CHAPTER 8

ELECTRIC POWER

8.1 Introduction

8.1.1 Utility Grid Description

The operating company grid system and interconnections to other grid systems and generating stations are as described.

8.1.2 Onsite Power System Description

The onsite power system is comprised of the main ac power system and the dc power system. The main ac power system is a non-Class 1E system. The dc power system consists of two independent systems: Class 1E dc system and non-Class 1E dc system. The ac and dc onsite power system configurations are shown on Figures 8.3.1-1 and 8.3.2-1, -2 and -3, respectively.

The normal ac power supply to the main ac power system is provided from the station main generator. When the main generator is not available, plant auxiliary power is provided from the switchyard by backfeeding through the main stepup and unit auxiliary transformers. This is the preferred power supply. When neither the normal or the preferred power supply is available due to an electrical fault at either the main stepup transformer, unit auxiliary transformer, isophase bus, or 6.9kv nonsegregated bus duct, fast bus transfer will be initiated to transfer the loads to the reserve auxiliary transformers powered by maintenance sources of power. In addition, two non-Class 1E onsite standby diesel generators supply power to selected loads in the event of loss of the normal, preferred, and maintenance power sources. The reserve auxiliary transformers also serve as a source of maintenance power. The maintenance sources are as described.

The main generator is connected to the offsite power system by three single-phase stepup transformers. The normal power source for the plant auxiliary ac loads comes from the generator bus through two unit auxiliary transformers of identical rating. In the event of a loss of the main generator, the power is maintained without interruption from the preferred power supply by an autotrip of the main generator breaker. Power then flows from the switchyard to the auxiliary loads through the main and unit auxiliary transformers.

A spare single-phase main stepup transformer is provided in the transformer area. The spare can be placed in service upon failure of one phase of the main stepup transformers.

The onsite standby power system, powered by the two onsite standby diesel generators, supplies power to selected loads in the event of loss of other ac power sources. Loads that are priority loads for investment protection due to their specific functions (permanent nonsafety loads) are selected for access to the onsite standby power supply. Availability of the standby power source is not required to accomplish any safety function.

The maintenance power supplies are provided at the medium voltage (6.9 kV) buses through normally open circuit breakers. Bus transfer to maintenance source either is automatic under fast bus transfer logic or may be initiated manually.

Four independent divisions of Class 1E 250 Vdc battery systems are provided for the Class 1E dc and UPS system. Divisions B and C have two battery banks; one battery bank is sized to supply power to safety-related loads for at least 24 hours and the other battery bank is sized to supply power to a second set of safety-related loads for at least 72 hours following a design basis event (including the loss of all ac power). Divisions A and D have one 24-hour battery bank. The loads are assigned to each battery bank, depending on their required function, during the 72 hour coping period so that no manual or automatic load shedding is required for the first 24 hours. Two ancillary diesel generators are provided for power for Class 1E post-accident monitoring, MCR lighting, MCR and I&C room ventilation, and power to refill the PCS water storage tank and spent fuel pool if no other sources of ac power are available.

A single spare Class 1E battery bank is provided for both Class 1E and non-Class 1E battery systems and a separate spare charger is provided for each of the systems. In order to preserve independence of each Class 1E dc system division, plug-in locking type disconnects are permanently installed to prevent connection of more than one battery bank to the spare. In addition, kirk-key interlock switches are provided to prevent transfer operation of more than one switchboard at a time. The spare battery bank is located in a separate room and is capable of supplying power to the required loads on any battery being temporarily replaced with the spare.

The non-Class 1E 125 Vdc power system provides continuous, reliable power to the plant nonsafety-related dc loads. Operation of the non-Class 1E dc system is not required to accomplish any safety function.

Uninterruptible power supplies (UPS) to the four independent divisions of the Class 1E 120 Vac instrument buses are included in the Class 1E dc system. The normal power to the uninterruptible power supply comes from the respective Class 1E 250 Vdc bus. The backup power comes from the main ac power system through Class 1E 480-208Y/120V voltage regulating transformers. The same configuration applies for the uninterruptible power to the non-divisional, non-Class 1E 120 Vac instrument buses. The normal power to the non-Class 1E uninterruptible power supply comes from the non-Class 1E 125 Vdc bus and the backup power comes from the main ac power system through a voltage regulating transformer.

8.1.3 Safety-Related Loads

The safety-related loads requiring Class 1E power are listed in Tables 8.3.2-1, -2, -3 and -4. Safety-related loads are powered from the Class 1E 250 Vdc batteries and the associated Class 1E 120 Vac instrument buses.

8.1.4 Design Basis

8.1.4.1 Offsite Power System

Offsite power has no safety-related function due to the passive design of the AP1000. Therefore, redundant offsite power supplies are not required. The design provides a reliable offsite power system that minimizes challenges to the passive safety system.

