

## **8.2 Offsite Power Systems**

### **8.2.1 Description**

#### **8.2.1.1 Scope**

This section provides a description of the design and performance requirements for the offsite power system. The offsite power system, as defined in the USNRC Standard Review Plan Section 8.2, consists of the following:

##### **Applicant Scope**

- (1) The offsite transmission network [including the tie lines to the switchyard(s)]
- (2) The plant switchyard(s)
- (3) The separated switching stations
- (4) The high voltage tie lines from the switching stations to the main power transformers, and to the reserve auxiliary transformers
- (5) The main step-up power transformers
- (6) The reserve auxiliary transformers

##### **ABWR Standard Plant Scope**

- (7) The three unit auxiliary transformers
- (8) The plant main generator
- (9) The combustion turbine generator
- (10) The isolated phase buses from the main power transformer to the main generator circuit breaker, and to the unit auxiliary transformers
- (11) The main generator circuit breaker
- (12) The non-segregated phase buses from the unit auxiliary transformers (UATs) to the input terminals of the non-safety-related medium voltage (13.8 kV) switchgear, the power cables from the UATs to the input terminals of the plant investment protection (PIP) medium voltage (4.16 kV) switchgear and safety-related switchgear.
- (13) The non-segregated phase bus and power cables from the reserve auxiliary transformers to the input terminals of the non-safety-related and safety-related medium voltage (13.8 kV and 4.16 kV) switchgear.

- (14) The power cables from the combustion turbine generator to the input terminals of the medium voltage (13.8 kV) switchgear, and interconnection power cables between 13.8 kV and 4.16 kV switchgear including the 13.8 kV/ 4.16 kV power transformer.

The design scope for the ABWR ends at the low voltage terminals of the main power transformer and the low voltage terminals of the reserve auxiliary transformers. Although the remainder of the offsite power system is not in the scope of the ABWR design, the ABWR design is based on a power system which meets certain design concepts. Design bases (10CFR52 interface requirements) consistent with these concepts are included in Subsection 8.2.3. Meeting the design bases presented in Subsection 8.2.3 will ensure that the power system within the design scope for the ABWR meets all regulatory requirements. Meeting the conceptual design bases presented in Section 8.2.5 will ensure that the total power system design is consistent and meets all regulatory requirements.

The portions of the offsite power system which fall under the design responsibility of the COL applicant will be unique to each COL application. It is the responsibility of all concerned parties to insure that the total completed design of equipment and systems falling within the scope of this section be in line with the description and requirements stated in. See Subsection 8.2.4 for a detailed listing and description of the COL license information.

#### **8.2.1.2 Description of Offsite Power System**

The offsite electrical power system components within the scope of the applicant include items (1) through (6) identified in Subsection 8.2.1.1. The remaining items (7) through (14) are within the scope of the ABWR standard plant design.

When used for normal operation, each preferred power supply is sized to supply the maximum expected coincident Class 1E and non-Class 1E loads.

The normal and alternate preferred power circuits are designed in accordance with industry-recommended practice in order to minimize the likelihood that they will fail while operating under the environmental conditions (such as, wind, ice, snow, lightning, temperature variations, or flood) to which they are subject.

Performance and operating characteristics of the normal and alternate preferred power circuits are required to meet operability and design-basis requirements, such as: (1) the ability to withstand short-circuits, (2) equipment capacity, (3) voltage and frequency transient response, (4) voltage regulation limits, (5) step load capability, (6) coordination of protective relaying and (7) grounding.

Air cooled isolated phase bus duct is sized to provide its load requirements and withstand fault currents until the fault is cleared. It provides for a power feed to the main power transformer and unit auxiliary transformers from the main generator. The sections of the isolated phase bus supplying the unit auxiliary transformers are rated as appropriate to the load requirements (see Figure 8.3-1).

A generator circuit breaker is provided in the isolated phase bus duct at an intermediate location between the main generator and the main power transformer. The generator circuit breaker provided is capable of interrupting a maximum fault current of 255 kA symmetrical and 320 kA asymmetrical in accordance with IEEE C37.013. This corresponds to the maximum allowable interface fault current specified in Subsection 8.2.3. The main generator circuit breaker allows the generator to be taken offline and the offsite transmission network to be utilized as a power source by backfeeding to the unit auxiliary transformers and their loads, both Class 1E and non-Class 1E. This is also the startup power source for the unit. Short circuit analysis will be performed in accordance with IEEE 141 and/or other acceptable industry standards or practices to determine fault currents.

