

## 8 ELECTRIC POWER

This chapter of the safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's review of Chapter 8, "Electric Power," of Tennessee Valley Authority's (TVA's or the applicant's) Construction Permit Application (CPA), Preliminary Safety Analysis Report (PSAR), as supplemented, against applicable regulatory requirements using regulatory guidance and standards to assess the sufficiency of the preliminary information on Chapter 8 for the issuance of a construction permit (CP) in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities." TVA submitted the CPA for a small modular reactor at the Clinch River Nuclear (CRN) Site located in Oak Ridge, Roane County, Tennessee. The PSAR is based on the proposed construction of a one-unit BWRX-300 small modular reactor (hereinafter referred to as CRN-1) designed by GE-Vernova Hitachi Nuclear Energy (GVH) with a nominal electrical output of 300 MWe. As part of this review, the staff evaluated information on Chapter 8, with special attention given to design and operating characteristics, unusual or novel design features, and principal safety considerations. The staff evaluated the preliminary design of the electric power system to ensure the design criteria, design bases, and information relative to construction are sufficient to provide reasonable assurance that the final design will conform to the design basis.

### 8.1.1 Introduction

PSAR Section 8.1, "Introduction," provides an overview of the electrical power systems supporting the BWRX-300 at the CRN Site. This section introduces the main objectives, functional scope, and design philosophy for the offsite and onsite alternating current (AC) and direct current (DC) electrical power systems. PSAR Section 8.1, "Introduction," briefly describes the electrical power systems of the electrical distribution system (EDS) with their safety category functions and discusses the design criteria, regulatory guides, and standards that are applicable to the EDS.

### 8.1.2 Regulatory Evaluation

This section summarizes the regulatory requirements and guidance that form the acceptance criteria for the NRC staff's review of the Clinch River Nuclear Unit 1 (CRN-1) electrical power systems of the EDS, as described in Section 8.1 of the PSAR and supporting supplements.

- Title 10 of the *Code of Federal Regulations* (10 CFR) 50.34, "Contents of applications; technical information," including:
  - 10 CFR 50.34(a)(3)(i) requires the principal design criteria (PDC) for the preliminary design of the facility.
  - 10 CFR 50.34(a)(3)(ii) requires the design bases and the relation of the design bases to the PDC.
  - 10 CFR 50.34(a)(3)(iii) requires "Information relative to materials of construction, general arrangement, and approximate dimensions, sufficient to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety."
  - 10 CFR 50.34(a)(4), which requires "[a] preliminary analysis and evaluation of the design and performance of [SSCs] structures, systems, and components of the facility..."
- 10 CFR 50.35, "Issuance of construction permits."

The applicable guidance for the evaluation of the CRN-1 electrical power systems is as follows:

- DNRL-ISG-2022-01, “Safety Review of Light-Water Power Reactor Construction Permit Applications Interim Staff Guidance,” dated October 2022, provides guidance to all applicants for a construction permit for a light-water power reactor under 10 CFR Part 50.
- NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition” (SRP), Section 8.1, “Electric Power – Introduction,” Rev. 5, identifies the acceptance criteria and guidelines and their applicability to various sections of SRP Chapter 8.

PSAR Section 3.1 states that guidance from Appendix A to Regulatory Guide (RG) 1.232, *Guidance for Developing Principal Design Criteria for Non-Light-Water-Reactors*, is used to inform the development of the CRN-1 PDC.

- RG 1.232, Appendix A, “Advanced Reactor Design Criteria,” (ARDCs) Criterion 17, “Electric power systems,” states:

Electric power systems shall be provided when required to permit functioning of structures, systems, and components. The safety function for each power system shall be to provide sufficient capacity and capability to ensure that (1) that the design limits for the fission product barriers are not exceeded as a result of anticipated operational occurrences and (2) safety functions that rely on electric power are maintained in the event of postulated accidents.

The electric power systems shall include an onsite power system and an additional power system. The onsite electric power system shall have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. An additional power system shall have sufficient independence and testability to perform its safety function.

If electric power is not needed for anticipated operational occurrences or postulated accidents, the design shall demonstrate that power for important to safety functions is provided.

### **8.1.3 Technical Evaluation**

The staff reviewed the information presented in Section 8.1 of the applicant’s PSAR, as supplemented, to determine whether the description of the electric power systems in PSAR Section 8.1 provides sufficient preliminary information consistent with the guidance in SRP Section 8.1 and DNRL-ISG-2022-01, which provides further guidance for the staff’s review of a CPA.

PSAR Section 8.1.1 states that for the proposed design, a loss-of-preferred power and loss-of-offsite power (LOOP) are the same and can be used interchangeably to represent a loss of the switchyard as a power source to the plant. This evaluation uses the term LOOP.

PSAR Sections 8.1.1 and 8.1.2 briefly describe the offsite power system, the onsite power systems, and their design bases (safety category functions). PSAR Section 8.1.3, “Design Criteria, Regulatory Guides, and Standards,” discusses the regulatory requirements, regulatory guidance, and industry standards that are applicable to the design of electric power systems and will be implemented in the design of the electrical power systems for CRN-1. Table 1.9-8, “Conformance with NUREG-0800 (Chapter 8 Electric Power),” provided the design conformance

to SRP Chapter 8. Specifically, in PSAR Table 1.9-8, the applicant described how the BWRX-300 design conforms with, or uses alternate approaches to, SRP Sections 8.1 (electric power introduction), 8.2 (offsite power system), 8.3.1 (onsite AC power system), 8.3.2 (onsite DC power system), 8.4 (station blackout), and various Branch Technical Positions. Because the BWRX-300 design does not rely on electrical power in the same way that the plants for which the SRP was developed, the applicant highlights a number of SRP acceptance criteria where either the criteria was not applicable or where alternate approaches were used. For example, SRP acceptance criteria related to offsite and onsite AC power functions were considered not to be applicable to the design because the BWRX-300 design does not rely on AC power to mitigate design basis events. For onsite DC power systems, the applicant has identified alternate approaches for several criteria, including design, testing, and application of single failure. Conformance with specific SRP acceptance criteria is discussed in this section.

In PSAR Section 3.1.2.8, "PDC 17 – Electric Power Systems," the applicant provided PDC 17, "Electric Power System," for Clinch River electric power system based on RG 1.232 guidelines, as an alternative to General Design Criterion (GDC) 17. The applicant's PDC 17 states the following:

PDC 17, "Electric Power Systems,"

During normal operations and design basis events that do not involve the loss of AC power, an offsite electric power system shall be provided to permit functioning of normally operating systems and components. The offsite electric power system shall not be required to perform Safety Category 1 functions. In the event of a loss of offsite AC power, onsite electric power system(s) shall be provided when required to permit functioning of systems and components for two layers of defense. The electric power system(s) shall have sufficient capacity and capability to ensure that (1) the design limits for the fission product barriers are not exceeded as a result of anticipated operational occurrences [AOOs] and (2) safety functions that rely on electric power are maintained in the event of DBAs [design basis accidents]. Each layer of defense shall have sufficient independence, redundancy, and testability to ensure the reliability of the functions being supported.

The staff reviewed PDC 17 against GDC-17 and RG 1.232 ARDC 17. The staff notes that proposed PDC 17 modifies GDC 17. The staff notes that PDC 17 provides requirements for capacity, capability, independence, redundancy, and testability for electric power systems. The staff finds this is sufficient to meet the intent of GDC 17 because the capacity, capability, independence, redundancy and testability requirements of the electrical distribution systems will provide an acceptable level of performance given the proposed design's reduced reliance on electrical power, the passive safety features and the defense-in-depth approach of the proposed design. Also, similar to GDC 17, the proposed PDC prescribes requirements for maintaining power to support DBA functions when required. Although PDC 17 references functional reliability, as detailed in Section 15.1 of this safety evaluation report (SER), the staff does not approve predefined numerical reliability targets for individual defense lines, SSCs, or functions because meeting a specified numerical reliability target alone may not by itself provide assurance that the equipment is capable of performing its safety function. At the operating license (OL) stage, consistent with the principles described in PDC 17, the staff will review the detailed system design and performance characteristics of the electric power systems to ensure sufficient capacity and capability to permit the functioning of systems and components required to perform safety functions during DBAs and AOOs. The staff will also evaluate the system design to confirm that appropriate independence, redundancy, and testability are provided.

The staff confirms that PSAR Section 8.1.3 provided the acceptance criteria and guidelines in SRP 8.1, Table 8-1, "Acceptance Criteria and Guidelines for Electric Power Systems," as superseded or supplemented by other regulatory guidance that is applicable to the design of the plant. The staff evaluated the acceptability of these criteria and guidelines in Sections 8.2, 8.3, and 8.4 of this report below.

For the electrical systems, PSAR Section 8.1.3 states that implementation of the maintenance rule, per 10 CFR 50.65(a)(4), will be provided with the OL application (OLA). 10 CFR 50.65 applies to holders of operating licenses and the staff will review compliance with 10 CFR 50.65(a)(4), as it pertains to the onsite and offsite power systems, during the OL review.

The staff will review the applicant's proposed classification of the offsite power system and onsite power system and compliance with regulatory requirements at the OL stage upon review of the final design because complete design information is not required under the NRC's regulations for issuance of a CP.

Regarding GDC 33, 34, 35, 38, 41, and 44, SER Section 15.1.3.7 states the following:

The FSAR must also demonstrate that the safety functions prescribed in GDC 33, 34, 35, 38, 41, and 44 can be accomplished, and by the SSCs identified in PSAR Section 3.1, with the onsite electric power system operation (assuming offsite power is not available) and with offsite electric power system operation (assuming onsite power is not available).

For the onsite and offsite power systems, the staff will review the final design's compliance with the electric power portions of GDC 33, 34, 35, 38, 41, and 44 in the final safety analysis report (FSAR) (i.e., at the OL stage) because complete design information is not required under the NRC's regulations for issuance of a CP.

#### **8.1.4 Conclusion**

The NRC staff has reviewed the offsite and onsite power systems provided in PSAR Chapter 8 against the applicable requirements of § 50.34(a)(3) and (4) and § 50.35 and the guidance in SRP Chapter 8. The staff determined that the preliminary information provided for the CRN-1 electrical power systems in Section 8.1 of the PSAR, as supplemented, includes brief descriptions of the offsite and onsite power systems. The staff's determination is limited to assessing whether the application contains sufficient preliminary design information and a technical and regulatory framework to support issuance of the CP. The staff's determination does not constitute approval of the safety of any design feature, as stated in 10 CFR 50.35(b).

10 CFR 50.35 permits issuance of a CP when, among other things, sufficient preliminary information is provided in the CPA to identify principal architectural and engineering criteria for the design and major features and the NRC staff has reasonable assurance that further information required to complete the staff's safety analysis, which can reasonably be left for later consideration, will be supplied in the FSAR. The staff's review documented in this section concludes that the applicant can provide adequate information to allow the staff to complete its evaluation of the final design in the FSAR. In addition, the staff's review documented in this section concludes that the preliminary information included in the PSAR meets the regulatory requirements of 10 CFR 50.34(a)(3) and 50.34(a)(4) and is sufficient to support the issuance of a CP for CRN-1 in accordance with 10 CFR 50.35 and 50.40.