8.1.4.2 Onsite Power System

8.1.4.2.1 Safety Design Basis

- The Class 1E dc and UPS power system meets the single failure criterion (GDC 17).
- The Class 1E dc and UPS system has sufficient capacity to achieve and maintain safe shutdown of the plant for 72 hours following a complete loss of all ac power sources without requiring load shedding for the first 24 hours.
- The Class 1E dc and UPS system is divided into four independent divisions. Any three-out-of-four divisions can shut down the plant safely and maintain it in a safe shutdown condition.
- Separation criteria preserve the independence of redundant Class 1E circuits as described in subsection 8.3.2.4 and no single credible event is capable of disabling redundant safety-related systems.
- Special identification criteria are applied for Class 1E equipment, cabling, and raceways as described in subsection 8.3.2.3.
- The Class 1E systems and equipment are designed to permit periodic inspection and testing (GDC-18).
- The Class 1E dc and UPS power system permits connection of any one 250 Vdc switchboard at a time to the spare battery and the spare battery charger. The spare battery and charger have sufficient capacity to permit continuous plant operation at 100-percent power in case of a failure or unavailability of one Class 1E battery bank and the associated battery charger.
- Two ancillary diesel generators provide ac power for Class 1E post-accident monitoring, MCR lighting, MCR and I&C room ventilation, and power to refill the PCS water storage tank and spent fuel pool if no other sources of power are available. The equipment used to perform this function is not safety-related because it is not needed for a prolonged period following a loss of ac and it is easily replaced with transportable generators.

8.1.4.2.2 Power Generation Design Basis

- The main ac power system is a non-Class 1E system and nonsafety-related. The normal power supply to the main ac power system comes from the station main generator through two identically rated unit auxiliary transformers and an additional unit auxiliary transformer for the electric auxiliary boiler and as described site-specific loads.
- The onsite standby power system supplies ac power to the selected permanent nonsafety loads in the event of a main generator trip concurrent with the loss of preferred power source and maintenance power source when under fast bus transfer conditions. The onsite standby diesel generators are automatically connected to the associated 6.9 kV buses upon loss of bus voltage only after the generator rated voltage and frequency is established. Loads that are

important for orderly plant shutdown are sequentially connected as shown in subsection 8.3.1 during this event.

The permanent nonsafety loads are not required for the plant safe shutdown; therefore, the onsite standby power system is a nonsafety-related system and non-Class 1E.

- For continued operation of the plant, a spare single-phase main transformer can be placed in service upon failure of one phase of the main stepup transformers.

8.1.4.3 Design Criteria, Regulatory Guides, and IEEE Standards

Refer to Table 8.1-1 for guidelines, and their applicability to Chapter 8.

The offsite and onsite ac power systems have no safety function and, therefore, their conformance to General Design Criteria, Regulatory Guides and IEEE Standards is not required, except as indicated in Table 8.1-1.

The Class 1E dc power system design is based on the following:

- General Design Criteria (GDC)

  See Section 3.1 for a discussion of conformance to the General Design Criterion.

- Nuclear Regulatory Commission (NRC) Regulatory Guides

  See Section 1.9 for the list and details of conformance to the regulatory guides.

- IEEE Standards.

  The Class 1E dc power system design is based on the following IEEE Standards that are generally acceptable to the NRC as stated in the referenced Regulatory Guides:

  – IEEE 308-1991, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations. Refer to Regulatory Guide 1.32.

  – IEEE 317-1983, IEEE Standard for Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations. Refer to Regulatory Guide 1.63.

  – IEEE 323-1974, IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations. Refer to Regulatory Guide 1.89.

  – IEEE 338-1987, IEEE Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems. Refer to Regulatory Guide 1.118.

  – IEEE 344-1987, IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations. Refer to Regulatory Guide 1.100.

- IEEE 379-2000, IEEE Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems. Refer to Regulatory Guide 1.53.
- IEEE 382-1996, IEEE Standard for Qualification of Actuators for Power Operated Valve Assemblies with Safety Related Functions for Nuclear Power Plants. Refer to Regulatory Guide 1.73.
- IEEE 383-1974, IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations. Refer to Regulatory Guide 1.131.
- IEEE 384-1981, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits. Refer to Regulatory Guide 1.75.
- IEEE 450-1995, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications. Refer to Regulatory Guide 1.32.
- IEEE 484-1996, IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications. Refer to Regulatory Guide 1.128.
- IEEE 741-1997, IEEE Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations. Refer to Regulatory Guide 1.63.
- IEEE 1202-1991, IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies.

8.1.5 Combined License Information

This section has no requirement for information to be provided in support of the Combined License application.

