter dated December 1, 2008 to RAI 08.02-30 (ADAMS Accession No. ML083390401), the applicant stated that it will revise FSAR Figure 8.2-201 to identify transformers 1, 2, 3, 5, and 6. The staff finds the applicant's

response acceptable, and the issue is resolved. The staff confirmed that these changes have been incorporated into the North Anna 3 FSAR Revision 8.

The DCD Revision 4, Section 8.2.4, item 8.2.4-5-A, notes that the COL applicant is responsible for switchyard protective relaying and will ensure that such relaying is coordinated, reviewed, and accepted by the applicable grid reliability organization. On June 13, 2008, the staff issued RAI 08.02-7 (ADAMS Accession No. ML081650433), requesting that the applicant discuss how it will accomplish such coordination, review, and acceptance. In the response letter dated July 28, 2008 to RAI 08.02-7 (ADAMS Accession No. ML082170400), the applicant stated as follows: Dominion is responsible for engineering, constructing, operating, and maintaining the electric transmission system and interfacing with the RTO, PJM. This responsibility includes the design, maintenance, and operation of the switchyard protective relaying associated with the interconnection of Unit 3 to the North Anna switchyard. PJM studied the interconnection of Unit 3 to the North Anna switchyard and recommended no additional design features or functions above those typically used by Dominion in the design of the protective relaying scheme at the switchyard. The staff in its review determined that the applicant has applied industry practice as well as its standard Dominion industrial maintenance program for the North Anna site switchyard therefore this issue is resolved.

For the reasons set forth above, the staff finds that the information the applicant provided in response to COL Items 8.2.4-5-A and 8.2.4-8-A conforms to the requirements of GDC 17.

- NAPS COL 8.2.4-9-A — Stability and Reliability of the Offsite Transmission Power System
- NAPS COL 8.2.4-10-A — Interface Requirements

The applicant provided additional information in NAPS COL 8.2.4-9-A and 8.2.4-10-A to address COL Items 8.2.4-9-A and 8.2.4-10-A. The applicant replaced DCD Section 8.2.2.1, “Reliability and Stability Analysis,” with the following:

> A system impact study was performed to assess the effects of interconnection of the 1933 MVA ESBWR on the transmission system in the areas of load flow, import/export capability, short circuit analysis, system stability, and voltage sensitivity. (Reference 8.2-201) The study was prepared using the 2013 summer light load base case and the 2013 summer peak load case projections. The analysis was performed using Power Technology International Software PSS/E for load flow, import/export capability and stability evaluation, and ASPEN One-liner for short circuit evaluation.

The applicant stated that grid availability in the region over the past 20 years was examined and it was confirmed that the system has been highly reliable with minimal outages due to equipment failures.

On June 13, 2008 the staff issued RAI 08.02-10, (ADAMS Accession No. ML081650433), requesting the applicant to clarify whether the analysis addressed multiple facility contingencies (e.g., did the analysis included tripping of all three nuclear units). In the response letter dated July 28, 2008, to RAI 08.02-10 (ADAMS Accession No. ML082170400), the applicant stated that it performed the grid stability analysis in accordance with NERC criteria and subsequently included a case for loss of all generating units at a single station in the latest SIS for PJM

Generator Interconnection (North Anna 3) dated September 2013 that does include an evaluation for all three generating units tripping at North Anna. On October 16, 2008, the staff issued RAI 08.02-31 (ADAMS Accession No. ML082900201), requesting the applicant provide a discussion (including failure mode and effect analysis) of why it believes that an event similar to that at Palo Verde that occurred on June 14, 2004, will not cause the loss of three units at North Anna Station, or if such an event occurs, why it will not impact grid stability.

In the response letter dated December 1, 2008 to RAI 08.02-31 (ADAMS Accession No. ML083390401), the applicant stated as follows: The applicant had reviewed the description of the Palo Verde event in NRC IN 2005-15, "Three-Unit Trip and Loss of Offsite Power at Palo Verde Nuclear Generating Station," dated June 1, 2005. As a result of its review of IN 2005-15, Dominion implemented certain modifications to the protective scheme within the 230 kV portion of the North Anna switchyard. The 500 kV portion of the North Anna switchyard and its connecting substations has circuit breakers with dual trip coils and dual control circuits. The 230 kV portion of the North Anna switchyard and its connecting substation has circuit breakers with single trip coils and single control circuits. The circuit protection scheme at the 230 kV transmission level uses overlapping zones of protection and relies on communications that span the transmission lines from substation to switchyard. If a fault occurs on the 230 kV line at the first remote substation from the North Anna switchyard and the remote substation breaker fails to open, a transfer trip signal will be sent to open the North Anna breaker. This same logic is true for a fault on the 230 kV line near the North Anna switchyard. Also, if a fault occurs on the 230 kV line at North Anna that is not immediately cleared because of breaker failure to operate, trip signals will be generated to open breakers in expanding zones of protection until the fault is cleared. If necessary, the 500 kV breakers will open to isolate the 230 kV portion of the switchyard. At this level, the breakers have dual trip coils and dual control circuits. Since North Anna 1 and 2 interconnect at the 500 kV level, and since Unit 3 is proposed to interconnect at the 500 kV level, the generating units are ultimately protected by equipment that uses dual trip coils and dual control circuits, thus limiting the possibility of an event similar to the Palo Verde event. The staff finds the applicant's response includes a protective breaker and a half scheme that would appropriately isolate a transmission system fault preventing a multi-unit trip like the Palo Verde event and therefore the staff finds the North Anna protective scheme acceptable.

The FSAR Revision 1, Section 8.2.2.1, stated that the stability analysis did not consider the 34.5 kV portion of the North Anna switchyard. The staff review identified the station auxiliary loads for all three units to be substantial. Accordingly, on June 13, 2008, the staff issued RAI 08.02-11 (ADAMS Accession No. ML081650433), requesting the applicant to provide the basis, and identify the connected total station auxiliary loads (of all three units), for excluding analysis of the 34.5 kV portion of the switchyard. In the response letter dated July 28, 2008, to RAI 08.02-11 (ADAMS Accession No. ML082170400), the applicant stated as follows: The stability analysis discussed in the FSAR is an angular stability analysis that verifies stability of the transmission system when exposed to loss of selected transmission and generation assets. This study is performed at the transmission voltage level and would therefore exclude loads operating at distribution voltage levels of 34.5 kV as they have limited ability to cause angular stability difficulties at the transmission level. This is the standard method for performing angular stability by Dominion and PJM.