## 8.2 Offsite Power System

### 8.2.1 Introduction

PSAR Section 8.2, “Offsite Power Systems,” states:

Power is supplied to the plant from the switchyard connected to the transmission grid offsite power sources via two connections in the switchyard. One connection is to the high voltage (HV) side of the Generator Step Up Transformer (GSU). The low voltage (LV) side of the GSU is connected to the main generator breaker via isolated phase bus duct and includes a branch to the Unit Auxiliary Transformer (UAT). The other connection is to the HV side of the Reserve Auxiliary Transformer (RAT).

PSAR Section 8.2.1, “Transmission,” states:

The transmission system provides electric power from the utility grid to the offsite power system. The system is designed and located to minimize the likelihood of simultaneous failure during DBAs and adverse environmental conditions. There are multiple transmission lines that interconnect the switchyard to the grid.

PSAR Section 8.3.1 provides a description of the preferred power system. PSAR Section 8.3.1.2, “Preferred Power System,” states that the preferred power system includes the entirety of the balance of plant distribution subsystem required for power generation.

SRP Section 8.2 states that the offsite power system, referred to as the “preferred power system,” includes two or more physically independent circuits capable of operating independently of the onsite standby power sources and encompasses the grid, transmission lines (overhead or underground), transmission line towers, transformers, switchyard components and control systems, switchyard battery systems, the main generator, generator circuit breakers or load break switches (if provided), disconnect switches, and other switchyard equipment, such as capacitor banks and volt amperes reactive (VAR) compensators, provided to supply electric power to safety-related and other equipment. Consistent with SRP Section 8.2, the staff considers the offsite power system to include, but not be limited to, the transmission connections to the switchyard, the switchyard itself, main generator, GSU, UAT, and RAT. For this safety evaluation (SE), the staff reviewed the CRN-1 offsite system, transmission system, and preferred power system as the offsite power system, per SRP Section 8.2.

### 8.2.2 Regulatory Evaluation

This section summarizes the regulatory requirements and guidance that form the acceptance criteria for the NRC staff’s review of the CRN-1 offsite power system as described in Section 8.2 of the PSAR and supporting supplements.

- 10 CFR 50.34, including:
  - 10 CFR 50.34(a)(3)(i) requires a CP applicant’s preliminary design of the facility to include the PDC.
  - 10 CFR 50.34(a)(3)(ii) requires a CP applicant’s preliminary design of the facility to include the design bases and the relation of the design bases to the PDC.

- 10 CFR 50.34(a)(3)(iii) requires “Information relative to materials of construction, general arrangement, and approximate dimensions, sufficient to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety.”
- 10 CFR 50.34(a)(4) requires “[a] preliminary analysis and evaluation of the design and performance of structures, systems, and components [SSCs] of the facility...”
- 10 CFR 50.35, “Issuance of construction permits.”

The applicant’s proposed PDC 17 as it relates to CRN-1 onsite DC power systems.

The applicable guidance for the evaluation of the CRN-1 offsite power system is as follows:

- DNRL-ISG-2022-01 provides guidance to all applicants for a CP for a light-water power reactor under 10 CFR Part 50.
- SRP Section 8.2, “Offsite Power System,” provides acceptance criteria for the design, performance, and safety evaluation of the offsite power system, including independence, redundancy, and single failure criterion.

SRP BTP 8-9, “Open Phase Conditions in Electric Power System,” provides guidance to the staff in reviewing electric power system designs’ vulnerability to open phase conditions.

### **8.2.3 Technical Evaluation**

The staff reviewed PSAR Chapter 8, as supplemented, to determine whether sufficient preliminary information is provided for the offsite power system consistent with the guidance in SRP Section 8.2 and DNRL-ISG-2022-01.

PSAR Section 8.2 discusses how the offsite power system provides power to the onsite power system. PSAR Section 8.2 states that (1) during normal operations, the main generator provides power to the plant loads via the UAT; (2) when the main generator is offline, power is backfed from the switchyard through the GSU to the UAT; and (3) the medium voltage buses can also be aligned to the RAT, either manually or via automatic transfer.

PSAR Section 8.2 states that the plant auxiliaries can be powered from the grid under all operating conditions and the offsite power from the grid is not required for mitigation of AOOs and DBAs. PSAR Section 8.1.1.1 states that the offsite power has no Safety Category 1 function. Section 8.1.1.1 also states that the offsite power is not a plant system and has no safety classification. The staff will review the applicant’s proposed safety classification of the offsite power system and compliance with regulatory requirements in the FSAR because complete design information is not required under the NRC’s regulations for issuance of a CP.

PSAR Section 8.2.2 states that the switchyard is planned to be a breaker-and-a half scheme and shows as such in PSAR Figure 8.1-2. PSAR Section 8.2.2, “Transmission Switchyard,” states the preliminary switchyard design includes four 161 kilovolt (kV) transmission lines connected to the switchyard, including the Fort Loudoun, Kingston 1, Kingston 2, and Bethel Valley lines. Further, PSAR Section 8.2.2 states that the Fort Loudoun line is on a separate right of way than the other three lines and Kingston 2 and Bethel Valley are on the same transmission structures. The staff finds that the description of the switchyard and transmission lines feeding the switchyard is acceptable since it describes the switchyard design as breaker-and-a half and provides the grid connections to the switchyard.

PSAR Section 8.2.4, "Grid Stability," states that the applicant will perform an interconnection study prior to plant operation to confirm that the transmission interface is adequate for Federal Energy Regulatory Commission and North American Electricity Reliability Corporation regulatory requirements. The staff will confirm completion of grid stability studies and transmission interface at the OL stage upon review of the FSAR because complete design information is not required under the NRC's regulations for issuance of a CP.

SRP Section 8.2, Appendix A, provides guidelines for main generator circuit breakers. The staff will confirm at the OL stage whether the main generator circuit breaker of the final design conforms to Appendix A because complete design information is not required under the NRC's regulations for issuance of a CP.

SRP BTP 8-9 discusses the vulnerability of the electric power system design resulting from open phase conditions in offsite electric power systems. For plants with passive features, BTP 8-9 discusses the detection of an open phase(s) of the independent circuits of the offsite power system on the HV side of a transformer connecting an offsite power circuit to the transmission system and detection in the main control room (MCR). PSAR Section 8.1.3 states that the proposed design conforms to BTP 8-9, Section B.1 and Section B.3, for new reactors that incorporate passive safety features. PSAR Section 8.2.2, "Transmission Switchyard," states that the proposed design conforms to the guidance in BTP 8-9 by including open phase detection for both the GSU and RAT that detects an open phase, and that following the open phase detection, an alarm is generated in the MCR. The staff finds that the design conforms to BTP 8-9 since there is open phase detection on the high side of the transformers and detection in the MCR.

#### **8.2.4 Conclusion**

The NRC staff has reviewed the offsite power systems provided in PSAR Chapter 8 against the applicable requirements of § 50.34(a)(3) and (4) and § 50.35 and the guidance in SRP Chapter 8. The staff determined that the preliminary information provided for the offsite power systems in Chapter 8 of the PSAR, as supplemented, includes brief descriptions of the offsite power system. The staff's determination is limited to assessing whether the application contains sufficient preliminary design information and a technical and regulatory framework to support issuance of the CP. The staff's determination does not constitute approval of the safety of any design feature, as stated in 10 CFR 50.35(b).

10 CFR 50.35 permits issuance of a CP when, among other things, sufficient preliminary information is provided in the CPA to identify principal architectural and engineering criteria for the design and major features and the NRC staff has reasonable assurance that further information required to complete the staff's safety analysis, which can reasonably be left for later consideration, will be supplied in the FSAR. The staff's review documented in this section concludes that the applicant can provide adequate information to allow the staff to complete its evaluation of the final design in the FSAR. In addition, the staff's review documented in this section finds that the preliminary information provided in the PSAR meets the regulatory requirements of 10 CFR 50.34(a)(3) and 50.34(a)(4) and supports issuance of a CP for CRN-1 in accordance with 10 CFR 50.35 and 50.40.

## 8.3 Onsite Power Systems

### 8.3.1 **Alternating Current Power Systems**

#### 8.3.1.1 *Introduction*

PSAR Section 8.3.1, "Alternating Current Power Systems (Onsite)," states that (1) the onsite AC power system starts on the HV side of the GSU and RAT and includes the GSU, the main generator, the main generator circuit breaker, the UAT, the RAT, and the rest of the plant AC distribution; (2) the onsite AC power system includes the preferred power system and the standby power system; (3) the preferred power system boundaries start on the HV side of the GSU and RAT, continue to the terminals of the main generator and downstream to the terminals of the balance of plant equipment, and include protective relaying associated with the GSU, RAT, UAT and main generator; and (4) the standby power system includes standby diesel generators (SDGs) and the interconnecting AC system that is derived from it.

SRP Section 8.3.1 states that the onsite AC power system includes those standby power sources, distribution systems, and auxiliary supporting systems provided to supply power to safety-related equipment or equipment important to safety for all normal operating and accident conditions. As discussed in Section 8.2.3 of this report, and consistent with SRP Section 8.2, the staff considers the offsite power system to include, but not be limited to, the transmission connections to the switchyard, the switchyard itself, main generator, GSU, UAT, and RAT. In addition, consistent with SRP Section 8.3.1, the staff considers the onsite power system to include, but not be limited to, the 6.9 kV and 600 volt (V) distribution systems, and standby AC power sources. This section will review the onsite AC power systems.

#### 8.3.1.2 *Regulatory Evaluation*

This section summarizes the regulatory requirements and guidance that provide the acceptance criteria for NRC staff review of the CRN-1 onsite power systems as described in Section 8.3.1 of the PSAR and supporting supplements.

- 10 CFR 50.34, including:
  - 10 CFR 50.34(a)(3)(i) requires the PDC for the preliminary design of the facility.
  - 10 CFR 50.34(a)(3)(ii) requires the design bases and the relation of the design bases to the PDC.
  - 10 CFR 50.34(a)(3)(iii) requires "Information relative to materials of construction, general arrangement, and approximate dimensions, sufficient to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety."
  - 10 CFR 50.34(a)(4) requires "[a] preliminary analysis and evaluation of the design and performance of structures, systems, and components [SSCs] of the facility..."
- 10 CFR 50.35, "Issuance of construction permits."

The following 10 CFR Part 50, Appendix A, GDC are applicable to the CRN-1 onsite AC power system:

- GDC 4, as it relates to AC power systems important to safety being designed to be protected against dynamic effects, such as the effects of missiles, and to accommodate the effects of environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

- GDC 33, “Reactor coolant makeup,” states, in part, that the reactor coolant makeup system shall be designed to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished using the piping, pumps, and valves used to maintain coolant inventory during normal reactor operation.

