8.2 Offsite Power System

8.2.1 System Description

The Combined License applicant is responsible for providing a transmission system to supply offsite ac energy for startup and normal shutdown through a site-specific transmission switchyard. This offsite ac power system is not required for plant safety.

[[A transformer area containing stepup transformers, unit auxiliary transformers, and the reserve auxiliary transformer is located next to the turbine building.]]

The normal ac power supply to the main ac power system is provided from the 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. In addition, two non-Class 1E onsite standby diesel generators supply power to selected plant loads in the event of loss of both the normal and preferred power sources. There is also a maintenance source of power provided through a reserve auxiliary transformer to supply power to selected loads. The maintenance source is site specific. Maintenance power is provided at the medium voltage level (4.16 kV) through normally open circuit breakers. Bus transfer to the maintenance source is manual. Connection of the preferred and maintenance power supplies to the utility grid or other power sources is site-specific.

The main generator is connected to the offsite power system via three single-phase main stepup transformers. The normal power source for the plant auxiliary ac loads is provided from the 22,000 V isophase generator buses through the two unit auxiliary transformers of identical ratings. In the event of a loss of the main generator, the power is maintained without interruption from the preferred power supply by an auto-trip of the main generator breaker. Power then flows from the transformer area to the auxiliary loads through the main and unit auxiliary transformers.

The transmission system is site-specific.

The transmission line structures associated with the plant are designed to withstand standard loading conditions for the specific-site as provided in Reference 1.

Automatic load dispatch is not used at the plant and does not interface with safety-related action required of the reactor protection system.

8.2.1.1 Transmission Switchyard

The transmission switchyard is site specific and the responsibility of the Combined License applicant.

8.2.1.2 Transformer Area

The transformer area contains the main stepup transformers, the unit auxiliary transformers, and the reserve auxiliary transformer. Protective relaying and metering required for this equipment is located in the turbine building. The necessary power sources (480 Vac, 120 Vac, and 125 Vdc) to the equipment are supplied from the turbine building. See subsection 9.5.1 for a discussion of fire protection associated with plant transformers.

One feeder connects the transformer area with the switchyard to supply power to/from the main stepup transformers for the unit. An arrangement is shown in Figure 8.3.1-1.

8.2.2 Grid Stability

The AP600 is designed with passive safety-related systems for core cooling and containment integrity and, therefore, does not depend on the electric power grid for safe operation. This feature of the AP600 significantly reduces the importance of the grid connection and the requirement for grid stability. The AP600 safety analyses assume that the reactor coolant pumps can receive power from either the main generator or the grid for a minimum of 3 seconds following a turbine trip.

The AP600 main generator is connected to the generator bus through the generator circuit breaker. The grid is connected to the generator bus through the main step-up transformers and the grid breakers. The reactor coolant pumps are connected to the generator bus through the reactor coolant pump breakers, the 4.16 kV switchgear, and the unit auxiliary transformers. During normal plant operation the main generator supplies power to the generator bus. Some of this power is used by the plant auxiliary systems (including the reactor coolant pumps); the rest of the power is supplied to the grid.

If, during power operation of the plant, a turbine trip occurs, the motive power (steam) to the turbine will be removed. The generator will attempt to keep the shaft rotating at synchronous speed (governed by the grid frequency) by acting like a synchronous motor. The reverse-power relay monitoring generator power will sense this condition and, after a time delay of at least 15 seconds, open the generator breaker. During this delay time the generator will be able to provide voltage support to the grid if needed. The reactor coolant pumps will receive power from the grid for at least 3 seconds following the turbine trip. The Combined License applicant will perform a grid stability analysis to show the grid will remain stable and the reactor coolant pump bus voltage will remain above the voltage required to maintain the flow assumed in the Chapter 15 analyses for a minimum of three (3) seconds following a turbine trip. The Combined License applicant will set the protective devices controlling the switchyard breakers with consideration given to preserving the plant grid connection following a turbine trip.

If the turbine trip occurs when the grid is not connected (generator supplying plant house loads only), the main turbine-generator shaft will begin to slow down as the energy stored in the rotational inertia of the shaft is used to supply the house loads (including reactor coolant

pumps). The system will coast down until the generator exciter can no longer maintain generator terminal voltage and the generator breaker is tripped on either generator under-voltage or exciter over-current. This coast down will last at least 3 seconds before the generator breaker trips.

The sequence of events following a loss-of-offsite-power event is the same as those described for grid-disconnected operation.

8.2.3 Conformance to Criteria

The offsite sources are not Class 1E. Commercial equipment is manufactured to the industrial standards listed in subsection 8.2.6. The design meets General Design Criterion 1. Unit trips occur at the generator breaker and do not cause the loss of the preferred power source to the plant electrical systems. The AP600 does not require ac power sources for mitigating design basis events; Chapter 15.0 describes the design bases assumptions utilized for analysis of these events. The AP600 meets the intent of General Design Criteria 17 as outlined in Section 3.1.

Conformance with General Design Criterion 18 is provided by the test and inspection capability of the system.

8.2.4 Standards and Guides

In addition to the General Design Criteria, the industry guides and standards listed as Reference 2 through 4 are used as guides in the design and procurement of the offsite power system.

8.2.5 Combined License Information for Offsite Electrical Power

Combined License applicants referencing the AP600 certified design will address the design of the ac power transmission system and its testing and inspection plan.

The Combined License applicant will address the technical interfaces for this nonsafety-related system listed in Table 1.8-1 and subsection 8.2.2. These technical interfaces include those for ac power requirements from offsite and the analysis of the offsite transmission system and the setting of protective devices.

8.2.6 References

1. ANSI C2-1990, National Electric Safety Code.

2. ANSI C37.010-1972, Application Guide for ac High Voltage Circuit Breakers.

3. ANSI C37.90-1989, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.

4. ANSI C57.12.00-1987, General Requirements for Distribution, Power, Regulating Transformers, and Shunt Reactors.