On October 16, 2008 the staff issued RAI 08.02-32 (ADAMS Accession No. ML082900201), requesting the applicant to quantify the 34.5 kV distribution loads (MW/MVA) in terms of the total load modeled for the 500 kV transmission system. In addition, the staff asked the applicant to explain the reason for its belief that the distribution loads have limited ability to affect the grid

stability. In the response letter dated December 1, 2008 to RAI 08.02-32 (ADAMS Accession No. ML083390401), the applicant stated as follows: In the North Anna switchyard, the 34.5 kV buses are fed from either the 500 kV switchyard or the 230 kV switchyard. Each of the 34.5 kV buses serves plant auxiliary loads associated with Units 1 and 2 only. There is no generation source connected to the 34.5 kV buses. The study did not explicitly model the 34.5 kV buses in the North Anna switchyard, but it did include the plant auxiliary loads on each of these buses at the 500 kV level. The applicant stated that it will revise FSAR Section 8.2.2.1 to indicate that the 34.5 kV loads are considered at the 500 kV level. Because the total load represented by plant auxiliaries was included in the analysis of the 500 kV system, and the staff verified that FSAR Revision 8 reflects this fact, therefore, the staff finds the applicant's response acceptable. The staff confirmed that these changes are incorporated in FSAR Revision 8, and the issue is resolved.

FSAR Section 8.2.2.1 states that an examination of grid availability in the region over the past 20 years confirmed that the system has been highly reliable with minimal outages resulting from equipment failure. On June 13, 2008 the staff issued RAI 08.02-12 (ADAMS Accession No. ML081650433), requesting the applicant to provide supporting information for this statement to include the frequency, duration, and causes of outages over the past 20 years for both the transmission system accepting the unit's output and the transmission system providing the preferred power for the unit's load. In the response letter dated July 28, 2008 to RAI 08.02-12 (ADAMS Accession No. ML082170400), the applicant stated that Dominion has reviewed equipment failure history for the period from 1988 to 2008. The applicant indicated further that major types of equipment that can affect the reliability of the North Anna switchyard are transmission lines, transformers, and specific circuit breakers within the switchyard. The applicant concluded that the switchyard has experienced relatively few equipment lockouts because of equipment failure and the equipment lockouts have been limited to individual pieces of equipment. In view of this the information, the staff determined that the North Anna switchyard and local transmission system has been reliable and has not experienced a complete loss of power in the past 20 years. Accordingly, the applicant has shown that the grid as well as the switchyard has been reliable with few cases of equipment failures, therefore, this issue is resolved.

FSAR Revision 1, Section 8.2.2.1 states:

> Upon approaching or exceeding a [maximum, minimum, or degraded switchyard voltage] limit, these procedures verify availability of required and contingency equipment and materials, direct notifications to outside agencies and address unit technical specifications (TS) actions until the normal voltage schedule can be maintained."

On June 13, 2008, the staff issued RAI 08.02-13 (ADAMS Accession No. ML081650433), requesting the applicant to clarify the reference to North Anna 3 TS in this statement. In the response letter dated July 28, 2008, to RAI 08.02-13 (ADAMS Accession No. ML082170400), the applicant stated as follows: The operating procedures for controlling the normal voltage schedule for existing Units 1 and 2 reference the associated Unit 1 and 2 TS for the offsite power system. Unit 3 will implement similar operating procedures to maintain the switchyard voltage schedule and address challenges to the maximum and minimum limits. However, the Unit 3 procedures will not reference any TS for offsite power, because they are not required. Therefore, Dominion will revise the FSAR Section 8.2.2.1 discussion of the operating procedures to delete the reference to the TS. The ESBWR passive reactor design used at

North Anna 3 does not require an offsite or diesel-generated ac source of power for 72 hours after an abnormal event, and the switchyard as well as any off-site power system is not safety related. However the ESBWR DCD prescribes periodic inspection and testing of the nonsafety-related offsite and onsite ac systems that supply ac power to the isolation power centers. Therefore, by implementing procedures to maintain the switchyard voltage schedule as done for the existing Units 1 and 2, the staff finds that the applicant has adequately addressed the issue of maintaining the switchyard limits. The staff confirmed that these changes are incorporated in FSAR Revision 8, and the issue is resolved.

On June 13, 2008, the staff issued RAI 08.02-14 (ADAMS Accession No. ML081650433), requesting the applicant to provide the basis for using 2011 summer light-load and 2014 summer base-case projections rather than the summer heavy-load projections. The staff also asked the applicant to clarify whether the summer loads bound winter peak loads. In the response letter dated July 28, 2008 to RAI 08.02-14 (ADAMS Accession No. ML082170400), the applicant indicated as follows: Load flow analysis and the import/export study portion of the SIS was based on data projected for the timeframe corresponding to Dominion's requested interconnection date of April 2014. The 2014 summer base case was used because it is considered to be the peak load for the transmission system affected and envelops the peak winter load. The stability study portion of the SIS uses a lighter load to identify any problems with angular stability of the system. Dominion submitted the stability study request to the RTO in 2006. The RTO uses a 5-year horizon for its studies; therefore, the 2011 summer case was selected for the stability study. After 2011, the RTO will perform annual baseline analyses to update the Regional Transmission Expansion Plan and identify potential reliability problems. The applicant includes in Part 10, "ITAAC" Table 2.4.8-1 of the COLA specific analyses to confirm these offsite interfaces would remain current for North Anna 3 prior to plant operation. As described above, the staff accepted the applicant's response, and this issue is resolved.

On June 13, 2008 the staff issued RAI 08.02-15 (ADAMS Accession No. ML081650433), requesting the applicant to identify the maximum and minimum grid frequency. Additionally, the staff asked the applicant to discuss how the auxiliary power system studies consider the combined effect of frequency and voltage variation on the operation of safety-related loads (safety-related battery chargers and safety-related UPS) and other running motor loads. In the response letter dated July 28, 2008 to RAI 08.02-15 (ADAMS Accession No. ML082170400), the applicant stated that the potential maximum and minimum grid frequency can be 62 hertz (Hz) to 57.5 Hz with the time restrictions for PJM generators. Generators and their protective systems must be capable of operating at a frequency of 57.5 Hz for 5 seconds or longer, or 58.0 Hz for 30 seconds or longer, to coordinate with system preservation under-frequency load shedding. Additionally, generators and their protective systems must be capable of operation at over frequency up to 62 Hz for a limited duration. These limits are included to increase system reliability as well as set protections for individual generators. The applicant stated further that the auxiliary power system studies conducted by GEH consider the combined effect of frequency and voltage variations on the safety-related loads and other motor loads. The isolation power centers supply power to safety-related loads of their respective division. These loads consist of the safety-related battery chargers or rectifiers as discussed in Section 8.3.1.1.2 and 8.3.1.1.3 of the ESBWR DCD. Isolation power centers are protected against degraded voltage and frequency conditions by way of voltage and frequency relays installed in each isolation power center to provide alarms and facilitate isolation power center bus isolation and transfer functions as described in ESBWR DCD Section 8.3.1.1.2. The staff accepted the applicant's response, and this issue is resolved.