Unit synchronization will normally be through the main generator circuit breaker. A coincidental three-out-of-three logic scheme and synchro-check relays are used to prevent faulty synchronizations.

It is a design basis requirement that synchronization be possible through the switching station's circuit breakers (Subsection 8.2.5 (24)).

Dual trip coils are provided on the main generator circuit breakers and control power is supplied from redundant load groups of the non-Class 1E onsite 125 VDC power system.

There are three Unit Auxiliary Transformers (UATs), which are designated the normal preferred offsite source. UATs A and B are rated at 82.5/110 MVA (ONAN/ONAF). UATs A and B each have primary windings at the main generator voltage and two secondary windings, one at 13.8 kV and one at 4.16 kV. UAT C is rated at 22.5/30 MVA (ONAN/ONAF). UAT C has primary winding at the main generator voltage and a single secondary winding at 4.16 kV. All three UATs use automatic tap changers to improve voltage regulation on the plant medium voltage buses. The UATs are designed with significant capacity margin during normal operation because the transformers operate near their ONAN ratings.

UAT A supports 13.8 kV Power Generation (PG) buses A1 and C1 and 4.16 kV Plant Investment Protection (PIP) bus A2 and Class 1E 4.16 kV bus A3. UAT B supports PG buses B1 and D1 and PIP bus B2 and Class 1E bus B3. UAT C supports PIP bus C2 and Class 1E bus C3.

Disconnect links are provided in the isolated phase bus duct feeding the unit auxiliary transformers so that any single failed transformer may be taken out of service and operation continued on the other two unit auxiliary transformers. One of the buses normally fed by the failed transformer would have to be fed from its associated reserve auxiliary transformer in order to keep all reactor internal pumps operating so as to attain full power. The reserve auxiliary transformers are sized for this type of service.

There are two Reserve Auxiliary Transformers (RATs), either of which can be used as the alternate preferred offsite source. RATs A and B are each rated at approximately 82.5/110

MVA (ONAN/ONAF). RATs A and B each have primary windings at the switchyard voltage and two secondary windings, one at 13.8 kV and one at 4.16 kV. RATs A and B use automatic tap changers to improve voltage regulation on the plant medium voltage buses. The RATs are designed with significant capacity margin during normal operation because the transformers operate near their ONAN ratings.

RAT A is designed to be capable of supporting PG buses A1 and C1, which are normally supported by UAT A, via an intermediate 13.8 kV bus designated as CTG 2. The 4.16 kV winding of RAT A can be aligned to support any of the three PIP buses (A2, B2, and C2) and any of the three Class 1E buses (A3, B3, and C3) and has the capacity to support all three Class 1E buses. RAT A is not normally aligned to support any PG, PIP, or Class 1E bus. RAT B is designed to be capable of supporting PG buses B1 and D1, which are normally supported by UAT B, via an intermediate 13.8 kV bus designated as CTG 1. The 4.16 kV winding of RAT B can be aligned to support any of the three PIP buses and any of the three Class 1E buses and has the capacity to support all three Class 1E buses.

The normal and alternate offsite preferred power circuits are designed with sufficient capacity and capability to limit variations of the operating voltage of the onsite power distribution system to a range appropriate to ensure: (1) normal and safe steady-state operation of all plant loads, (2) starting and acceleration of the limiting drive system with the remainder of the loads in service, and (3) reliable operation of the control and protection systems under conditions of degraded voltage [Subsection 8.3.1.1.7 (8)]. Specifically, the unit auxiliary transformers and the reserve auxiliary transformers are designed to limit the voltage variation of the onsite power distribution system to  $\pm 10\%$  of load rated voltage during all modes of steady state operation and a voltage dip of no more than 20% during motor starting.

Voltage levels at the low-voltage terminals of the unit and reserve auxiliary transformers will be analyzed to determine the maximum and minimum load conditions that are expected throughout the anticipated range of voltage variations of the offsite transmission system and the main generator. Separate analyses will be performed for each possible circuit configuration of the offsite power supply system.