The applicable guidance for the evaluation of the CRN-1 onsite AC power system is as follows:

- DNRL-ISG-2022-01 provides guidance to all applicants for a CP for a light-water power reactor under 10 CFR Part 50.
- SRP Section 8.3.1, “AC Power Systems (Onsite),” provides acceptance criteria for the design, performance, and safety evaluation of the onsite AC power system, including independence, redundancy, and single failure criterion.

### *8.3.1.3 Technical Evaluation*

The staff reviewed PSAR Chapter 8, as supplemented, to determine whether sufficient preliminary information is provided for the onsite AC power systems consistent with the guidance in SRP 8.3 and DNRL-ISG-2022-01.

#### *8.3.1.3.1 Onsite Power System*

The staff reviewed the information presented in Section 3.1 and Section 8.1 of the applicant’s PSAR, as supplemented, to determine whether the description of the electric power systems in the PSAR provides sufficient preliminary information consistent with the guidance in SRP Section 8.3 and DNRL-ISG-2022-01.

### GDC 1 – Quality Standards and Records

GDC 1 requires SSCs important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

PSAR Section 3.1.1.1, “GDC 1 – Quality Standards and Records,” states that quality controls for non-Safety Class 1 (SC1) SSCs that are risk-significant are consistent with SRP 17.5, Acceptance Criterion II.U, “Nonsafety-Related SSC Quality Controls” of SRP.”

The staff will evaluate compliance of the final design of the preferred power system with GDC 1 during review of the OLA because complete design information is not required under the NRC’s regulations for issuance of a CP.

### GDC 4 – Environmental and Dynamic Effects Design Bases

GDC 4 requires that SSCs important to safety be designed to be protected against dynamic effects, such as the effects of missiles, and to accommodate the effects of environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

PSAR Section 8.1.3 states that the SC2 and SC3 SSCs in the onsite power system and Standby Power System that support normal operations or mitigate AOOs are confirmed to be compatible with the environmental and dynamic effects present during the event scenarios where these functions are credited, and therefore, these SSCs meet the requirements of GDC

4. The applicant also stated that the failure of these SC2 and SC3 SSCs due to environmental and dynamic effects will not impair SC1 equipment.

The PSAR description does not describe the manner or methods of protecting equipment from environmental and dynamic effects. The applicant's proposed safety classification of the final design of the onsite AC power system and how GDC 4 is met will be reviewed in the OL stage because complete design information is not required under the NRC's regulations for issuance of a CP.

#### **8.3.1.3.2 Standby AC Power System**

PSAR Section 8.3.1 states that the standby power system provides two SDGs for 600 volts alternating current (VAC) backup power to the LV buses for the emergency power system (EPS), plant mechanical systems, battery chargers and uninterruptible power supplies (UPSs), and investment protection. The standby AC power system is shown in PSAR Figure 8.1-1, "Main Electrical One-Line," and Figure 8.3-3, "Standby Power System Low Voltage Distribution Train A." PSAR Table 3A-1 shows that SDGs, LV switchgear, LV motor control center, and dry-type transformers in the standby AC power system are classified as SC3.

The applicant's proposed safety classification of the final design of the preferred power system of the standby AC power will be reviewed at the OL stage because complete design information is not required under the NRC's regulations for issuance of a CP.

PSAR Section 8.3.1.3 states that the SDGs are sized to supply 100% of the required SC1 EDS divisional loads in the three SC1 EDS divisions including a single charger per division operating at rated load, while also supplying power to the required EDS loads during a LOOP event. The applicant further states in PSAR Section 8.3.1.3 that upon loss of power to the bus, the SC3 SDGs (1) are automatically started after a short delay and loaded, (2) have the capability of continuous operation for at least 7 days at rated power without any offsite resources, (3) provide voltage and frequency regulation within the limits required by National Electrical Manufacturers Association (NEMA) MG-1-2021, and (4) started and controlled from the main control room and locally. Although NEMA MG-1-2021 is not endorsed by the NRC, the staff finds this standard to be good engineering practice for motor design and operation. PSAR Sections 8.3.1.15 and 8.3.1.15.1 state that the SDGs are periodically tested by starting and loading, and inspection and testing are based on preventive and predictive maintenance programs. The staff finds that the description in the PSAR, as discussed above, is adequate and addresses capacity (i.e., sizing of the SDGs to provide power to required loads and continuous operation for 7 days), capability (i.e., voltage and frequency regulation, start and control capability from the main control room and local panel), and inspection and testing (i.e., periodic testing by starting and loading SDGs).

PSAR Table 3A-1 states that the SDGs are in the turbine building, and PSAR Section 9.5.4.2 states that the two SDGs are self-contained skid mounted power packages, with the SDG rooms having separate exhausts. Therefore, since each SDG is located in a separate room, the SDGs are physically separated. The staff notes that, based on PSAR Figure 8.1-1, each SDG is electrically independent and connects to 600 VAC Bus A21 or Bus B21. Therefore, the staff finds that the PSAR description for independence of the SDGs is adequate.

The staff determined that the preliminary information provided for the CRN-1 onsite standby AC power system in Section 8.3.1 of the PSAR, as supplemented, is sufficient and addresses capacity, capability, independence, and inspection and testing.

#### 8.3.1.3.3 Freeze and Cathodic Protection System

PSAR Section 8.3.1.7, "Freeze and Cathodic Protection System," describes the freeze protection subsystem, which provides environmental protection to plant equipment to prevent freezing, and the cathodic protection subsystem, which prevents or decreases the rate of corrosion of a metal in an electrolyte. The freeze and cathodic protection system is classified as Non-safety Class (SCN). Since the freeze and cathodic protection system does not support SC1, SC2, or SC3 functions, the staff agrees with the applicant's proposed safety classification of this system. The staff finds that the preliminary information provided for freeze and cathodic protection is adequate at this stage of the design for the issuance of a CP in accordance with 10 CFR 50.34(a)(3) and 50.35.

#### 8.3.1.3.4 Grounding and Lightning Protection System

PSAR Section 8.3.1.9 discusses the grounding system, which serves to protect plant personnel and electrical equipment and consists of a plant ground grid and grounding conductors. The grounding system is classified as SCN. In addition, PSAR Section 8.3.1.10 states that the grounding system is designed and installed to applicable sections of Institute of Electrical and Electronics Engineers (IEEE) 80-2013, IEEE 81-2012, IEEE 665-1995, IEEE 1050-2004, National Fire Protection Association (NFPA) 780, IEEE C62.23-2017, IEEE 666-2007, and IEEE 142-2007. Since the grounding system does not support SC1, SC2, or SC3 functions, the staff agrees with the applicant's proposed safety classification of this system. As the PSAR contains a description of the grounding system and applicable codes and standards, the staff finds that the preliminary information provided for the grounding system is adequate at this stage of the design for the issuance of a CP in accordance with 10 CFR 50.34 and 50.35.

PSAR Section 8.3.1.10 states that lightning protection is installed to protect structures and electrical equipment from lightning strikes and is classified as SCN. Since the lightning protection system does not support SC1, SC2, or SC3 functions, the staff agrees with the applicant's safety classification of this system.

PSAR Section 8.3.1.10 states that the lightning protection system conforms to RG 1.204, *Guidelines for Lightning Protection of Nuclear Power Plants*. The applicant further stated that the lightning protection subsystem is designed and installed to the applicable sections of industry guides and standards including IEEE 80-2013; IEEE 81-2012; IEEE Std. 665-1995; IEEE 1050-2004; NFPA 780, "Standard for the Installation of Lightning Protection Systems"; IEEE C62.23-2017, "IEEE Application Guide for Surge Protection of Electric Generating Plants"; IEEE 666-2007, "IEEE Design Guide for Electric Power Service Systems for Generating Stations"; and IEEE 142-2007. RG 1.204 states that the collective guidance of IEEE Std. 665-1995, IEEE Std. 666-2007, IEEE Std. 1050-2004, and IEEE C62.23-2017 provides an acceptable approach to the NRC staff for meeting the agency's regulatory requirements for adequate lightning protection of SSCs. RG 1.204 Regulatory Position C.1 provides guidance on the inspection of lightning protection systems, and Regulatory Position C.2 provides guidance on testing and maintenance procedures and programs of lightning protection systems. The applicant applies the industry codes and standards endorsed in RG 1.204 for the CPA and does not explicitly address RG 1.204 Regulatory Positions C.1 and C.2. While PSAR Table 1.9-20 and PSAR Sections 8.1.3 and 8.3.1.10 state that the design fully conforms to RG 1.204, staff will review the details of inspection, testing, and maintenance aspects of the lightning protection system against RG 1.204 in the FSAR because complete design information is not required under the NRC's regulations for issuance of a CP.

The staff finds that the preliminary information provided for the freeze and cathodic protection is adequate at this stage of the design for the issuance of a CP in accordance with 10 CFR 50.34(a)(3) and 50.35.

#### 8.3.1.3.5 Cable and Raceway System

For cables and raceways associated with the AC power systems, PSAR Section 8.3.1.14, "Cable Raceway System," states that the cable raceway system includes raceway and supports necessary to route cables in and between buildings and equipment using cable trays, conduits, duct banks, or tunnels. PSAR Section 8.3.1.14.1 states that cables and raceways are separated on the basis of defense lines, division and voltage class, and equipment cabling separation, and electrical isolation is based on IEEE 384-2018 and International Electrotechnical Commission (IEC) 60709. The staff finds these standards are good engineering practice for the design of cable and raceway systems. The staff finds that the PSAR adequately addresses separation and independence of the cables and raceway system.

PSAR Sections 8.3.1.14.2 and 8.3.1.14.3 address cable derating, cable tray fill, and routing of cable trays and cables. Specifically, PSAR 8.3.1.14.2 states that cable tray fill is limited to a percentage of cross-sectional area. Staff notes that cable derating occurs when environmental or installation conditions prevent effective heat dissipation, risking insulation failure. PSAR Section 8.3.1.14.3 states that cable trays and conduits are supported and underground raceways, where used, are sloped and drained to minimize the potential for long-term submergence. The staff finds that the PSAR adequately addresses cable tray fill and routing of cable trays and cables since the PSAR contains a description and methodology for cable tray fill and routing of trays and cables.

The applicant further states in PSAR Section 8.3.1.14 that IEEE 1202-2023 and IEEE 383-2023 are utilized for the qualification of copper cables and fiber optic cables are qualified to IEEE 1202-2023. The staff notes that RG 1.257, "Qualification of Fiber-Optic Cables, Connections, and Optical Fiber Splices for Use in Safety Systems for Production and Utilization Facilities," endorses IEEE 1682 on the qualification of fiber optic cables, and staff will review the qualification of fiber optic cables at the OL stage. The staff notes that RG 1.257 was issued in August 2025, after submittal of the CPA to the NRC.

PSAR Section 8.3.1.14.4 addresses the inspection and testing of cables and raceways and states that (1) inspections are not required after installation and commissioning testing and (2) testing is based on preventative and predictive maintenance programs. In addition, PSAR Table 1.9-20 states that conformance to RG 1.218, *Condition-Monitoring Techniques for the Electric Cables Used in Nuclear Power Plants*, will be discussed in the FSAR, at the OL stage. Since the PSAR discusses inspection and testing and states that conformance to applicable guidance (i.e., RG 1.218) will be discussed in the FSAR, the staff finds that the PSAR adequately addresses inspection and testing of cables and raceways.