The FSAR Revision 1, Chapter 1, Table 1.9-201, "Conformance with Standard Review Plan," for SRP Section 8.2 indicated that North Anna 3 satisfies the requirements of 10 CFR 50.65, "Maintenance Rule". However, the staff review of North Anna 3 FSAR Chapter 8 found no discussion of 10 CFR 50.65. On June 13, 2008, the staff issued RAI 08.02-19 (ADAMS Accession No. ML081650433), requesting the applicant to clarify compliance with the requirements of 10 CFR 50.65(a)(4). In the response letter dated July 28, 2008, to RAI 08.02-19 (ADAMS Accession No. ML082170400), the applicant stated as follows: North Anna 3 complies with the requirements of 10 CFR 50.65(a)(4). In particular, the subject regulation is one aspect of the "Maintenance Rule" (10 CFR 50.65), an operational program. Item 17 in FSAR Table 13.4-201 addresses the implementation of the program, and FSAR Section 17.6 discusses its content.

However, the staff requested that the applicant address the applicability of the Maintenance Rule to switchyard equipment. Accordingly, on October 16, 2008, the staff issued RAI 08.02-36 (ADAMS Accession No. ML082900201), requesting the applicant to address the applicability of the Maintenance Rule to switchyard components, discuss actions to limit the risk associated with transmission system degradation, and discuss actions planned before performing "grid-risk-sensitive" maintenance activities for switchyard components. In the response letter dated December 1, 2008 to RAI 08.02-36 (ADAMS Accession No. ML083390401), the applicant stated as follows: Maintenance Rule Program implementation incorporates by reference Nuclear Energy Institute (NEI) Technical Report 07-02A, "Generic FSAR Template Guidance for Maintenance Rule Program Description for Plants Licensed Under 10 CFR Part 52." The scope of SSCs covered by the Maintenance Rule Program is determined using the scoping procedure defined in the program description in NEI 07-02A. The offsite power system and its components will be evaluated for inclusion in the Maintenance Rule Program in accordance with these scoping procedures during program implementation. NEI 07-02A, Section 17.X.1.5, addresses risk assessment and risk management pursuant to 10 CFR 50.65(a)(4) and considers the issues associated with grid and offsite power system reliability as identified in NRC GL 06-02, items 5 and 6. Therefore, although detailed Maintenance Rule Program development is not anticipated in advance of the schedule defined in Table 13.4-201, performance of grid reliability evaluation as part of the maintenance risk assessment before performing grid-risk-sensitive maintenance activities (such as surveillances, post maintenance testing, and preventive and corrective maintenance) is considered a necessary part of the program in accordance with NEI 07-02A guidance. Since North Anna 3 will implement the Maintenance Rule in accordance with NRC endorsed NEI 07-02A guidance, the staff finds the applicant has provided in its COLA an acceptable plan to implement the Maintenance Rule, and the issue is resolved.

The DCD Revision 10, Section 8.2.3, states that a transmission system reliability and stability review of the site-specific configuration to which the plant is connected will be performed to determine the reliability of the offsite power system and verify that it is consistent with the analysis of Chapter 19. On June 13, 2008, the staff issued RAI 08.02-23 (ADAMS Accession No. ML081650433), requesting the applicant to clarify the manner in which the reliability of the offsite power system is verified to be consistent with the analysis of Chapter 19. In the response letter dated July 28, 2008, to RAI 08.02-23 (ADAMS Accession No. ML082170400), the applicant stated as follows: The ESBWR probabilistic risk assessment (PRA) used site-specific PRA information from the North Anna site to develop PRA parameters for loss of preferred power (LOPP) frequency. The LOPP frequency is divided into plant-centered, switchyard, grid-related, and weather-related initiating events. ESBWR LOPP frequencies are based on NUREG/CR-6890, "Reevaluation of Station Blackout Risk at Nuclear Power Plants, Analysis of Loss of Offsite Power Events: 1986–2004," issued November 2005. The North

Anna LOPP frequencies were compared to the ESBWR frequencies to identify any outliers. The data show that grid-related losses of power are significantly more frequent than plant-centered, switchyard, or weather-related losses of power. There is a variance in the values for the LOPP frequencies, but their range is acceptable because the change in core damage frequency by using the highest frequency is less than $1x10^{-10}$ per year. Furthermore, the conclusions in DCD Tier 2, Section 19.2.3.1, "Risk from Internal Events," remain valid for the minor variances in LOPP frequencies. Therefore, the ESBWR PRA provides a reasonable representation of the parameters and conditions that are specific to the North Anna site. Additionally, the SIS has identified the transmission facility upgrades necessary to ensure that reliability is not reduced below the set standards. Finally, when the upgrades are made, the reliability of the offsite power system will be consistent with the analysis of Chapter 19, because the applicant is required to be in conformance with the change in core damage frequency as specified in Chapter 19 of the ESBWR DCD related to the switchyard risk, therefore the staff accepted the applicant's response, and this issue is resolved.

FSAR Section 8.2.2.1, "Reliability and Stability Analysis," NAPS COL 8.2.4-9-A, identified maximum and minimum switchyard voltage limits of 534 kV and 505 kV. On July 9, 2008 the staff issued RAI 08.02-27 (ADAMS Accession No. ML081910316), requesting the applicant to explain how these limits were established and confirm that these voltage limits are acceptable for auxiliary power system equipment operation, including safety-related battery chargers and safety-related UPS during different operating conditions. The staff requested that the confirmation include assumptions, acceptance criteria, and summary of results for the following: 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. The staff also requested a separate set of calculations for each available connection to offsite power supply. In addition, the applicant was requested to discuss how the results of the calculations will be verified.