The unit and reserve auxiliary transformers are designed and constructed to withstand the mechanical and thermal stresses produced by external short circuits. In addition, these transformers meet the corresponding requirements of the latest revisions of ANSI Standard C57.12.00. See Subsection 8.2.3(4) for interface requirements on the main step-up transformers and the reserve auxiliary transformers.

The non-segregated phase bus or power cable that connects the unit auxiliary and reserve auxiliary transformers to their respective switchgear is sized to supply its load requirements and rated to withstand fault currents until the fault is cleared.

Redundant offsite system circuits derive their control, protection, and instrument DC power from redundant non-Class 1E DC sources that are independent of the Class 1E DC sources.

### 8.2.1.3 Separation

The location of the main power transformer, unit auxiliary transformers, and reserve auxiliary transformers are shown on Figure 8.2-1. The reserve auxiliary transformers are separated from the main power and unit auxiliary transformers by a minimum distance of 15.24 m. It is a requirement that the 15.24 m minimum separation be maintained between the switching stations and the incoming tie lines. The transformers are provided with oil collection pits and drains to a safe disposal area.

Reference is made to Figures 8.3-1 for the single line diagrams showing the method of feeding the loads. The circuits associated with the alternate offsite circuit from the reserve auxiliary transformers to the Class 1E buses are separated by walls or floors, or by at least 15.24 m, from the main and unit auxiliary transformers. The circuits associated with the normal preferred offsite circuit from the unit auxiliary transformers to the Class 1E buses are separated by walls or floors, or by at least 15.24 m, from the reserve auxiliary transformers. Separation of the normal preferred and alternate preferred circuits is accomplished by floors and walls over their routes through the Turbine, Control and Reactor Buildings except within the switchgear rooms where they are routed to opposite ends of the same switchgear lineups. Either reserve auxiliary transformer may be used to satisfy requirements as the alternate preferred power supply. Separation between the two reserve auxiliary transformers is not sufficient to allow each to be considered an independent offsite power supply.

The normal preferred feeds from the unit auxiliary transformers are routed around the outside of the Turbine Building in an electrical tunnel from the unit auxiliary transformers to the Turbine Building switchgear rooms as shown on Figure 8.2-1. (An underground duct bank is an acceptable alternate.) From there the feeds to the Reactor Building exit the Turbine Building and continue across the roof on the Divisions I and III side of the Control Building (Figure 8.2-1, Sheet 3). They drop down the side of the Control Building in the space between the Control and Reactor Buildings where they enter the Reactor Building and continue on through the Divisions I and III side of the Reactor Building to the respective Class 1E switchgear rooms in the Reactor Building.

The alternate preferred feeds from the reserve auxiliary transformers are routed inside the Turbine Building. The Turbine Building switchgear feed from the reserve auxiliary transformer is routed directly to the Turbine Building switchgear rooms. The feed to the Control Building is routed in corridors outside of the Turbine Building switchgear rooms. It exits the Turbine Building and crosses the Control Building roof on the opposite side of the Control Building from the route for the normal preferred power feeds. The steam tunnel is located between the normal preferred feeds and the alternate preferred feeds across the stepped roof of the Control Building. The alternate preferred power feed turns down between the Control and Reactor Building and enters the Reactor Building on the Division I side of the Reactor Building. From there it continues on to the respective switchgear rooms in the Reactor Building.

Feeder circuit breakers from the unit auxiliary and reserve auxiliary transformers to the medium voltage switchgear are interlocked to prevent paralleling the normal and alternate power sources.

Instrument and control cables associated with the normal preferred power circuits are separated [i.e., by 15.24 m, or by walls or floors] from the instrument and control cables associated with the alternate preferred power circuits; with exception of the circuits in the control room, the circuits at the control and instrument DC power sources, and the interlock circuitry required to prevent paralleling of the two offsite sources. However, these circuits are electrically isolated and separated to the extent practical, and are not routed together in the same raceway. The reserve auxiliary transformers' power, instrument and control cables do not share raceways with any other cables. The instrumentation and control circuits for the normal and alternate preferred power shall not rely on a single common DC power source.

The instrumentation and control cables for the unit auxiliary transformers and the main generator circuit breaker may be routed in the raceways corresponding to the load group of their power source.

Class 1E rotating equipment, which could produce potential missile hazards, are not located in the same rooms as feeder circuits from the offsite to the Class 1E buses, unless protective barriers are installed to preclude possible interaction between offsite and onsite systems.