PSAR Table 3A-1 provides the classification of cables in the reactor building and other areas that include SC1, SC2, SC3, and SCN cables. The staff will review the applicants proposed classification of the AC and DC systems, and the associated cables and raceways at the OL stage because complete design information is not required under the NRC's regulations for issuance of a CP.

#### 8.3.1.4 Conclusion

The NRC staff has reviewed the alternating current power systems provided in PSAR Chapter 8 against the applicable requirements of § 50.34(a)(3) and (4) and § 50.35 and the guidance in SRP Chapter 8. The staff determined that the preliminary information provided for the offsite power systems in Chapter 8 of the PSAR, as supplemented, includes brief descriptions of the alternating current power system. The staff's determination is limited to assessing whether the application contains sufficient preliminary design information and a technical and regulatory framework to support issuance of the CP. The staff's determination does not constitute approval of the safety of any design feature, as stated in 10 CFR 50.35(b).

10 CFR 50.35 permits issuance of a CP when, among other things, sufficient preliminary information is provided in the CPA to identify principal architectural and engineering criteria for the design and major features and the NRC staff has reasonable assurance that further information required to complete the staff's safety analysis, which can reasonably be left for later consideration, will be supplied in the FSAR. The staff's review documented in this section concludes that the applicant can provide adequate information to allow the staff to complete its evaluation of the final design in the FSAR. In addition, the staff's review documented in this section finds that the preliminary information provided in the PSAR meets the regulatory requirements of 10 CFR 50.34(a)(3) and 50.34(a)(4) and supports issuance of a CP for CRN-1 in accordance with 10 CFR 50.35 and 50.40.

### 8.3.2 Direct Current Power Systems

#### 8.3.2.1 Introduction

PSAR Section 8.3.2, "Direct Current Power Systems," states that the onsite DC power system is divided into three subsystems: the EPS, the preferred power 250 volts direct current (VDC) subsystem, and the standby power 250 VDC subsystem. The preferred power 250 VDC subsystem includes two independent 250 VDC batteries and provides power to SC3 and SCN DC loads, such as protective relaying and breaker control power. The standby power 250 VDC subsystem includes battery chargers, batteries, and UPSs.

#### 8.3.2.2 Regulatory Evaluation

This section summarizes the regulatory requirements and guidance that provide the acceptance criteria for NRC staff review of the CRN-1 onsite DC power systems as described in Section 8.3.2 of the PSAR and supporting supplements.

- 10 CFR 50.34, including:
  - 10 CFR 50.34(a)(3)(i) requires the PDC for the preliminary design of the facility.
  - 10 CFR 50.34(a)(3)(ii) requires the design bases and the relation of the design bases to the PDC.
  - 10 CFR 50.34(a)(3)(iii) requires "Information relative to materials of construction, general arrangement, and approximate dimensions, sufficient to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety."
  - 10 CFR 50.34(a)(4), which requires "[a] preliminary analysis and evaluation of the design and performance of structures, systems, and components [SSCs] of the facility..."
- 10 CFR 50.35, "Issuance of construction permits."

The following 10 CFR Part 50, Appendix A, GDC and PDC are applicable to CRN-1 onsite DC power systems:

- GDC 2, as it relates to DC power systems important to safety being designed to be capable of withstanding the effects of natural phenomena without the loss of the capability to perform their safety functions.
- GDC 4, as it relates to DC power systems important to safety being designed to be protected against dynamic effects, such as the effects of missiles, and to accommodate the effects of environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.
- The applicant's proposed PDC 17 as it relates to CRN-1 onsite DC power systems.
- GDC 18, as it relates to DC power systems important to safety being designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components.
- GDC 50 as it relates to the design of containment electrical penetrations containing circuits of safety-related and non-safety-related DC power systems that is required to accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident.

The applicable guidance for the evaluation of the CRN-1 onsite DC power systems is as follows:

- DNRL-ISG-2022-01 provides guidance to all applicants for a CP for a light-water power reactor under 10 CFR Part 50.
- SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs," dated March 28, 1994 ([NRC 1994-TN12883](#)), relates to the policy and technical issues associated with the regulatory treatment of nonsafety systems (RTNSS) affecting passive plant designs.
- SRP Section 8.3.2, "DC Power Systems (Onsite)," provides acceptance criteria for the design, performance, and safety evaluation of the onsite DC power system, including independence, redundancy, and single failure criterion.

### 8.3.2.3 *Technical Evaluation*

The staff reviewed PSAR Chapter 8, as supplemented, to determine whether sufficient preliminary information is provided for the onsite DC power systems consistent with the guidance in SRP Section 8.3 and DNRL-ISG-2022-01.

#### 8.3.2.3.1 *Emergency Power System*

##### 8.3.2.3.1.1 *Design Basis (Safety Category Function) and Safety Classification*

PSAR Section 8.3.2.1 states that (1) the EPS consists of three separate and independent divisions of power, (2) only two of the three EPS divisions are required to mitigate a DBA, (3) each EPS division includes two battery chargers, batteries, and UPSs, and (4) the EPS 250 VDC batteries provide 72 hours of emergency power.

PSAR Table 3A-1 shows that the UPS, battery chargers, battery monitors, and battery banks of the EPS are SC1. PSAR Section 8.3.2 states that the SC1 DC power subsystem powers the SC1 distributed control and information system (DCIS) equipment responsible for automatic shutdown and decay heat removal that performs Safety Category 1 functions in a fail-safe manner through removal of power with exception of isolation of a faulted isolation condenser system (ICS) line. PSAR Section 3.2.2 states that components that are required to perform Safety Category 1 functions are assigned to SC1. The EPS is shown in PSAR Figures 8.1-1 and 8.3-2, "Emergency Power System."

The staff finds that since the EPS performs Safety Category 1 functions, the applicant's designation of the EPS's safety classification as SC1 is acceptable. The staff will review the final safety analysis at the OL stage to ensure that the EPS can perform its safety function because complete design information is not required under the NRC's regulations for issuance of a CP.

#### *8.3.2.3.1.2 Regulations, Design Criteria, and Guidance*

PSAR Sections 8.1.3 and 8.3.2 discuss the applicable regulations, design criteria, RGs, and industry standards that are applicable to the onsite DC power system. PSAR Table 1.9-8 and Table 1.9-20 summarize conformance with NUREG-0800, SRP Section 8.3.2, acceptance criteria including branch technical positions (BTPs) and RGs. The staff further discusses these regulations, design criteria, RGs and industry standards below.

#### 10 CFR 50.34(f)(2)(v): Additional Three Mile Island (TMI)-Related Requirements (Item I.D.3)

10 CFR 50.34(f)(2)(v) requires the provision of automatic indication for the bypassed and operable status of safety systems to address TMI Action Item I.D.3, Safety System Status Monitoring. PSAR Section 8.1.3 states that this regulation is met by conformance with RG 1.47, *Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems*; BTP 8-5, "Supplemental Guidance for Bypass and Inoperable Status Indication for Engineered Safety Features"; and IEEE Std. 603-2018, "Standard Criteria for Safety Systems for Nuclear Power Generating Stations."

As discussed below for 10 CFR 50.55a(h), the staff will evaluate the applicant's request for NRC authorization for use of IEEE Std. 603-2018 during the OLA review because this information is not required under the NRC's regulations for issuance of a CP.

#### 10 CFR 50.55a(h) Codes and Standards - Protection and Safety Systems

Regulations in 10 CFR 50.55a(h) require compliance with the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995. PSAR Section 8.1.3 states that 10 CFR 50.55a, "Codes and standards," is met for electrical systems by compliance with IEEE Std. 603-2018. In PSAR Section 8.1.3, the applicant states that the EPS complies with 10 CFR 50.55a(h) and IEEE Std. 603-2018 or IEEE Std. 603-1991 when specified by regulation or regulatory guidance. PSAR Table 1.9-20 indicates that conformance with RG 1.153, *Criteria for Safety Systems*, Revision 1, is provided by IEEE Std. 603-2018 or IEEE Std. 603-1991 when specified by regulation or regulatory guidance. PSAR Section 7.1.3.2, "Regulations Directly Related to Instrumentation and Control Systems," states that 10 CFR 50.55a(z), "Alternatives to codes and standards requirements," allows use of alternatives to the requirements of 10 CFR 50.55a(h), when authorized by the NRC.

As endorsed by RG 1.153, IEEE Std. 603-1991 provides a method acceptable to the staff to evaluate all aspects of the electrical portions of the safety-related systems including instrumentation and control systems. The staff will evaluate the applicant's request for NRC authorization for use of IEEE Std. 603-2018 during the OLA review because this information is not required under the NRC's regulations for issuance of a CP.

#### GDC 1—Quality Standards and Records

GDC 1 requires SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

PSAR Section 3.1.1.1, "GDC 1 – Quality Standards and Records," states "Safety Class 1 (SC1) Structures, Systems, and Components (SSCs), and their Safety Category 1 functions, are subject to the GEH Quality Assurance (QA) program, which satisfies the requirements of 10 CFR 50, Appendix B, 'Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants' and American Society of Mechanical Engineers (ASME) NQA-1-2015, 'Quality Assurance Requirements, for Nuclear Facility Applications,' with the exceptions and clarifications noted in RG 1.28, *Quality Assurance Program Criteria (Design and Construction)*."

The NNP-TR-001-NP-A, "Quality Assurance Program Description for TVA New Nuclear," Revision 2, dated September 15, 2025 ([TVA 2025-TN12800](#)) is described and evaluated in PSAR Section 17.1. The staff finds that the information provided in PSAR Section 3.1.1.1 provides sufficient information for the preliminary design that addresses GDC 1 requirements for the SC1 EPS based on the information above and in Section 17.1 of this report.

#### GDC 2—Design Bases for Protection Against Natural Phenomena

GDC 2 requires that SSCs important to safety be designed to withstand the effects of natural phenomena without loss of capability to perform their safety functions.

PSAR Section 8.1.3 states that the SC1 EPS is designed to retain the capability to perform its Safety Category 1 functions during and after design-basis natural phenomena events, and therefore, it meets the requirements of GDC 2. PSAR Table 3A-1 indicates that the EPS is located in the reactor building, and PSAR Section 3.8.4 states that the reactor building structure is seismic category I. PSAR Section 8.3.2 states that the DC power source is seismically qualified. PSAR Section 8.3.2 states that transient voltage surge suppressors are used on the input circuit to the EPS battery chargers, UPSs, and associated bypass circuits to protect against voltage surges to support conformance to RG 1.204, regarding lightning protection.

The staff finds that the EPS complies with GDC 2 since the EPS is housed in the reactor building, which is a seismic category 1 structure, and the EPS conforms to RG 1.204, regarding lightning protection.