On August 21, 2008 (ADAMS Accession No. ML083470290), the applicant stated that Dominion would submit its response at a later date. On November 19, 2008 (ADAMS Accession No. ML083260325), the applicant indicated as follows: The North Anna 500 kV switchyard voltage limits of 540 kV and 505 kV were established for the operation of Units 1 and 2. Furthermore, the DCD does not then include limits for voltage and frequency variation that need to be met by site-specific offsite power systems. Analyses of the as-built onsite power system will be performed to determine the maximum load during design-basis operating modes. These analyses will, in part, specify credited power, voltage, frequency, and interrupting capability necessary for the offsite power system to support safety-related load operation during design-basis operating modes. These analyses will be accomplished as part of a site-specific ITAAC (see Section 14.3 of this SER) and will ensure that each as-built offsite circuit has sufficient capacity and capability.

On March 18, 2009 (ADAMS Accession No. ML090790310), the applicant stated that the effect of a North Anna 3 trip on the switchyard voltage and frequency limits is addressed as a part of the ITAAC process (see Section 14.3 of this SER). The North Anna 3 COL ITAAC require verification that the offsite portion of the preferred power system has the capability to provide voltage and frequency sufficient to meet the voltage and frequency determined as part of completing DCD ITAAC Table 2.13.1-2, Item 9. The staff finds that the applicant will adequately address the issue of North Anna 3 generator trip on the North Anna site switchyard in its analysis as part of ITAAC prior to plant operation. Therefore the issue is resolved.

For the reasons set forth above, the staff finds that the information the applicant provided in response to COL Items 8.2.4-9-A and 8.2.4-10-A, and as discussed above, conforms to the guidance of RG 1.206; BTP 8-3; BTP 8-6; RG 1.160, and therefore the design complies with the requirements of 10 CFR 50.65 and GDC 17 in this regard.

- NAPS SUP 8.2-1 Monitoring of Transformers for Open Circuit (Bulletin 2012-01)

The applicant has incorporated by reference the ESBWR design for open phase protection described in in ESBWR DCD, Revision 10, Section 8.2.1.2.2 (see Bulletin 2012-01 for discussion of open phase conditions). Operator actions and training are addressed in procedures, as described in North Anna 3 FSAR Section 13.2 and 13.5. Analysis and testing of the monitoring system are performed to determine set points and to verify proper monitoring system functionality. The applicant as well will develop training and procedures for the operations and maintenance staff to support this protection system throughout the plant lifetime. The applicant has also incorporated the following into North Anna COL FSAR Section 8.2.1.2.2 of the FSAR:

> Plant operating procedures associated with the monitoring system, including off-normal operating procedures, will be developed in accordance with Section 13.5.2.1 at least six months prior to fuel load.
>
> Maintenance and testing procedures associated with the monitoring system, including calibration and setpoint determination procedures will be developed in accordance with Section 13.5.2.2.6.1 prior to fuel load.
>
> Control Room operator and maintenance technician training associated with the operation and maintenance of the monitoring system will be developed in accordance with Section 13.2.1 for reactor operators and Section 13.2.2 for non-licensed plant staff. Training will be completed prior to fuel load.

The staff has reviewed the above Dominion FSAR training and procedures associated with the monitoring system for single phase faults, and, for the reasons set forth in Sections 13.2 and 13.5 of this SER, finds them to be acceptable for implementing the monitoring system for open phase faults described in the ESBWR DCD. Therefore the staff finds that the North Anna 3 training and procedures associated with the design for addressing the concerns presented in Bulletin 2012-01 are acceptable.

- NAPS SUP 8.2-2 Testing and Inspection

The applicant provided a new Section 8.2.1.2.4, “Testing and Inspection,” as NAPS SUP 8.2-2 with the following addition:

> Transmission lines are inspected via an aerial inspection program approximately twice per year. The inspection focuses on such items as right-of-way encroachment, vegetation management, conductor and line hardware condition, and the condition of supporting structures. Routine switchyard inspection activities include, but are not necessarily limited to, the following:
>
> - Daily transformer inspections

- Periodic inspections of circuit breakers and batteries
- Quarterly infrared scans
- Semi-annual infrared scans (relay panels)
- Semi-annual inspection of substation equipment
- Annual infrared scans
- Annual corona camera scan

Routine switchyard testing activities include, but are not necessarily limited to, the following:

- Transformers – dissolved gas analysis every 5 months
- Electromechanical Relay testing (500 kV) –every 2 years
- Electromechanical Relay testing (230 kV) – every 3 years
- Microprocessor Relay testing (500 kV and 230 kV) – every 4 years
- Transformer Load Tap Changers – dissolved gas analysis every
- Battery Discharge testing – every 5 years
- Circuit Breakers – maintenance and inspection every 6 years
- [Current Transformer] CT maintenance – every 6 years
- Disconnect Switches (line zone) – maintenance and inspection every 6 years
- Ground Grid testing – every 8 years
- Disconnect Switches (bus zone) – maintenance and inspection every 10 years
- [Potential Transformer] PT testing – every 10 years
- [Capacitive Voltage Transformer] CCVT testing – every 10 years
- Arrester testing (bus zone) – every 10 years
- Wave Trap testing – every 12 years

On June 13, 2008, the staff issued RAI 08.02-8 (ADAMS Accession No. ML081650433), requesting the applicant to address the industry (Federal Energy Regulatory Commission, NERC, and IEEE) standards that will be followed for switchyard protection system, monitoring, maintenance, and testing. The staff also asked the applicant to confirm that generator circuit breakers will meet IEEE Standard C37.013, "Standard for AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current." In the response letter dated July 28, 2008 to RAI 08.02-8 (ADAMS Accession No. ML082170400), the applicant stated as follows: Monitoring, maintenance, and testing of the switchyard protection system are performed under NERC Standard PRC-005-1, "Transmission and Generation Protection System Maintenance and Testing"; Standard PRC-008-0, "Underfrequency Load Shedding Equipment Maintenance Program"; and Standard PRC-017-0, "Special Protection System Maintenance and Testing." IEEE C37.013 was written specifically for high-current circuit breakers installed between generators and transformer terminals. The proposed Unit 3 at North Anna places the circuit breaker on the high side terminals of the generator step-up transformers. Thus, IEEE C37.013 does not directly apply to the ESBWR standard design, however IEEE C37.010 does apply to the ESBWR generator breaker configuration and is referenced in ESBWR DCD, Section 8.3.1.1 for breaker sizing and design.

The applicant stated that it will revise FSAR Section 8.2.1.2.3 to include the above NERC standards for monitoring, maintenance, and testing of the switchyard protection system. The staff finds that the applicant's commitment to these industry standards acceptable such that switchyard components (but not transformers) will be adequately tested and maintained. The staff confirmed that these changes are incorporated in FSAR Revision 8, and the issue is resolved.