A combustion turbine generator (CTG) supplies standby power to the non-Class 1E buses which supply the non-Class 1E plant investment protection (PIP) loads. It is a 20 MW (minimum) rated self-contained unit which is capable of operation without external auxiliary systems. Although it is located on site, it is treated as an additional offsite source in that it supplies power to multiple load groups. In addition, manually controlled breakers provide the capability of connecting the combustion turbine generator to any of the Class 1E buses if all other AC power sources are lost.

In this way, the CTG provides a second "offsite" power source to any Class 1E bus being fed from the reserve auxiliary transformers while the associated unit auxiliary transformer is out of service.

The combustion turbine generator (CTG) is located in the Turbine Building, and is shown on Figure 8.2-1, Sheet 2. The CTG standby power feed and instrument and control cables for the Turbine Building are routed directly to the switchgear rooms in the Turbine Building. The power feeders and instrument and control cables to the Reactor Building are routed adjacent to the alternate preferred feeds across the Control and Reactor Buildings in their own raceway.

## **8.2.2 Analysis**

In accordance with the NRC Standard Review Plan (NUREG-0800), Table 8-1 and Section 8.2, the offsite power distribution system is designed consistent with the following criteria, so far as it applies to the non-Class 1E equipment. Any exceptions or clarifications are so noted.

### **8.2.2.1 General Design Criteria**

- (1) GDC 5 and RG 1.81—Sharing of Structures, Systems and Components

The ABWR is a single unit plant design. Therefore, these criteria are not applicable.

- (2) GDC 17—Electric Power Systems

Each circuit of the preferred power supply is designed to provide sufficient capacity and capability to power equipment required to ensure that: (1) Fuel design limits and design conditions of the reactor coolant pressure boundary will not be exceeded as a result of anticipated operational occurrences, and (2) In the event of plant design-basis accidents, the core will be cooled, and containment integrity and other vital functions will be maintained.

As shown in Figure 8.3-1, each of the Class 1E divisional 4.16 kV M/C buses can receive power from multiple sources. There are separate utility feeds from the offsite transmission network (via the main power transformer, the unit auxiliary transformers, and the reserve auxiliary transformers). The unit auxiliary transformer output power feeds and instrumentation and control circuits and the reserve auxiliary transformer output power feeds and instrumentation and control circuits are routed by two completely separate paths through the yard, the Turbine Building, Control Building and Reactor Building to their destinations in the electrical equipment rooms and main control room. The transformers are provided with separate oil collection pits and drains to a safe disposal area.

Separation of offsite equipment is discussed in Subsection 8.2.1.3. The plant fire protection system is discussed in Section 9.5.1. Although these preferred power sources are non-Class 1E, such separation and provision assure the physical independence requirements of GDC 17 are preserved.

Switching and lightning surge protection is provided by the station grounding and surge protection systems described in Appendix 8A, and by the independent feeds (i.e., normal and alternate preferred power circuits described in Subsection 8.2.1.2). Maximum and minimum voltage ranges are specified in Subsection 8.2.3(2) and transformers are designed per Subsection 8.2.1.2. Allowable frequency variation or stability limitations are addressed in Subsection 8.2.3. Surge and EMI protection for Class 1E systems, equipment and components is described in Appendix 7A. Protection for degraded voltage conditions is discussed in Subsection 8.3.1.1.7(8).

## (3) GDC 18—Inspection and Testing of Electrical Power Systems

All equipment can be tested, as necessary, to assure continued and safe operation of the plant. For equipment which cannot be tested during plant operation, the reliability will be such that testing can be performed during plant shutdown (for example, the main generator circuit breaker). See Subsection 8.2.4 for COL license information.

Isolated and non-segregated phase bus ducts provide access for inspection and maintenance. They also have provisions for excluding debris and fluids, and for draining condensates.

The ABWR is designed to provide testing and/or verification capability as described above, including the items identified in Subsection 8.2.4.1.

## (4) RG's 1.32, 1.47, and BTP ICSB 21

These distribution load groups are non-Class 1E and non-safety-related. However, they are important to safety and are in compliance with these guidelines.