#### GDC 4—Environmental and Dynamic Effects Design Bases

GDC 4 requires that SSCs important to safety be designed to be protected against dynamic effects, such as the effects of missiles, and to accommodate the effects of environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

PSAR Table 3A-1 indicated that the EPS is located in the reactor building, and PSAR Section 3.8.4 states that the reactor building structure is seismic category I. Therefore, the staff finds

that the reactor building provides the EPS with protection against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit.

PSAR Section 8.3.2.1 states that the SC1 electrical components and equipment are qualified to environmental and seismic conditions. PSAR Table 1.9-20 states that, for the qualification of batteries, the alternate approach to RG 1.158 is used and that IEEE 535-2022 is instead used. Furthermore, PSAR Table 1.9-20 states that, regarding the qualification of safety-related battery chargers and inverters, an alternate approach for RG 1.210, which endorses IEEE 650-2017, is used and that IEEE 650-2006 is instead applied. Staff will review conformance to RG 1.210 and the alternate approach in the OL stage because complete design information is not required under the NRC's regulations for issuance of a CP.

The staff finds that the EPS design conforms with GDC 4 since the EPS is located in the reactor building and EPS is qualified to environmental and seismic conditions.

### PDC 17—Electric Power Systems

PDC 17 states, in part, that in the event of a loss of offsite AC power, onsite electric power system(s) shall be provided when required to permit functioning of systems and components for two layers of defense. The electric power system(s) shall have sufficient capacity and capability to ensure that (1) the design limits for the fission product barriers are not exceeded as a result of AOOs and (2) safety functions that rely on electric power are maintained in the event of DBAs. Each layer of defense shall have sufficient independence, redundancy, and testability to ensure the reliability of the functions being supported.

PSAR Section 3.1.2.8 provides the following evaluation of the EPS compliance with PDC 17:

The electric power system is the SC1 Emergency Power System for monitoring and actuating SC1 passive systems, such as emergency core cooling provided by the ICS. All passive SC1 systems for DBAs are actuated by SC1 Distributed Control and Information System (DCIS) control systems that are supplied power from the Emergency Power System 72-hour DC emergency batteries. The SC1 Emergency Power provides three divisions of SC1 DC power such that no single failure (or removal of service for testing or maintenance) results in the loss of a Safety Category 1 function. The independence, redundancy, and testability of the SC1 Emergency Power System is sufficient to ensure that the Safety Category 1 functions it supports achieve their reliability target in accordance with NEDC-33934P, 'BWRX-300 Safety Strategy.'

PSAR Table 1.9-20 and PSAR Sections 8.1.3 and 8.3.2 identify the SRP RGs and BTPs and industry standards that are applicable to the EPS. The staff reviewed the description of the EPS in the PSAR to determine whether it includes sufficient preliminary information about the capacity, capability, redundancy, independence, and testability of the SC1 EPS, as required by PDC 17 based on the guidance in SRP Section 8.3.2. SRP Section 8.3.2 cites RGs 1.6, 1.32, 1.53, 1.75, 1.128, 1.129, and 1.153 as establishing acceptable guidance for meeting the requirements for the safety-related DC systems. In some cases (i.e., RG 1.53, 1.75, and 1.153), the applicant has proposed alternate methods to address this guidance as discussed below.

## Capacity

Regarding capacity of the EPS batteries, PSAR Section 8.3.2.1 states that the EPS battery banks (1) have enough stored capacity to independently supply loads continuously for at least 72 hours with a minimum final discharge voltage sufficient to support the associated loads and (2) are sized such that the sum of the loads required in support of Safety Category 1 functions and post-accident monitoring does not exceed the battery ampere-hour rating over the rated 72-hour discharge period or warranted capacity at the end of the installed life with 100% design demand. The staff finds that the 72-hour mission time is consistent with SECY-94-084 guidance. PSAR Section 8.3.2.1 states that the EPS divisional batteries are sized with an expected service life of 20 years using the methodology given in IEEE Std. 485-2020, "IEEE Recommended Practice for Sizing Lead Acid Batteries for Stationary Applications." PSAR Section 8.3.2.1 also states that the sizing of the EPS divisional batteries conforms to RG 1.212, *Sizing of Large Lead-Acid Storage Batteries*. RG 1.212, Revision 2, is identified in Table 1.9-20. Based on the above, the staff finds the application of IEEE Std. 485-2020 and RG 1.212 for sizing the EPS batteries and the 72-hour mission time acceptable and, therefore, finds that the PSAR adequately addresses capacity for the EPS batteries.

Regarding capacity of the battery chargers, PSAR Section 8.3.2.1 states that each of the two battery chargers in a division has the capacity to power loads while providing the maximum battery charge current and the UPSs can supply 100% of the divisional load in accordance with IEEE Std. 603-2018. PSAR Section 8.3.2.1 states that the EPS design meets the recommended practices in IEEE Std. 946-2020, "IEEE Recommended Practice for the Design of DC Power Systems for Stationary Applications." The staff finds the application of IEEE Std. 946-2020 acceptable and good engineering practice for sizing the battery chargers and, therefore, that the PSAR adequately addresses capacity of the battery chargers.

## Capability

Regarding capability of the EPS, PSAR Section 8.3.2.1 describes the capability of the EPS batteries, battery chargers, and UPS to supply loads in each division. PSAR Section 8.3.2.1 states that the EPS batteries (emergency supply) can supply each EPS division independent of offsite power system or standby power system. In addition, PSAR Section 8.3.2.1 states that the EPS is an ungrounded system with ground detection and follows the recommendation in IEEE Std. 142-2007. The staff finds that IEEE Std. 142-2007 is an acceptable engineering practice and the PSAR adequately addresses grounding of the EPS system. The staff finds that the PSAR adequately addresses grounding aspects due to consensus standards applying acceptable engineering principles to the EPS design to prevent adverse effects on other plant equipment.

Regarding protection aspects associated with capability, the applicant stated in PSAR Section 8.3.2.1 that (1) the EPS battery chargers are of a current limiting design to provide additional overload protection for DC loads and prevent the AC source from becoming a load on the batteries and (2) include overvoltage protection on their outputs in accordance with IEEE Std. 946-2020. Between SC1 and non-SC1 components, PSAR Section 8.3.2.1.4 states that coordination between protective devices to isolate faults is in accordance with IEEE 308-2020, IEEE 242-2001, and IEEE 741-2022. PSAR Section 8.1.3 states that the EPS conforms to RG 1.32, which endorses IEEE 308-2020. The staff will review conformance of the EPS to RG 1.32 in the OL stage since complete design information is not required under the NRC's regulations to support issuance of a CP. In addition, PSAR Section 8.3.2.1 states that circuit protection devices supplied by the UPS are coordinated with UPS short circuit shutoff magnitude and time

and EPS protection is designed in accordance with IEEE Std. 741-2022, "IEEE Standard for Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations." Since the PSAR addresses overload and overvoltage protection of the loads supplied by the battery chargers and EPS protection in accordance with IEEE 741-2022, the staff finds the PSAR adequately addresses protection. The staff will evaluate overload and overvoltage protection, as related to the capability of the battery chargers, at the OL stage.

Regarding electromagnetic and radio-frequency interference aspects associated with capability, PSAR Section 8.3.2.1 states that the EPS battery chargers produce a filtered DC output that follows IEC 61000-4 and the EPS battery chargers, UPS, and regulating voltage transformers provide filtering in accordance with IEEE 1050-2004. The staff finds that the PSAR adequately addresses electromagnetic and radio-frequency interference aspects due to IEEE 61000-4 and IEEE 1050-2004 applying acceptable engineering principles to the EPS design to prevent adverse effects on other plant equipment. The staff notes IEEE 2425-2025, published after the CP submission, provides qualification methods and criteria to establish the electromagnetic compatibility of equipment, and staff will review at the OL stage if IEEE 2425 is applied to the EPS to ensure the EPS can perform its safety function.

PSAR Section 8.3.2.1 states that the EPS is designed in accordance with IEEE 379-2014 and IEEE 603-2018. The staff will review the final design's conformance to these standards at the OL stage because complete design information is not required under the NRC's regulations to support issuance of the CP.

The staff reviewed PDC 17 against RG 1.232 ARDC 17 and noted that PDC 17 meets the intent of GDC 17 by addressing requirements for capacity, capability, independence, redundancy and testability for electric power systems, as discussed in SER Section 8.1.3. At the OL stage, consistent with the principles described in PDC 17, the staff will review the final detailed system design and performance characteristics of the EPS to ensure sufficient capacity and capability to permit the functioning of systems and components required to perform safety functions during DBAs and AOOs. The staff will also evaluate the system design to confirm that appropriate independence, redundancy, and testability are provided, consistent with the application of the single-failure criterion described above.

The staff will review the final safety analysis at the OL stage to ensure that the EPS can perform its safety function, and therefore, the staff will make a finding on the capability of the EPS design at the OL stage.

### Independence

Regarding independence of the EPS, PSAR Section 8.3.2.1 states that EPS divisions are physically and electrically separated and isolated from each other without electrical crossties to other divisions or battery systems and that divisional components are in separate rooms that are fire and flood barriered from each other by division. PSAR Section 8.3.2.1 further states that the design of the EPS conforms to RG 1.6, *Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems*. PSAR Section 8.1.3 states that portions of RG 1.6 pertaining to the EPS meet IEEE 603-2018, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generation Stations." PSAR Section 8.3.2.1.3, "Independence of Redundant Systems," states that the separation and isolation of SC1 SSCs support conformance to RG 1.75. PSAR Section 8.3.2.4 states that the equipment, cabling separation, and electrical isolation are performed in accordance with IEEE Std. 384-2018, IEC 60709, and RG 1.75; separation between redundant SC1 and non-SC1 raceway systems is in

accordance with RG 1.75 and IEEE Std. 384-2018; and separation for SCN components and systems are derived from the application of IEC 60709, as appropriate.

Since the design has physically and electrically separated redundant trains and supports conformance with the objectives of RG 1.75, the staff finds that the PSAR adequately addresses independence between divisions, consistent with PDC 17, for the EPS. Regarding isolation between SC1 and non-SC1 components, PSAR Section 8.3.2.1.4 states that coordination between protective devices to isolate faults is in accordance with IEEE 308-2020, IEEE 242-2001, and IEEE 741-2022. As it relates to independence between the EPS and non-SC1 components, staff will verify at the OL stage conformance to RG 1.75 or use of an acceptable alternative approach and conformance to RG 1.32, which endorses IEEE 308-2020, and to RG 1.238, which endorses IEEE 741-2022.

### Redundancy

Regarding redundancy of the EPS, PSAR Section 8.3.2.1 states that the EPS consists of three separate and independent divisions of power. Only two of the three corresponding EPS divisions are required to support two divisions of the SC1 DCIS to mitigate a DBA. Within each EPS division, UPS supplies AC power for the DCIS cabinets, scram and isolation valves, and various other equipment. Each division contains two battery chargers, each with the capacity to power loads while providing the maximum battery charge current. PSAR Figure 8.3-2, "Emergency Power System," shows the EPS for division 1 in Train A, and Figure 8.1-1 shows a representation of two divisions of EPS buses. Staff will verify at the OL stage the finalized design of how the three EPS divisions connect with the 600 VAC buses. Since the EPS consists of three separate divisions, the staff finds the PSAR adequately addresses the redundancy requirement in PDC 17 for the EPS.