Table 8.1-1 (Sheet 1 of 5)

CRITERIA AND GUIDELINES FOR ELECTRIC POWER SYSTEMS

Criteria	Applicability (DCD[a] Section/Subsection)			Remarks
	8.2	8.3.1	8.3.2	
1. 10CFR50 Appendix A – General Design Criteria (GDC) (See Section 3.1 for a discussion of conformance to each of the GDC).				
a. GDC 2 Design Bases for Protection Against Natural Phenomena			A	
b. GDC 4 Environmental and Missile Design Basis			A	
c. GDC 5 Sharing of Structures, Systems, and Components				not applicable
d. GDC 17 Electric Power Systems			A	
e. GDC 18 Inspection and Testing of Electric Power Systems			A	
f. GDC 50 Containment Design Basis		A	A	applicable to penetration design

Note:

(a) "A" denotes applicable to AP1000, and "G" denotes guidelines as defined in NUREG-0800, Rev. 2, Table 8-1 (SRP). No letter denotes "Not Applicable."

Table 8.1-1 (Sheet 2 of 5)

CRITERIA AND GUIDELINES FOR ELECTRIC POWER SYSTEMS

Criteria	Applicability (DCD[a] Section/Subsection)			Remarks
	8.2	8.3.1	8.3.2	
2. Regulatory Guide (See Section 1.9 for list and discussion of conformance to the Regulatory Guides).				
a. RG 1.6 Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems			G	
b. RG 1.9 Selection, Design, and Qualification of Diesel Generator Units Used as Stand-by (Onsite) Electric Power Systems at Nuclear Power Plants				not applicable
c. RG 1.32 Criteria for Safety-Related Electric Power Systems for Nuclear Power Generating Stations			G	
d. RG 1.47 Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems			G	
e. RG 1.63 Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants		G	G	

Note:

(a) "A" denotes applicable to AP1000, and "G" denotes guidelines as defined in NUREG-0800, Rev. 2, Table 8-1 (SRP). No letter denotes "Not Applicable."

Table 8.1-1 (Sheet 3 of 5)

CRITERIA AND GUIDELINES FOR ELECTRIC POWER SYSTEMS

Criteria		Applicability (DCD[a] Section/Subsection)			Remarks
		8.2	8.3.1	8.3.2	
f. RG 1.75	Physical Independence of Electric Systems			G	
g. RG 1.81	Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants				not applicable
h. RG 1.106	Thermal Overload Protection for Electric Motors on Motor-Operated Valves			G	
i. RG 1.108	Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants				not applicable
j. RG 1.118	Periodic Testing of Electric Power and Protection Systems			G	
k. RG 1.128	Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants			G	
l. RG 1.129	Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants				site-specific
m. RG 1.131	Qualification Tests of Electric Cables, Field Splices, and Connections for Light-Water-Cooled Nuclear Power Plants			G	The insulating and jacketing material for electrical cables are selected to meet the fire and flame test requirements of IEEE Standard 1202 or IEEE Standard 383 excluding the option to use the alternate flame source, oil or burlap.

Note:

(a) "A" denotes applicable to AP1000, and "G" denotes guidelines as defined in NUREG-0800, Rev. 2, Table 8-1 (SRP). No letter denotes "Not Applicable."

Table 8.1-1 (Sheet 4 of 5)

CRITERIA AND GUIDELINES FOR ELECTRIC POWER SYSTEMS

Criteria	Applicability (DCD[a] Section/Subsection)			Remarks
	8.2	8.3.1	8.3.2	
3. Branch Technical Position (BTP)				
a. BTP ICSB 4 (PSB) Requirements on Motor-Operated Valves in the ECCS Accumulator Lines			G	see DCD 1.9.2
b. BTP ICSB 8 (PSB) Use of Diesel-Generator Sets for Peaking				not applicable
c. BTP ICSB 11 (PSB) Stability of Offsite Power Systems				site-specific
d. BTP ICSB 18 (PSB) Application of the Single Failure Criterion to Manually Controlled Electrically-Operated Valves			G	see DCD 1.9.2
e. BTP ICSB 21 Guidance for Application of RG 1.47			G	see also DCD 7.5
f. BTP PSB 1 Adequacy of Station Electric Distribution System Voltages				not applicable
g. BTP PSB 2 Criteria for Alarms and Indications Associated with Diesel-Generator Unit Bypassed and Inoperable Status				not applicable

Note:

(a) "A" denotes applicable to AP1000, and "G" denotes guidelines as defined in NUREG-0800, Rev. 2, Table 8-1 (SRP). No letter denotes "Not Applicable."

Table 8.1-1 (Sheet 5 of 5)

CRITERIA AND GUIDELINES FOR ELECTRIC POWER SYSTEMS

Criteria	Applicability (DCD[a] Section/Subsection)			Remarks
	8.2	8.3.1	8.3.2	
4. NUREG Reports				
a. NUREG CR0660 Enhancement of Onsite Diesel Generator Reliability				not applicable

Note:

(a) "A" denotes applicable to AP1000, and "G" denotes guidelines as defined in NUREG-0800, Rev. 2, Table 8-1 (SRP). No letter denotes "Not Applicable."