## (5) RG 1.153—Criteria For Power, Instrumentation and Control Portions of Safety Systems

## (6) RG 1.155—Station Blackout

See Appendix 1C

## (7) BTP ICSB 11 (PSB)—Stability of Offsite Power Systems

## (8) Appendix A to SRP Section 8.2

It is a requirement that the design, testing and installation of the main generator circuit breaker meet the specific guidelines of this appendix, therefore compliance with the appendix is assured.

## (9) IEEE-765, IEEE Standard for Preferred Power Supply for Nuclear Powered Generating Stations

It is a requirement that the total design provided by the Nuclear Steam Supply System (NSSS) Vendor and the applicant meet the requirements of this IEEE standard as modified by the specific additional requirements and explanatory statements in Table 8.2-1. The additional requirements are more restrictive than the requirements which they replace or modify from the IEEE standard. Any stated requirements in Tier 2 which are in conflict with the requirements stated in this standard take precedence over the requirements of the standard.



### **8.2.3 Interface Requirements**

The standard design of the ABWR is based on certain assumptions concerning the design bases which shall be met by the COL applicant in designing the portion of the offsite power system in his scope, as defined in Subsection 8.2.1.1. Those design bases assumptions are listed here which the COL applicant shall meet.

- (1) The offsite system shall consist of a minimum of two independent offsite transmission circuits from the transmission network.
- (2) Voltage variations of the offsite transmission network during steady state operation shall not cause voltage variations at the loads of more than plus or minus 10% of the loads nominal ratings.
- (3) The normal steady state frequency of the offsite transmission network shall be within plus or minus 2 hertz of 60 hertz during recoverable periods of system instability.
- (4) The offsite transmission circuits from the transmission network through and including the main step-up power and reserve auxiliary transformers shall be sized to supply their load requirements, during all design operating modes, of their respective Class 1E divisions and non-Class 1E load groups.
- (5) The impedance of the main step-up power and reserve auxiliary transformers shall be compatible with the interrupting capability of the plant's circuit interrupting devices.
- (6) The independence of offsite transmission power, instrumentation, and control circuits shall be compatible with the portion of the offsite transmission power, instrumentation, and control circuits within the ABWR Standard Plant scope.
- (7) Instrumentation and control system loads shall be compatible with the capacity and capability design requirements of DC systems within the ABWR Standard Plant scope.

### **8.2.4 COL License Information**

#### **8.2.4.1 Periodic Testing of Offsite Equipment**

Appropriate plant procedures shall include periodic testing and/or verification to ensure the following:

- (1) The normal and alternate offsite power circuits are verified to be energized and connected to the appropriate Class 1E distribution system division at least once every 12 hours.

- (2) The instrumentation, control, and protection systems, equipment, and components associated with the normal and alternate offsite preferred circuits are properly calibrated and perform their required functions.
- (3) The required Class 1E and non-Class 1E loads can be powered from their designated preferred power supply within the capacity and capability margins specified in Tier 2 for the offsite system circuits.
- (4) The loss of the offsite preferred power supply can be detected.
- (5) Switching between preferred power supplies can be accomplished.
- (6) The batteries and chargers associated with the preferred power system can meet the requirements of their design loads.
- (7) The generator breaker can open on demand. (Note: The breaker's actual opening and closing mechanisms are inherently confirmed during the shutdown and synchronizing processes. Trip circuits shall be periodically verified during shutdown periods while the breaker is open.)
- (8) Isolated and non-segregated phase bus ducts are inspected and maintained such that they are clear of debris, fluids, and other undesirable materials. Also, terminals and insulators are inspected, cleaned and tightened, as necessary.

The test and inspection intervals will be established and maintained according to the guidelines of IEEE-338, Section 6.5, as appropriate for non-Class 1E systems (i.e., Items (4) and (7) of Section 6.5.1 are not applicable).

#### **8.2.4.2 Procedures when a Reserve or Unit Auxiliary Transformer is Out of Service**

Appropriate plant operating procedures will be imposed whenever the reserve auxiliary transformer or a unit auxiliary transformer is out of service.

#### **8.2.4.3 Offsite Power Systems Design Bases**

Interface requirements for the COL applicant offsite power systems design bases are provided in Subsection 8.2.3.

#### **8.2.4.4 Offsite Power Systems Scope Split**

Interface requirements for the COL applicant pertaining to offsite power systems scope split are provided in Subsection 8.2.3.