### Installation

Regarding installation of the EPS, PSAR Section 8.3.2.1 states that the EPS batteries conform to RG 1.128, *Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants*, and are designed with consideration of the recommended practices in IEEE 484-2019, "IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications." PSAR Table 1.9-20 further states conformance to RG 1.128. The staff finds that the PSAR adequately addresses installation design of the EPS batteries since the EPS conforms to RG 1.128.

### Testability

Regarding testability of the EPS, PSAR Table 1.9-8 and Table 1.9-20 indicate that the EPS design conforms to RG 1.32, *Criteria for Power Systems for Nuclear Power Plants*, Revision 4, which endorses IEEE Std. 308-2020, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations," and state that the RG conditions related to testing of the EPS will be addressed in the FSAR. PSAR Section 8.3.2.1 states that the EPS conforms to RGs 1.118 and 1.129, which pertain to testing. The staff finds the PSAR adequately addresses testing of the EPS since the EPS design conforms to RGs 1.118 and 1.129.

PDC 17 requires the EPS to have sufficient independence, redundancy, and testability to ensure the reliability of the functions being supported. PSAR Section 3.1.2.8 states that the SC1 EPS provides three divisions of SC1 DC power such that no single failure (or removal of service for testing or maintenance) results in the loss of a Safety Category 1 function. PSAR Section

8.1.3 states that the EPS conforms to RG 1.53, *Application of the Single-Failure Criterion to Safety Systems*, and meets IEEE Std. 379-2014, “IEEE Standard for Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems,” and IEEE Std. 603-2018. The staff will review how the final design addresses single failure and verify conformance to IEEE Standards 379-2014 and 603-2018 at the OL stage, as discussed in SER Section 8.1.3.

As summarized in the paragraphs above, the PSAR discusses PDC 17 conformance to RGs to address the EPS capacity, capability, independence, redundancy, and testability. Based on its review of the descriptions of the EPS provided in the PSAR, as supplemented, the staff finds that sufficient information is provided for the preliminary design that addresses the PDC 17 requirements for the capacity, redundancy, independence, and testability of the EPS, while EPS capability will be reviewed at the OL stage, as discussed above. As discussed in Section 8.1.3 of this report, the staff will also review how the final design addresses single failure at the OL stage because the complete design information is not required under the NRC’s regulations to support issuance of the CP.

### GDC 18—Inspection and Testing of Electric Power Systems

GDC 18 requires that electric power systems important to safety be designed to permit appropriate periodic inspection and testing of important areas and features to assess their continuity and the condition of their components.

The staff reviewed the description of the EPS in the PSAR to determine whether it includes sufficient preliminary information about inspection and testing, as required by GDC 18 based on the guidance in SRP Section 8.3.2. SRP Section 8.3.2 cites RGs 1.32, 1.47, 1.118, 1.129, and 1.153 and BTP 8-5 as establishing acceptable guidance for meeting the requirements of GDC 18.

PSAR Section 8.3.2.5, “Inspection and Testing,” states the EPS conforms to RG 1.118, *Periodic Testing of Electric Power and Protection Systems*, and is designed for surveillance testing in accordance with IEEE Std. 338-2022, “IEEE Standard for Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems.” PSAR Section 8.3.2.5 provides details on capacity testing for the EPS battery, inverter, charger, and auxiliary equipment, and testing is governed by the technical specifications and industry standards. Staff reviewed the technical specifications in Chapter 16 of this SER. PSAR Section 8.3.2.1 states that the SC1 EPS batteries conform to RG 1.129, *Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants*, and meet the recommendations of IEEE Std. 450-2020, “IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.” PSAR Table 1.9-8 and Table 1.9-20 show that the EPS design conforms to RG 1.32, Revision 4.

PSAR Section 8.3.1.13, “Bypass and Inoperable Status Indication for Engineered Safety Features Systems,” states that the SC1 EDS design includes provisions for bypass and inoperable status indications in accordance with SRP BTP 8-5. PSAR Sections 8.1.3 and 8.3.2.1 state that the design of the EPS conforms to RG 1.47 and RG 1.153.

Based on the description of the inspection and testing of the EPS in the PSAR, as summarized above, the staff finds that the preliminary design information adequately addresses GDC 18 requirements for the periodic inspection and testing for the EPS, since the design conforms to RGs 1.32, 1.47, 1.118, 1.129, and 1.153 and addresses capacity testing for the battery, inverter, charger, and auxiliary equipment. The staff will evaluate the use of alternative or supportive

standards that are not endorsed in NRC RGs during the review of the OLA because this information is not required under the NRC's regulations to support issuance of the CP.

#### Criterion 50—Containment Design Basis

GDC 50 requires the reactor containment structure, including access openings, penetrations, and the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident. GDC 50 relates to the design of containment electrical penetrations containing circuits of DC power systems.

SRP Section 8.3.2 cites RG 1.63, *Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants*, as guidance acceptable for evaluating the circuit protection for the circuits that penetrate containment.

PSAR Section 8.3.2.4, "Cable Raceway System," states that the cable raceway system also includes the primary containment electrical penetration assemblies. PSAR Section 8.1.3 states that the containment electrical penetrations are designed to minimize leakage such that the containment does not exceed leakage limits, and therefore, they meet the requirements of GDC 50. PSAR Section 8.3.1.8 states that the containment electrical penetrations meet IEEE Std. 317-2013, "IEEE Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations." The staff finds that IEEE Std. 317-2013, a revision to the NRC-endorsed standard IEEE Std. 317-1983, continues to provide a good engineering practice for the design of cable and raceway systems and their associated electrical penetrations. Therefore, conformance to this identified standard supports compliance with RG 1.63, *Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants*."

Based on the information provided in the PSAR, the staff finds that the preliminary design adequately addresses GDC 50 requirements for the EPS. The staff will confirm the final design's compliance with GDC 50 at the OL stage because complete design information is not required under the NRC's regulations to support issuance of the CP.

#### *8.3.2.3.1.3 Conclusion*

The NRC staff has reviewed the SC1 EPS provided in PSAR Chapter 8 against the applicable requirements of 10 CFR Part 50, including §50.34(a)(3) and (4) and §50.35, and the guidance in SRP Chapter 8. The staff determined that the preliminary information regarding the EPS provided in Section 8.3.2 of the PSAR, as supplemented, includes a brief description of the EPS. The staff's determination is limited to assessing whether the application contains sufficient preliminary design information and a technical and regulatory framework that will allow the staff to complete the safety review during the OL stage.

10 CFR 50.35 permits issuance of a CP when, among other things, sufficient preliminary information is provided in the CPA and the NRC staff has reasonable assurance that further information required to complete the staff's safety analysis, which can reasonably be left for later consideration, will be supplied in the FSAR. The staff's review documented in this section concludes that the applicant can provide adequate information to allow the staff to complete its evaluation of the final design in the FSAR. In addition, the staff's review documented in this section concludes that the preliminary information included in the PSAR meets the applicable

guidance and regulatory requirements identified in this section and is sufficient to support the issuance of a CP for CRN-1 in accordance with 10 CFR 10 CFR 50.35 and 50.40.

#### *8.3.2.3.2 SC3 Preferred Power 250 VDC Subsystem*

##### *8.3.2.3.2.1 Design Basis (Safety Category Function) and Safety Classification*

PSAR Section 8.3.2 states that the SC3 preferred power 250 VDC subsystem is designed to provide power to SC3 DC loads, such as SC3 DCIS, protective relaying, breaker control power, and SCN DC loads. PSAR Section 3.1.2.8 states that the SC3 preferred power 250 VDC subsystem provides the Safety Category 3 functions ensuring that fission product barrier design limits are not exceeded because of AOOs. PSAR Section 3.2.2 states that components that are required to perform Safety Category 3 functions are assigned to at least SC3. The preferred power 250 VDC subsystem is shown on PSAR Figure 8.3-5, “Preferred Power 250 VDC Subsystem Part One,” and Figure 8.3-6, “Preferred Power 250 VDC Subsystem Part Two.”

The staff will review the preferred power 250 VDC subsystem and the system’s final safety classification in the FSAR because complete design information is not required under NRC’s regulations to support issuance of the CP.

##### *8.3.2.3.2.2 Design Criteria and Guidance*

PSAR Sections 8.1.3 and 8.3.2 discuss the applicable regulations, design criteria, RGs, and industry standards that are applicable to the preferred power 250 VDC subsystem. PSAR Table 1.9-8 and Table 1.9-20 summarize conformance with SRP Section 8.3.2 acceptance criteria, including branch technical positions (BTPs) and RGs provided in NUREG-0800. The staff discusses these regulations, design criteria, RGs and industry standards below.

#### GDC 1—Quality Standards and Records

GDC 1 requires SSCs important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

PSAR Section 3.1.1.1, “GDC 1 – Quality Standards and Records,” states that quality controls for non-SC1 SSCs that are risk-significant are consistent with SRP Section 17.5, Acceptance Criterion II.U, “Nonsafety-Related SSC Quality Controls”.

The staff will evaluate compliance of the preferred power 250 VDC subsystem with GDC 1 during review of the OLA because complete design information is not required under NRC’s regulations to support issuance of the CP.

#### GDC 4—Environmental and Dynamic Effects Design Bases

GDC 4 requires that SSCs important to safety be designed to be protected against dynamic effects, such as the effects of missiles, and to accommodate the effects of environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

PSAR Section 8.1.3 states that the SC2 and SC3 SSCs in the preferred power system and standby power system that support normal operations or mitigate AOOs are confirmed to be compatible with the environmental and dynamic effects present during the event scenarios where these functions are credited, and therefore, these SSCs meet the requirements of GDC

4. The applicant also stated that the failure of these SC2 and SC3 SSCs due to environmental and dynamic effects will not impair SC1 equipment.

The staff will review compliance with GDC 4 at the OL stage because complete design information is not required under the NRC's regulations to support issuance of the CP.

#### PDC 17—Electric Power Systems

PDC 17 states that, in the event of a loss of offsite AC power, onsite electric power system(s) shall be provided when required to permit functioning of systems and components for two layers of defense. The electric power system(s) shall have sufficient capacity and capability to ensure that (1) the design limits for the fission product barriers are not exceeded as a result of AOOs and (2) safety functions that rely on electric power are maintained in the event of DBAs. Each layer of defense shall have sufficient independence, redundancy, and testability to ensure the reliability of the functions being supported.