On June 13, 2008, the staff issued RAI 08.02-9 (ADAMS Accession No. ML081650433), requesting the applicant to include transformer testing as part of the overall routine switchyard component testing. In the response letter dated July 28, 2008 to RAI 08.02-9 (ADAMS Accession No. ML082170400), the applicant stated as follows: North Anna switchyard transformers have dissolved gas analysis performed every 6 months. Additionally, if the transformer has a load tap changer (LTC), the dissolved gas analysis is performed on the LTC every 4 years. Infrared scans are performed quarterly on transformers. FSAR Section 8.2.1.2.3 will be revised to indicate that semiannual dissolved gas analysis on transformers and 4-year dissolved gas analysis on LTC will be conducted. The staff confirmed that these changes are incorporated in FSAR Revision 8, in FSAR Section 8.2.1.2.4 and that the testing provided provides increased reliability to these electrical systems. Accordingly, the staff finds that the applicant addressed the issue of testing the non-Class 1E electrical system adequately.

Based on the foregoing, the staff concludes that the information in NAPS SUP 8.2-2, which provides for testing and inspection of off-site electrical components and conforms with the guidance of RG 1.118 and therefore meets the requirements of GDC 18 as described in the ESBWR DCD.

- NAPS SUP 8.2-3 Failure Mode and Effects Analysis

The applicant provided Section 8.2.2.3, "Failure Modes and Effects Analysis," as NAPS SUP 8.2-3 with the following, in part, addition:

> Unit 3 is connected to the Dominion transmission system via four 500 kV and one 230 kV overhead transmission lines. Each transmission line occupies a separate right-of-way, except the two parallel Ladysmith lines, which share the same right- of-way. Failure of any one tower due to structural failure can at most disrupt and cause a loss of power distribution to itself and the adjacent line. Failure of a line conductor would cause the loss of one of the four 500 kV lines, with the other three lines remaining available as normal and alternate preferred power sources.
>
> A breaker-and-a-half scheme is incorporated in the design of the switchyard. This arrangement offers the following flexibility to control a failed condition within the switchyard.
>
> - Any faulted transmission line into the switchyard can be isolated without affecting any other transmission line.
> - Either bus can be isolated without interruption of any transmission line or other bus.
> - Relay schemes used for protection of the offsite power circuits and switchyard equipment include primary and backup protection features. All breakers are equipped with dual trip coils. Each protection circuit that supplies a trip signal is connected to a separate trip coil.

According to the applicant, the failure of any component within the intermediate switchyard may disrupt the normal preferred power supply. However, the alternate preferred power supply will remain available to supply the load.

On the basis of its review, the staff determined that Dominion, in its failure mode and effects analysis, showed that is unlikely that any individual switchyard component failure would prevent the North Anna 3 offsite power system from performing its function to provide normal or alternate power to Unit 3, and therefore the switchyard design meets the guidance of RG 1.206. Therefore, as described above, the North Anna 3 switchyard design meets the requirements of GDC 17 for providing two separate and redundant off-site sources of power, which provides additional reliability to its safety system functions.

8.2.5 Post Combined License Activities

There are no post COLA activities related to this section.

8.2.6 Conclusion

The staff reviewed the application and checked the referenced DCD. The staff finds that the application includes all the information relevant to this section, and the staff confirmed that no outstanding information related to this section remains to be addressed in the COL FSAR. The results of the staff's technical evaluation of the information incorporated by reference in the North Anna 3 COLA are documented in NUREG–1966, and NUREG–1966, Supplement 1.

In addition, the staff has compared the additional COLA and supplemental information within the application for this section to the relevant NRC regulations, guidance in SRP Section 8.2 and other NRC RGs. For the reasons set forth above, the applicant has adequately addressed COL Information Items NAPS COL 8.2.4-1-A through 8.2.4-10-A involving the design details of the plant site switchyard and its interface with the local transmission grid and NAPS SUP 8.2-1, 8.2-2 and 8.2-3 involving monitoring of transformers for open phase(s), testing and inspection of switchyard components and failure modes and effects analysis. Accordingly, the staff concludes that the application meets the requirements of GDC 17 and 18 and 10 CFR 50.65 in regard to offsite power.

8.3 Onsite Power Systems

8.3.1 AC Power System

8.3.1.1 Introduction

This section of the COL FSAR provides descriptive information, analyses, and referenced documents that include the applicant's information on electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the onsite ac power system. The onsite ac power system includes those standby power sources, distribution systems, and auxiliary support systems that supply power to safety-related equipment or equipment important to safety, for all normal operating, anticipated operational occurrences (AOO), and accident conditions.

In the North Anna 3 ESBWR passive reactor design, the onsite ac power system consists of power supplied to the plant from two independent offsite power sources, the "Normal Preferred" power source and the "Alternate Preferred" power source. The on-site ac system consists of safety-related and nonsafety-related power systems. Two nonsafety-related ancillary diesel

generators are capable of supplying power to the ancillary buses when no other sources of ac power are available. There are four independent safety-related dc divisions to provide power for the safety-related loads discussed in more detail in the next section of this SER.

The onsite power system is divided into two medium voltage power levels of 13.8 kV and 6.9 kV for operational flexibility of the plant nonsafety-related non-Class 1E systems that provide reliable ac power to the various electrical loads. These non-Class 1E nonsafety systems do not perform any safety-related functions or provide a risk-important, nonsafety-related active systems function. These redundant non safety capabilities enhance plant system reliability in normal or abnormal plant operational conditions. Plant 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. Those portions of the onsite ac power systems that are not related to safety are described only in sufficient detail to permit an understanding of their interactions with the safety-related portions.

The plant's UPS system (120 V of ac vital power) comprises independent Class 1E and non-Class 1E UPS systems. Each system consists of rectifiers, inverters, ungrounded batteries, and distribution panels. The Class 1E UPS system provides reliable power for the safety-related equipment, including the plant instrumentation, control, monitoring, and other systems that perform vital functions needed to shut down the plant. In addition, the Class 1E UPS system provides power to the emergency lighting in the main control room and the remote shutdown area.

8.3.1.2 Summary of Application

Section 8.3 of the North Anna 3 COL FSAR, Revision 8, incorporates by reference Section 8.3 of the ESBWR DCD, Revision 10. Section 8.3 of the ESBWR DCD includes Section 8.3.1, "AC Power Systems," which addresses SRP Section 8.3.1, "AC Power Systems (Onsite)."