#### **8.2.4.5 Capacity of Auxiliary Transformers**

Appropriate plant procedures shall be provided to assure ONAN/ONAF ratings of any reserve auxiliary transformer, or any unit auxiliary transformer, will not be exceeded under any operating mode (Subsection 8.2.1.2).

#### **8.2.5 Conceptual Design**

- (1) Voltage variations of the offsite transmission network during steady state operation do not cause variations at the loads of more than plus or minus 10% of the loads nominal ratings.
- (2) The normal steady state frequency of the offsite transmission network are within plus or minus 2 hertz of 60 hertz during recoverable periods of system instability.
- (3) The offsite transmission lines from the transmission network to the main power and reserve switching stations do not have a common takeoff structure or use common structure for support.
- (4) The tie lines from the main step-up power and reserve auxiliary switching stations to their respective transformers do not have a common takeoff structure or use common structures for support.
- (5) The two offsite circuits from the transmission network to the transformers are designed to minimize their simultaneous loss as a result of failure of any transmission tower, crossing line, single breaker, switchgear bus, or cable.
- (6) The main and reserve offsite power systems' transmission lines from the transmission network and tie lines do not cross over each others offsite lines or switching station equipment.
- (7) The offsite circuits are designed in accordance with industry recommended practice in order to minimize the likelihood that they will fail while operating under the environmental conditions (such as, wind, ice, snow, lightning, temperature variations, or flood) to which they are subject.
- (8) System studies demonstrate that the offsite transmission network will not degrade below a level consistent with the availability goals of the plant as a result of contingencies such as loss of any of the following elements: Nuclear power generating unit, largest generating unit, most critical transmission circuit or intertie, or largest load.
- (9) Separation between the main and reserve offsite circuits (e.g., the transmission lines, tie lines, switching stations, transformers, bus ducts, and power, instrumentation and control cables), is at least 15.24 meters and is greater than the height of any

component which could cause loss of both offsite circuits up to the point at which the component can no longer affect both circuits. (Note: the switching stations may be in the same switchyard or separated switchyards provided the required minimum separation is maintained).

- (10) The reserve auxiliary transformers are separated by a minimum of 15.24 m from the unit auxiliary transformers.
- (11) Instrumentation and control circuits of the main power offsite circuit (i.e., normal preferred power circuit) are separated from the instrumentation and control circuits for the reserve power circuit (i.e., alternate preferred power circuit) in the same manner as described in (9) and (10) above.
- (12) Lightning arresters are provided for each phase of all tie lines connecting the plant electrical systems to the switchyard and transmission network. These arresters are connected to the high-voltage terminals of the main step-up power and reserve auxiliary transformers. Transformers are also grounded.
- (13) The main step-up power and reserve auxiliary transformers are provided with separate oil collection pits and drains to safe disposal area, and are provided with fire protection deluge systems as specified in Section 9A.4.6.
- (14) Analyses of the incoming transmission lines assures that the expected availability of the offsite power is as good as the assumptions made in performing the plant probabilistic risk analysis (see item 5.1.2 of Table 8.2-1, and Chapter 19).
- (15) The main step-up power and the reserve auxiliary transformers are designed to meet the requirements of ANSI Standard C37.06 (Reference 8.2-1), General Requirements for Liquid-Immersed Distribution, Power Regulating Transformers.
- (16) The main power transformer consists of three normally energized single-phase transformers with an additional installed spare. Provisions are made to permit connecting and energizing the spare transformer in no more than 12 hours following a failure of one of the normally energized transformers.
- (17) The offsite transmission circuits from the transmission network through and including the main step-up power and reserve auxiliary transformers are designed and constructed to withstand the mechanical and thermal stresses from the worst case faults.
- (18) The calculated rated conditions for the main step-up power transformer is 3-537.5 MVA single phase at a power factor of 0.9 and a voltage of approximately 26 kV plus or minus 10%. The main step-up power transformer and high voltage circuit has

sufficient impedance to limit the primary side maximum available fault current contribution from the system to that required by the main generator output circuit breaker as defined in Subsection 8.2.1.2.