PSAR Section 3.1.2.8 states:

Safety Category 3 functions ensuring fission product barrier design limits are not exceeded as a result of AOOs are provided power by the SC3 Preferred Power 250 VDC Subsystem. The SC3 Preferred Power 250 VDC Subsystem has the capacity and capability to provide power to SC3 DC loads, such as DCIS. The SC3 Preferred Power 250 VDC Subsystem provides redundant, battery backed feeds such that no single power failure results in the loss of a Safety Category 3 function to mitigate AOOs. Similarly, a single power feed can be removed from service for testing or maintenance without impacting Safety Category 3 functions. The independence, redundancy, and testability of the SC3 Preferred Power 250 VDC Subsystem is sufficient to ensure that the Safety Category 3 functions it supports for AOO mitigation achieve their reliability target in accordance with NEDC-33934P, "BWRX-300 Safety Strategy."

The staff reviewed the description of the preferred power 250 VDC subsystem in the PSAR to determine whether it includes sufficient preliminary details about the capacity, capability, redundancy, independence, and testability of the preferred power 250 VDC subsystem for compliance with PDC 17.

Regarding capacity, PSAR Section 8.3.2.2 states that the preferred power 250 VDC subsystem batteries have enough stored capacity without chargers to independently supply loads continuously for at least eight hours, with a minimum final discharge voltage sufficient to support the associated loads. PSAR Section 8.3.2.2 states that IEEE Std. 1187 and IEEE Std. 1188 for VRLA batteries are used for the design, installation, maintenance, and testing of the preferred power 250 VDC subsystem batteries. Each charger is designed to supply 100% of the required load of a single bus while charging the battery. Each of the EPS UPSs can supply 100% of the divisional load in accordance with IEEE Std. 603-2018. PSAR Section 8.3.2.2 states that the preferred power 250 VDC subsystem batteries are valve-regulated lead-acid (VRLA) batteries and conform to RG 1.212 and the NRC-endorsed IEEE Std. 485-2020, which is used for battery design and related design parameters and which references IEEE Std. 1187-2013 and 1188-2005. The staff finds that, since the design meets RG 1.212 and follows IEEE 946-2020, 1187-2013, and 1188-2005 the PSAR adequately addresses preferred power 250 VDC system capacity.

Regarding capability, and specifically the protection aspect, PSAR Section 8.3.2.1 states that the preferred power 250 VDC subsystem battery chargers are of a current limiting design to provide additional overload protection for DC loads and prevent the AC source from becoming a load on the batteries, and they include overvoltage protection on their outputs in accordance with IEEE Std. 946-2020. The transient voltage surge suppressors are used on the input circuit to battery chargers, UPSs, and associated bypass circuits to protect against voltage surges to support conformance to RG 1.204. PSAR Section 8.3.2.2 states that IEEE Std. 1187 and IEEE Std. 1188 for VRLA batteries are used for the design, installation, maintenance, and testing of the preferred power 250 VDC subsystem batteries. Based on the information above, the staff finds that the PSAR adequately addresses the protection aspect of capability.

The staff will review the PDC 17 aspect of capability of the SC3 preferred power 250 VDC subsystem in the FSAR, including the safety analyses that demonstrate that it can perform its safety function, because complete design information is not required under NRC regulations to support issuance of the CP.

Regarding redundancy, PSAR Section 8.3.2.2 states that (1) two independent 250 VDC batteries are provided, supplying power to two independent 250 VDC buses; (2) each DC bus and battery are normally supplied power and charging current from their associated battery charger; and (3) two independent UPSs supply a three-phase 208/120 VAC output to independent buses. The staff notes in PSAR Figure 8.3-5 that each of the two 250 VDC buses is supported by a battery, battery charger, and UPS, and therefore, the preferred power 250 VDC subsystem complies with redundancy in PDC 17, with two trains.

Regarding independence, PSAR Section 8.3.2.2 states that the batteries are physically separated and electrically independent in accordance with the applicable requirements of the grid connection authority having jurisdiction. The staff will review the applicable requirements to ensure physical and electrical separation at the OL stage because complete design information is not required under the NRC's regulations to support issuance of the CP. The equipment, cable separation, and electrical isolation are performed in accordance with IEEE Std. 384-2018, IEC 60709, and RG 1.75, and separation between redundant SC1 and non-SC1 raceway systems is in accordance with RG 1.75 and IEEE Std. 384-2018. In response to audit question A-8-19 ([TVA 2026-TN13052](#)), the applicant states that the breakers to the common swing bus are interlocked to prevent cross connection of the two 250 VDC buses. The staff finds that the PSAR adequately addresses independence since the SC3 preferred power 250 VDC subsystem conforms to RG 1.75.

Regarding testability, PSAR Section 8.3.2.2 states that IEEE Std. 1188 for VRLA batteries is used for the maintenance and testing of the preferred power 250 VDC subsystem batteries. The staff evaluated testing of the preferred power 250 VDC subsystem with respect to GDC 18, as further discussed below.

Based on its review of the description of the preferred power 250 VDC subsystem design in PSAR Chapter 8, as discussed above, the staff finds that sufficient information is provided for the preliminary design that addresses the PDC 17 requirements of the preferred power 250 VDC subsystem. The staff will confirm the final design meets all requirements of PDC 17 at the OL stage and upon review of the FSAR.

#### GDC 18—Inspection and Testing of Electric Power Systems

GDC 18 requires that electric power systems important to safety be designed to permit

appropriate periodic inspection and testing of important areas and features to assess their continuity and the condition of their components.

PSAR Section 3.1.2.9 states that the preferred power 250 VDC subsystem is designed to permit appropriate periodic inspection and testing of each SC3 battery, rectifier, battery charger, and inverter in accordance with the requirements of GDC 18.

PSAR Section 8.3.2.2 states that IEEE 1188, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve- Regulated Lead-Acid (VRLA) Batteries for Stationary Applications," is applied for maintenance and testing of the preferred power 250 VDC subsystem VRLA batteries.

IEEE 1188-2005 provides recommended inspection guidance as part of maintenance activities described by the standard. The staff finds that sufficient information is provided for conformance of the preferred power 250 VDC subsystem design with GDC 18 because the applicant applies IEEE 1188, which the staff considers to provide good engineering practice for testing and inspection.

Based on its review of the description of the preferred power 250 VDC subsystem design in the PSAR, as supplemented, as discussed above, the staff finds that sufficient information is provided for the preliminary design that addresses the GDC 18 requirements for periodic inspection and testing of the preferred power 250 VDC subsystem.

#### *8.3.2.3.2.3 Conclusion*

The NRC staff has reviewed the SC3 250 VDC Preferred Power subsystem described in PSAR Chapter 8 against the applicable requirements of 10 CFR Part 50, including §50.34(a)(3) and (4) and §50.35 and the guidance in SRP Chapter 8. The staff determined that the preliminary information provided for the CRN-1 in the PSAR Section 8.3.2, as supplemented, includes a brief description of the SC3 250 VDC Preferred Power subsystem. The staff's determination is limited to assessing whether the application contains sufficient preliminary design information and technical and regulatory framework that will allow the staff to complete the safety review during the OL stage.

The 10 CFR 50.35 permits issuance of a CP when, among other things, sufficient preliminary information is provided in the CPA and the NRC staff has reasonable assurance that further information required to complete the staff's safety analysis, which can reasonably be left for later consideration, will be supplied in the FSAR. The staff's review documented in this section concludes that, with the permit conditions and OL action items identified above, the applicant can provide adequate information to allow the staff to complete its evaluation of the final design in the FSAR. In addition, the staff's review documented in this section concludes that the preliminary information provided in the PSAR supports issuance of a CP for CRN-1 in accordance with 10 CFR 50.34 and 10 CFR 50.35.

#### *8.3.2.3.3 SC2 Standby Power 250 VDC Subsystem*

PSAR Section 8.1 states that the standby power DC backed power supplies provide Safety Category 2 functions including functions associated with the SC2 fine motion control rod drive and the SC2 DCIS. PSAR Section 8.3.1.3, "Standby Power System," states that the standby power 250 VDC subsystem provides backup power in the event of a LOOP for loads that have a function required during a LOOP or loads that require power for plant investment protection.

PSAR Section 8.3.2.2, "Non-Safety Class 1 DC and UPS System," states that the loads assigned to the SC2 standby power system UPSs and batteries are those required for the proposed design to achieve shutdown and include the equipment that provides a diverse, active means for reactor vessel injection and to remove heat from the reactor vessel and containment, which are Safety Category 1 functions. The staff notes that the SC2 standby 250 VDC subsystem is not credited for AOOs or DBAs. This matter is further evaluated in section 15.1.3.6 of this report. Since the standby 250 V DC subsystem is not credited for AOOs or DBAs, the staff will perform a detailed evaluation of the standby power 250 VDC subsystem in accordance with the SRP during the review of the CRN-1 COLA to ensure that the final design complies with all regulatory requirements.

#### *8.3.2.3.4 Cable and Raceway System*

For cables and raceways associated with the DC power systems, PSAR Section 8.3.2.4, "Cable Raceway System," states that the cable raceway system includes raceway and supports necessary to route cables in and between buildings and equipment using cable trays, conduits, duct banks, or tunnels. PSAR Section 8.3.2.4.2 states that cables and raceways are separated on the basis of defense lines, division and voltage class, and equipment cabling separation, and PSAR Section 8.3.2.4.3 states that cabling separation and electrical isolation are based on RG 1.75, IEEE 384-2018, and IEC 60709. Based on the information above, the staff finds that the PSAR adequately addresses separation and independence of the cables and raceway system.

The applicant further states in PSAR Section 8.3.2.4 that IEEE 1202-2023 and IEEE 383-2023 are utilized for the qualification of copper cables, and fiber optic cables are qualified to IEEE 1202-2023. Staff notes that RG 1.257 (which was issued after submission of the CPA) endorses IEEE 1682 on the qualification of fiber optic cables, and staff will review the qualification of fiber optic cables at the OL stage. In addition, IEEE 628, "IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations," provides information on the qualification of raceway systems for Class 1E circuits, which may apply to SC1 DC systems. Staff will review application of IEEE 628 at the OL stage because complete design information is not needed under NRC regulations to support issuance of the CP. IEEE 690, "IEEE Standard for Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations," provides information on the design and installation of cable systems, which may apply to SC1 systems. Staff will review the application of IEEE 690 in the OL stage because complete design information is not needed under NRC regulations to support issuance of the CP.

PSAR Section 8.3.2.4.3 addresses the inspection and testing of cables and raceways and states that (1) inspections are not required after installation and commissioning testing and (2) inspections are based on operational surveillance programs, maintenance, and testing programs. In addition, PSAR Table 1.9-20 states that conformance to RG 1.218, "Condition-Monitoring Techniques for the Electric Cables Used in Nuclear Power Plants," will be discussed in the FSAR at the OL stage. Since the PSAR discusses inspection and testing and lists applicable guidance (i.e., RG 1.218), the staff finds that the PSAR adequately addresses inspection and testing of cables and raceways.

PSAR Table 3A-1 provides the classification of cables in the reactor building and other areas that include SC1, SC2, SC3, and SCN cables. The staff will review the final safety classification of the DC systems and the associated cables and raceways at the OL stage because complete design information is not required under NRC regulations to support issuance of the CP.