In addition, in FSAR Section 8A,"Miscellaneous Electrical Systems," the applicant provided the following information:

COL Items

- NAPS COL 8A.2.3-1-A Cathodic Protection System

The applicant provided additional information regarding a cathodic protection system to address NAPS COL 8A.2.3-1-A.

Supplemental Information

- NAPS SUP 8.3-1 Onsite Power Description

In FSAR Section 8.3.1.1, "Description," the applicant provided information describing an intermediate switchyard to transition offsite power from the NAPS switchyard.

8.3.1.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, the FSER related to the ESBWR DCD and NUREG–1966, Supplement 1, FSER related to the Certification

of the ESBWR Standard Design, Supplement 1. In addition, the relevant requirements of the Commission regulations for the offsite power system and the associated acceptance criteria are in SRP Section 8.3.1," AC Power Systems (Onsite)."

In addition, the NRC requirements governing the COL supplemental information are in GDC 17.

8.3.1.4 Technical Evaluation

As documented in NUREG–1966, the staff reviewed and approved Section 8.3.1 and Appendix 8A of the certified ESBWR DCD. The staff reviewed Section 8.3.1 and Appendix 8A of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COLA represent the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and incorporated by reference includes all the information necessary for the review of ac power systems (onsite).

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

COL Item

- NAPS COL 8A.2.3-1-A Cathodic Protection System

The applicant provided additional information in NAPS COL 8A.2.3-1-A. The applicant stated that a cathodic protection system is provided, as required, and that the system is designed in accordance with the standards of the National Association of Corrosion Engineers.

The staff finds that the applicant has adequately addressed the COL item.

Supplemental Information

- NAPS SUP 8.3-1 Onsite Power Description

The applicant provided the following supplemental information to modify Section 8.3.1.1, "Description":

> An intermediate switchyard is utilized to transition off-site power from the NAPS switchyard to the Unit 3 main power transformers, and unit auxiliary transformers (UATs). This intermediate switchyard contains the main generator circuit breaker, and a supply circuit breaker, which provides power to 500/230 kV intermediate transformers used to supply power to the UATs. These intermediate transformers consist of three single phase transformers and include an installed spare transformer. Also included in the intermediate switchyard is a transmission tower which supports a 500 kV disconnect switch that is identified as the point of interconnection between the onsite power sources and offsite power sources.

The staff finds that the applicant has adequately described the North Anna 3 connection to the utility grid and the connection conforms to the requirements of GDC 17 because the North Anna 3 normal and alternate power supplies would provide sufficient capacity and capability to assure that safety system vital functions are maintained in the event of an AOO or postulated accidents.

8.3.1.5 Post Combined License Activities

There are no post COLA activities related to this chapter.

8.3.1.6 Conclusion

The staff's finding related to information incorporated by reference is in NUREG–1966. The staff reviewed the application and checked the referenced DCD. The staff finds that the application includes all the information relevant to this section, and the staff confirmed that no outstanding information related to this section remains to be addressed in the COL FSAR. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the onsite ac power system that were incorporated by reference have been resolved.

In addition, the staff has compared the additional COL item and supplemental information within the application to the relevant NRC regulations, guidance in SRP Section 8.3.1, and other NRC RGs and, for the reasons discussed above, concludes that the applicant is in compliance with the NRC regulations.

As discussed above, the staff concludes that the applicant has adequately addressed the North Anna 3 COL item involving cathodic protection systems and supplemental information involving the transmission system and its electrical connection to the plant. In conclusion, the staff finds that the applicant has provided sufficient information to satisfy the requirements of GDC 17 for this section.

8.3.2 DC Power Systems

8.3.2.1 Introduction

This section of the COL FSAR provides descriptive information, analyses, and referenced documents that include the applicant's information on electrical single-line diagrams, electrical schematics, logic diagrams, tables, and physical arrangement drawings for the onsite dc power systems. Onsite dc power systems include those power sources and their distribution systems that supply motive or control power to safety-related equipment. The non-safety-related portions are described only in sufficient detail to permit an understanding of their interactions with the safety-related portions. This section clearly identifies the safety loads and states the length of time they would be operable in the event of a loss of ac power.

The plant's 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 the UPS.

The Class 1E dc and UPS system in the ESBWR passive reactor design plant is capable of providing reliable power for the safe shutdown of the plant without the support of battery

chargers, during a loss of all ac power sources coincident with a design-basis accident for 72 hours. The system is designed so that no single failure will result in a condition that will prevent the safe shut down of the plant.

The non-Class 1E dc and UPS system in the ESBWR passive reactor design plant provides continuous and reliable electric power to the plant's non-Class 1E control and instrumentation loads and equipment, which are used for plant operation and investment protection and for the hydrogen igniters located inside containment. Operation of the non-Class 1E dc and UPS system is not required for nuclear safety-related systems.

8.3.2.2 Summary of Application

Section 8.3 of the North Anna 3 COL FSAR, Revision 8, incorporates by reference Section 8.3 of the certified ESBWR DCD, Revision 10. Section 8.3 of the ESBWR DCD includes Section 8.3.2, "DC Power Systems," which addresses SRP Section 8.3.2, "DC Power Systems (Onsite)."

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

COL Items

- NAPS COL 8.3.4-1-A — Safety-Related Battery Float and Equalizing Voltage Values

In FSAR Section 8.3.2.1.1, "Safety-Related Station Batteries and Battery Chargers," the applicant provides information on safety-related battery float and equalizing voltage values. Additionally, the applicant modifies DCD Table 8.3-4 item b.

- NAPS COL 8.3.4-2-A — Underground or inaccessible power and control cable

In FSAR Section 8.3.3.2, "Cables and Raceways" the applicant provides information on accident mitigating functions that are supplied by DC power that is susceptible to protracted exposure to wetted environments.

Supplemental Information

- NAPS SUP 8.3-2 — Safety-Related Station Batteries and Battery Chargers Station Blackout

In FSAR Section 8.3.2.1.1, "Safety-Related Station Batteries and Battery Chargers Station Blackout," the applicant provided information on the training and procedures to mitigate SBO, with references to Sections 13.2 and 13.5 of the FSAR and DCD Section 15.5.5.

8.3.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is in NUREG–1966, the FSER related to the ESBWR DCD and NUREG–1966, Supplement 1, FSER related to the Certification of the ESBWR Standard Design, Supplement 1. In addition, the relevant requirements of the

Commission regulations for the DC power system and the associated acceptance criteria are in SRP Section 8.3.2," DC Power Systems (Onsite)."