- (19) The calculated rated conditions for the reserve auxiliary transformers are 82.5/110 MVA (ONAN/ONAF) at a 0.9 power factor. When coordinated with the design of the reserve auxiliary transformers, the offsite transmission system circuit supports a maximum allowable voltage dip of 20% during the starting of large motors.
- (20) The offsite transmission circuits from the transmission network through and including the main step-up power and reserve auxiliary transformers are sized to supply their load requirements, during all design operating modes, of their respective Class 1E divisions and non-Class 1E load groups.
- (21) The impedances of the main step-up power and reserve auxiliary transformers are compatible with the interrupting capability of the plant's circuit interrupting devices.
- (22) Circuit breakers and disconnect switches are sized and designed in accordance with the latest revision of ANSI Standard C37.06 (Reference 8.2-1), Preferred Ratings and Related Capabilities for AC high-Voltage Circuit Breakers Rated on a Symmetrical Current Basis. All circuit breakers are purchased new (i.e., not refurbished used ones) in accordance with resolution of NRC Information Notice 88-46 (see Question/Response 435.56 in Subsection 20.3.8).
- (23) The main power switching station has at least two full capacity main buses arranged such that:
  - (a) Any incoming or outgoing transmission line can be switched without affecting another line;
  - (b) Any single circuit breaker can be isolated for maintenance without interrupting service to any circuit; and
  - (c) Faults of a single main bus are isolated without interrupting service to any circuit.
- (24) Provisions are made to synchronize the generating unit through the main power switching station's circuit breakers.
- (25) All relay schemes used for protection of the offsite power circuits and the switching station's equipment include primary and backup protection features. All breakers are equipped with dual trip coils. Each protection circuit which supplies a trip signal is connected to a separate trip coil. All equipment and cabling associated with primary and backup protection circuits are physically separated from each other.

- (26) Each transformer has a primary and backup protective devices. DC power to the primary and backup devices is supplied from separate non Class 1E DC sources.
- (27) The DC power needed to operate primary and backup protection and control equipment of the offsite power system is supplied from two separate switching station batteries located in each switching station, each with a battery charger fed from a separate AC bus. Each battery is capable of supplying the DC power required for normal operation of the switching station's equipment. Each charger is capable of supplying the required loads while recharging its battery.
- (28) Two redundant low voltage AC power supply systems are provided to supply AC power to the switching station's auxiliary loads. Each system is supplied from separate, independent AC buses. The capacity of each system is adequate to meet the AC power requirements for normal operation of the switching station's equipment.

### **8.2.6 References**

- 8.2-1 ANSI Std C37.06, Preferred Ratings and Related Capabilities for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
- 8.2-2 ANSI Std C57.12.00, General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.

**Table 8.2-1 Additional Requirements IEEE-765**

IEEE-765 Reference		Requirement or Explanatory Note
4.1	General	Tier 2 Figure 8.3-1 should be used as the reference single line instead of the IEEE Std example, Figures 2, (a), (b) and (c).
4.2	Safety Classification	The separation criteria called for in Subsection 8.2.1.3 must be met.
4.5	Availability	The ABWR design utilizes direct connection of the two preferred power circuits to the Class 1E buses.
5.1.2	Transmission System Reliability	Additional analysis is required per Section 8.2.3(4).
5.1.3	Transmission System Independence	
	5.1.3.2	Specific requirements for tolerance to equipment failures are stated in Tier 2 and must be met.
	5.1.3.3	Since a separation of at least 15.24 m is required for the exposed circuits, a common takeoff structure cannot be used.
5.3.2	Class 1E Power System Interface Independence	(See 5.1.3.3 comments)
5.3.3	Connections with Class 1E Systems	
	5.3.3.2	Automatic dead-bus transfers are used to transfer from the preferred power supply to the onsite AC source. Manual dead-bus and live-bus transfers are used between preferred power supplies, and to transfer from the onsite source back to the preferred power supply. Automatic live-bus transfers are not required and are not used.
	5.3.3.3	Only standby power sources may be paralleled with the preferred power sources for load testing. The available fault current must be less than the rating of the breakers. It is not required and not allowed for the normal and alternate preferred power supply breakers for a bus to be closed simultaneously so there is no time that the available fault current at a bus exceeds the equipment rating.
7.0	Multi-Unit Considerations	The ABWR is a single unit design, therefore there is no sharing of preferred power supplies between units.

The following figure is located in Chapter 21:

**Figure 8.2-1 Power Distribution System Routing Diagram (Sheets 1–7)**