#### 8.3.2.4 Conclusion

The NRC staff has reviewed the information on direct current power systems provided in PSAR Chapter 8 against the applicable requirements of § 50.34(a)(3) and (4) and § 50.35 and the guidance in SRP Chapter 8. The staff determined that the preliminary information provided for the direct current power systems in Chapter 8 of the PSAR, as supplemented, includes brief descriptions of the offsite power system. The staff's determination is limited to assessing whether the application contains sufficient preliminary design information and a technical and regulatory framework to support issuance of the CP. The staff's determination does not constitute approval of the safety of any design feature, as stated in 10 CFR 50.35(b).

10 CFR 50.35 permits issuance of a CP when, among other things, sufficient preliminary information is provided in the CPA to identify principal architectural and engineering criteria for the design and major features and the NRC staff has reasonable assurance that further information required to complete the staff's safety analysis, which can reasonably be left for later consideration, will be supplied in the FSAR. The staff's review documented in this section concludes that the applicant can provide adequate information to allow the staff to complete its evaluation of the final design in the FSAR. In addition, the staff's review documented in this section finds that the preliminary information provided in the PSAR meets the regulatory requirements of 10 CFR 50.34(a)(3) and 50.34(a)(4) and supports issuance of a CP for CRN-1 in accordance with 10 CFR 50.35 and 50.40.

### 8.4 Station Blackout

#### 8.4.1 Introduction

PSAR Section 8.4, "Station Blackout," states that the passive design of the plant does not depend on offsite AC power sources or diesel generators to mitigate a DBA. The plant has SC1 DC power sources to support passive core cooling and containment safety category functions.

#### 8.4.2 Regulatory Evaluation

This section summarizes the regulatory requirements and guidance that provide the acceptance criteria for NRC staff review of the CRN-1 onsite power systems as described in Section 8.4 of the PSAR and supporting supplements.

- 10 CFR Section 50.34, including:
  - 10 CFR 50.34(a)(3)(i) requires the PDC for the preliminary design of the facility.
  - 10 CFR 50.34(a)(3)(ii) requires the design bases and the relation of the design bases to the PDC.
  - 10 CFR 50.34(a)(3)(iii) requires "Information relative to materials of construction, general arrangement, and approximate dimensions, sufficient to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety."
  - 10 CFR 50.34(a)(4), which requires "[a] preliminary analysis and evaluation of the design and performance of structures, systems, and components [SSCs] of the facility..."
- 10 CFR 50.35, "Issuance of construction permits."

The following 10 CFR Part 50, Appendix A, GDC and PDC are applicable to CRN-1 onsite AC power system:

- The applicant's proposed PDC 17 as it relates to CRN-1 electrical power systems
- GDC 18, as it relates to the inspection and testing of the onsite power systems.

The applicable guidance for the evaluation of the CRN-1 onsite AC power system is as follows:

- DNRL-ISG-2022-01 provides guidance to all applicants for a CP for a light-water power reactor under 10 CFR Part 50.
- SRP Section 8.4, "Station Blackout," provides acceptance criteria for the design, performance, and safety evaluation of the onsite DC power system, including independence, redundancy, and single failure criterion.
- RG 1.75, as it relates to the independence of SBO-related power sources and distribution systems between the onsite and offsite AC power systems, especially the isolation capability of the battery chargers for the DC system
- RG 1.155, as it relates to compliance with 10 CFR 50.63.
- RG 1.160, as it relates monitoring the effectiveness of maintenance.
- SECY-95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems (RTNSS) in Passive Plant Designs (SECY-94-084)," dated May 22, 1995 (ML003708005), relates to the policy and technical issues associated with the RTNSS affecting passive plant designs.
- SECY-90-016, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," and SECY-94-084, as they relate to the use of AAC power sources and the RTNSS process at plants that have passive safety systems.

### **8.4.3 Technical Evaluation**

In the following discussion, the staff reviewed the descriptive information on SBO in PSAR Sections 8.1 and 8.4 against the acceptance criteria in SRP Section 8.4 and guidelines in DNRL-ISG-2022-01 to determine whether sufficient information is provided consistent with the guidance for CP approval.

GDC 18 discusses the inspection and testing of electric power systems important to safety, and SER Section 8.1.3 discusses compliance with GDC 18. In addition, compliance with PDC 17 is discussed in SER Section 8.1.3.

10 CFR 50.63 requires that each nuclear power plant be capable of withstanding or coping with, and recovering from, an SBO of a specified duration (known as coping duration) and of maintaining adequate core cooling and appropriate containment integrity for the SBO coping duration. SRP Section 8.4 states that passive plants need not evaluate SBO coping duration if they are able to demonstrate that the design selected can perform safety-related functions for 72 hours, which is consistent with the NRC's policy as stated in SECY-94-084 and SECY-95-132 and the associated staff requirements memoranda.

PSAR Section 8.1.3 states that the proposed design does not rely upon offsite power, SDG AC power, or operator action for the first 72 hours to achieve and maintain safe shutdown, and as such, the proposed passive design can meet the requirements of 10 CFR 50.63. PSAR Section 8.4 states that SC1 DC power sources (i.e., EPS batteries) are provided to support passive core cooling and containment safety category functions and have a coping period of 72 hours for

DBAs. The loss of power is discussed in Sections 15.5.3.2.4 and 15.5.4.2.2 of this report, which confirm that the proposed design does not rely on AC power for the first 72 hours after the initiating event to achieve and maintain safe shutdown. The staff finds that the 72-hour mission time is consistent with the NRC's policy in SECY-94-084 and SECY-95-132 and associated staff requirements memoranda and with guidance in SRP Section 8.4.

RG 1.155 provides guidance for implementing the SBO requirements of 10 CFR 50.63. PSAR Section 8.1.3 and Table 1.9-20 state that the design conforms to RG 1.155. SRP Section 8.4 Acceptance Criterion 1 pertains to RG 1.155, as it relates to compliance with 10 CFR 50.63. The loss of power is discussed in SER Sections 15.5.3.2.4 and 15.5.4.2.2, which confirm that the proposed design does not rely on AC power for the first 72 hours after the initiating event to achieve and maintain safe shutdown.

The guidance in RG 1.75 pertains to the independence of the SBO-related power sources and distribution systems between the onsite and offsite AC power systems. In PSAR Table 1.9-20, the applicant has identified an alternate approach to conform to the objectives of RG 1.75. The staff will verify conformance to RG 1.75 or an acceptable alternate approach. The SC1 EPS batteries are provided to support passive core cooling and containment safety category functions. The independence of the SC1 EPS batteries from the non-safety power sources is discussed in Section 8.3.2.3.1 of this report.

SRP Section 8.4 Acceptance Criterion 2 relates to guidelines and criteria of SECY-90-016, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," and SECY-94-084, regarding the use of AC power sources and regulatory treatment of non-safety systems at plants with passive safety systems. PSAR Table 1.9-8 indicates that SRP Section 8.4 Acceptance Criterion 2 regarding the AC and the guidelines of SECY-90-016 and SECY-94-084 are not applicable because AC power is not required for SBO mitigation. The staff finds that SRP Acceptance Criterion 2 is not applicable since the design does not rely on AC power, as discussed above, and is not needed to achieve and maintain safe shutdown following an SBO.

SRP Section 8.4 Acceptance Criterion 3 relates to the reliability goals for emergency AC power sources per RG 1.155. Since the proposed design does not rely on offsite power or AC power from the SDGs, as stated in PSAR Table 1.9-8, the staff finds that SRP Section 8.4 Acceptance Criterion 3 is not applicable.

SRP Section 8.4 Acceptance Criterion 4 discusses the guidelines of RG 1.160, as it relates to the effectiveness of maintenance activities for onsite emergency power sources, including grid-risk-sensitive maintenance activities (i.e., activities that tend to increase the likelihood of a plant trip, increase LOOP frequency, or reduce the capability to cope with a LOOP or SBO) and compliance with the maintenance rule. PSAR Table 1.9-8 states that SRP Section 8.4 Acceptance Criterion 4 for maintenance of onsite emergency AC power source in accordance with guidance in RG 1.160 will be addressed in the FSAR (i.e., at the OL stage). Review of conformance to SRP Section 8.4 Acceptance Criterion 4 and RG 1.160 is not necessary for issuance of a CP. Therefore, the staff will review conformance to SRP Section 8.4 Acceptance Criterion 4 and RG 1.160 during the review of the OLA.

Review of compliance with 10 CFR 50.65(a)(4), which relates to maintenance, is not necessary for issuance of a CP. Therefore, the staff will review compliance with 10 CFR 50.65(a)(4) during the OL stage.

Based on the above descriptions in the PSAR, as supplemented, the staff finds that the preliminary design, for the purposes of this CP application, sufficiently addresses the acceptance criteria of SRP section 8.4 and guidance in RG 1.155 because the design can perform safety-related functions for 72 hours without AC power using the SC1 EPS batteries. The staff will review compliance with 10 CFR 50.63 and 10 CFR 50.65(a)(4) at the OL stage because complete design information is not required under the NRC's regulations to support issuance of the CP.

#### **8.4.4 Conclusion**

Based on its review, the staff has determined that the preliminary information provided for the CRN-1 SBO in PSAR Section 8.4, as supplemented, is sufficient and meets the requirements of 10 CFR 50.34(a)(3) and (4) because it adequately demonstrates performance of safety-related functions for 72 hours. Therefore, the NRC staff concludes that the preliminary information provided for the SBO is adequate at this stage of the design and meets the regulatory requirements of 10 CFR 50.34(a)(3) and 50.34(a)(4) and supports issuance of a CP for CRN-1 in accordance with 10 CFR 50.35 and 50.40. The staff will perform a more detailed evaluation of the SBO coping capability to achieve and maintain safe shutdown during an SBO in accordance with 10 CFR 50.63 during the review of the CRN-1 OLA to ensure that the final design complies with regulatory requirements.

#### **8.5 Summary and Conclusion on Electric Power**

The NRC staff has reviewed the offsite and onsite power systems provided in PSAR Chapter 8 against the applicable requirements of §50.34(a)(3) and (4) and §50.35 and the guidance in SRP Chapter 8. The staff's determination is limited to assessing whether the application contains sufficient preliminary design information and a technical and regulatory framework that will allow the staff to complete the safety review during the OL stage.

10 CFR 50.35 permits issuance of a CP when, among other things, sufficient preliminary information is provided in the CPA and the NRC staff has reasonable assurance that further information required to complete the staff's safety analysis, which can reasonably be left for later consideration, will be supplied in the FSAR. The staff's review documented in this section concludes that the applicant can provide adequate information to allow the staff to complete its evaluation of the final design in the FSAR. In addition, the staff's review documented in this section concludes that the preliminary information included in the PSAR meets the regulatory requirements of 10 CFR 50.34(a)(3) and 50.34(a)(4) and is sufficient to support the issuance of a CP for CRN-1 in accordance with 10 CFR 50.35 and 50.40.

#### **8.6 References**

Chapter 8 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NUREG-0800, Chapter 8)"

DNRL-ISG-2022-01, "Safety Review of Light-Water Power Reactor Construction Permit Applications," October 2022 ([NRC 2022-TN12894](#))