In addition, the NRC requirements governing the COL supplemental information are in 10 CFR 50.63, "Loss of All Alternating Current Power." The guidance and acceptance criteria for meeting Section 50.63 are in the guidelines of RG 1.155, "Station Blackout"; and Nuclear Management and Resource Council (NUMARC) 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," issued November 1987, and endorsed by RG 1.155.

8.3.2.4 Technical Evaluation

As documented in NUREG–1966, the staff reviewed and approved Section 8.3.2 of the certified ESBWR DCD. The staff reviewed Section 8.3.2 of the North Anna 3 COL FSAR and checked the referenced DCD to ensure that the combination of the information in the ESBWR DCD and the information in the COL FSAR represents the complete scope of information relating to this review topic.[1] The staff's review confirmed that the information in the application and the information incorporated by reference includes all the information necessary for review of the DC power system.

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

COL Items

- NAPS COL 8.3.4-1-A — Safety-Related Battery Float and Equalizing Voltage Values

The applicant provides additional information to address COL Item 8.3.4-1-A. The applicant replaces the fourth paragraph of DCD Section 8.3.2.1.1 with the following:

> In Divisions 1, 2, 3, and 4, the two 250 volt safety-related batteries per division are sized together so that their total rated capacity will exceed the required battery capacity per division for 72-hour station blackout conditions. The DC system minimum battery terminal voltage at the end of the discharge period is 210 VDC (1.75 volts per cell). The maximum equalizing charge voltage for safety-related batteries is specified by the battery vendor and is as allowed by the voltage rating of the connected loads (UPS inverters). The UPS inverters are designed to supply 120 VAC power with DC input less than the minimum discharge voltage (210 VDC) and greater than the maximum equalizing charge voltage. The safety-related battery float voltage and maximum equalizing charge voltage values are included in Table 8.3-4R.

Additionally, the applicant modifies DCD Table 8.3-4 item b to include float and maximum equalizing charge voltage as follows:

- float voltage at 77°F- 267.6 VDC at the battery terminals
- maximum equalizing charge voltage at 77°F-288 VDC at the battery terminals.

The staff finds that optimum long-term battery performance is obtained by maintaining a float voltage within established design values of 2.22 volts per cell to 2.24 volts per cell provided by

the battery manufacturer, which corresponds to nominally 2.23 volts per cell or 267.6 Vdc at 77°F. This provides adequate over-potential, which limits the formation of lead sulfate and self discharge. Therefore, float voltage of 267.6 Vdc at 77°F is acceptable. Additionally, the maximum equalizing charge voltage of 288 Vdc at the battery terminals is acceptable because the UPS inverters (only connected load on dc bus) are designed to function properly with dc input less than the minimum discharge voltage (210 VDC) and greater than the maximum equalizing charge voltage (288 Vdc).

In view of the forging, the staff finds that the applicant adequately resolved COL Item 8.3.4-1-A and float and maximum equalizing charge voltage values were consistent with battery vendor's recommendation and in conformance with the requirements of GDC 17.

- NAPS COL 8.3.4-2-A — Underground or inaccessible power and control cable

The applicant stated in FSAR Section 8.3.3.2, "Cables and Raceways" that:

> Underground or inaccessible power and control cable runs to the [Plant Service Water System] PSWS and DG Fuel Oil Transfer System that have accident mitigating functions and are susceptible to protracted exposure to wetted environments or submergence as a result of seasonal or weather event water intrusion are adequately identified and monitored for appropriate corrective actions under the Maintenance Rule (MR) program described in Section 17.6.4.

Given that 10 CFR 50.65, "Maintenance Rule," requirements will be applied to these control cables, and the applicant's Maintenance Rule Program is adequate as described in Section 17.6.4 of this SER, these underground power and control cables will be adequately monitored to ensure reliability of these accident mitigating functions and is therefore acceptable.

Supplemental Information

- NAPS SUP 8.3-2 — Safety-Related Station Batteries and Battery Chargers Station Blackout

The applicant provided supplemental information in Section 8.3.2.1.1 of the FSAR for addressing training and procedures to mitigate an SBO event by adding the following at the end of FSAR Section 8.3.2.1.1:

> Training and procedures to mitigate an SBO event are implemented in accordance with Sections 13.2 and 13.5, respectively. As recommended by NUMARC 87-00 (Reference 8.3-201), SBO event mitigation procedures address SBO response (e.g., restoration of on-site standby power sources), 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), as applicable. The ESBWR is a passive design and does not rely on offsite or onsite AC sources of power for at least 72 hours after an SBO event, as described in DCD Section 15.5.5, Station Blackout. In addition, there are no nearby large power sources, such as a gas turbine or black start fossil fuel plant, that can directly connect to the station to mitigate the SBO event. Restoration from an SBO

event will be contingent upon power being made available from any one of the following sources:

- Any of the standby or ancillary diesel generators.
- Restoration of any one of the four 500 kV transmission lines described in Section 8.2.
- Restoration of the 230 kV transmission line described in Section 8.2.

According to NUMARC 87-00, which is endorsed by RG 1.155, the SBO response procedures include (1) SBO response guidelines, (2) ac power restoration, and (3) severe weather guidelines. On June 19, 2008, the staff issued RAI 08.03.02-1 (ADAMS Accession No. ML081710161), in which the staff asked the applicant to confirm that training and procedures cover all three SBO response procedures. In the response letter dated August 4, 2008 to RAI 08.03.02-1 (ADAMS Accession No. ML082200626), the applicant stated that it will revise the FSAR to indicate that procedures will include these three areas. The applicant further stated that licensed and non-licensed plant personnel receive adequate training for responding to all plant events, both normal and abnormal, and such training encompasses an SBO event. The staff finds that the applicant conforms to the guidance of RG 1.155 and therefore meets the requirements of 10 CFR 50.63, contingent on maintaining these procedures and personnel training. Because the detailed training and procedures will not be fully developed until required by license condition, they will be subject to inspection after implementation. Accordingly, the subject RAI is adequately addressed. The staff confirmed that these changes are incorporated in Revision 8 of the FSAR, and the issue is resolved.

In view of the above, the staff finds that NAPS SUP 8.3-2 conforms to the guidance of RG 1.155 and therefore complies with the requirements of 10 CFR 50.63.

8.3.2.5 Post Combined License Activities

There are no post COL activities related to this section.

8.3.2.6 Conclusion

The staff's finding related to information incorporated by reference is in NUREG–1966. The staff reviewed the application and checked the referenced DCD. The staff finds that the application includes all the information relevant to this section, and the staff confirmed that no outstanding information related to this section remains to be addressed in the COL FSAR. Pursuant to 10 CFR 52.63(a)(5) and 10 CFR Part 52, Appendix E, Section VI.B.1, all nuclear safety issues relating to the onsite DC power system that were incorporated by reference have been resolved.

In addition, the staff has compared the supplemental information within the application to the relevant NRC regulations, guidance in SRP Section 8.3.2, and other NRC RGs and, for the reasons discussed above, concludes that the applicant is in compliance with the NRC regulations.

As discussed above, the applicant has adequately addressed North Anna 3 COL supplemental information pertaining to training and procedures to mitigate an SBO event. Accordingly, the staff finds that the applicant has provided sufficient information to satisfy the requirements of 10 CFR 50.63 for this section.

8.4 Station Blackout

The North Anna 3 COL FSAR does not include Section 8.4. Instead, the COL FSAR analyzes SBO in FSAR Section 15.5.5, "Station Blackout." ESBWR DCD, Section 15.5.5 presents the SBO safety analysis. In the North Anna 3 COL FSAR, Revision 8, Section 15.5.5, "Station Blackout," the applicant incorporated by reference Section 15.5.5, "Station Blackout," of the ESBWR DCD, Revision 10, with no departures or supplements. The staff evaluation is set forth in Section 15.5.5 of the staff SER for findings related to information incorporated by reference in NUREG–1966.

References

1. 10 CFR 50.12, "Specific exemptions."

2. 10 CFR 50.63, "Loss of all alternating current power."

3. 10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants."

4. 10 CFR 52.63, "Finality of standard design certification."

5. 10 CFR 52.7, "Specific exemptions."

6. 10 CFR 52.97, "Issuance of combined licenses."

7. 10 CFR 52.98, "Finality of combined licenses; information requests."

8. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

9. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."

10. 10 CFR Part 50, Appendix A, GDC 17, "Electric power systems."

11. 10 CFR Part 50, Appendix A, GDC 18, "Inspection and testing of electric power and protective systems."

12. 10 CFR Part 50, Appendix A, GDC 5, "Sharing of structures, systems, and components."

13. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

14. 10 CFR Part 52, Appendix E, "Design Certification Rule for the ESBWR Design."

15. Dominion Transmission Line Standards, North Anna 3 FSAR Revision-9, June 2016.

16. GEH ESBWR Design Control Document (DCD), Revision 10, April 2014 (ADAMS Accession No. ML14104A929).

17. Hileman, Andrew R., "Insulation Coordination for Power Systems," published by Marcel Dekker, Inc. of New York and Basel, ISBN 0-8247-9957-7, Jun 15, 1999.

18. IEEE Standard 1313.2-1999, "IEEE Guide for the Application of Insulation Coordination."

19. IEEE Standard 141-1986, "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants."

20. IEEE Standard 242-2001, "IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems."

21. IEEE Standard 988-2000, "Guide to Direct Lightning Shielding of Substations."

22. IEEE Standard C37.013, "Standard for AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current."

23. IEEE Standard C62.22-2003, "IEEE Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems."

24. IEEE Standard C62.23-1995, "IEEE Application Guide for Surge Protection of Electric Generating Plants."

25. IEEE Std C37.010-1999, "IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis".

26. IEEE Std C37.013, "Standard for AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current."

27. IEEE Std C57.19.100-1995, "IEEE Guide for Application of Power Apparatus Bushings."

28. NEI 07-02A, "Generic FSAR Template Guidance for Maintenance Rule Program Description for Plants Licensed under 10 CFR Part 52," March 2008. (ADAMS Accession No. ML080910149.)

29. NERC Standard PRC-005-1, "Transmission and Generation Protection System Maintenance and Testing," May 1, 2006.

30. NERC Standard PRC-008-0, "Underfrequency Load Shedding Equipment Maintenance Program," 2005.

31. NERC Standard PRC-017-0, "Special Protection System Maintenance and Testing."

32. North American Electric Reliability Corporation (NERC) Criteria.

33. NRC BL 2012-01, "Design Vulnerability in Electric Power System," (ADAMS Accession No. ML12074A115). NRC BTP 8-3, "Stability of Offsite Power Systems," March 2007. (ADAMS Accession No. ML070710446).

34. NRC BTP 8-6, "Adequacy of Station Electric Distribution System Voltages," March 2007. (ADAMS Accession No. ML070710478).

35. NRC GL 07-01, "Inaccessible or Underground Power Cable Failures That Disable Accident Mitigation Systems or Cause Plant Transients," dated February 7, 2007.

36. NRC GL 2006-02, "Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power," March 30, 2006. (ADAMS Accession No. ML060940432).

37. NRC GL 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients," February 7, 2007. (ADAMS Accession No. ML070360665).

38. NRC IN 2005-15, "Three-Unit Trip and Loss of Offsite Power at Palo Verde Nuclear Generating Station," dated June 1, 2005.

39. NRC IN 95-37, "Inadequate Offsite Power Voltages During Design-Basis Events," dated September 7, 1995.

40. NRC IN 98-07, "Offsite Power Reliability Challenges from Industry Deregulation," dated February 27, 1998.

41. NRC RG 1.118, Revision 3, "Periodic Testing of Electric Power and Protection Systems," April 1995. (ADAMS Accession No. ML003739468).

42. NRC RG 1.155, "Station Blackout," August 1988. (ADAMS Accession No. ML003716792)

43. NRC RG 1.160, Revision 2, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," March 1997. (ADAMS Accession No. ML003761662).

44. NRC RG 1.204 "Guidelines for Lightning Protection of Nuclear Power Plants," November 2005. (ADAMS Accession No. ML052290422).

45. NRC RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," June 2007. (ADAMS Accession No. ML070720184).

46. NRC RG 1.32, Revision 3, "Criteria for Power Systems for Nuclear Power Plants," March 2004. (ADAMS Accession No. ML040680488).

47. NRC Staff NUREG/CR-6890, "Reevaluation of Station Blackout Risk at Nuclear Power Plants, Analysis of Loss of Offsite Power Events: 1986-2004," issued November 2005.

48. NRC Staff NUREG 0800, "Standard Review Plan [SRP] for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," March 2007 (ADAMS Accession No. ML070660036).

49. NRC Staff NUREG-1966, "Final Safety Evaluation Report Related to the Certification of the Economic Simplified Boiling-Water Reactor Standard Design," and its Supplement 1, April 2014 (ADAMS Accession Nos. ML14099A519, ML14099A522, ML14099A532, ML14100A187, ML14100A190, ML14100A194, ML14265A084).

50. NUMARC 87 00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," issued November 1987, and endorsed by RG 1.155.