August 26, 1992

Docket No. 52-001

MEMORANDUM FOR: Michael H. Finkelstein, Attorney
Office of the General Counsel

Faust Rosa, Chief
Electrical Systems Branch
Division of Systems Technology, NRR

FROM: Robert C. Pierson, Director
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal, NRR

SUBJECT: REVIEW OF ADVANCED BOILING WATER REACTOR (ABWR) FINAL SAFETY EVALUATION REPORT (FSER) FOR CHAPTER 8

The enclosed FSER section noted above for the ABWR Standard Safety Analysis Report (SSAR) has been assembled, based upon input received from your branch. You are requested to review the enclosed section for technical content, and ensure that the positions stated in the FSER have an adequate technical basis provided. This review will not constitute your final concurrence review of this section, but is being requested in an effort to meet an extremely aggressive schedule for issuance of the FSER.

During this review, you are requested to ensure that 1) your technical input has been accurately incorporated, 2) all previously open and confirmatory items are specifically addressed, 3) the FSER chapter reflects all changes to the SSAR through Amendment 20, and 4) the metrication policy is properly reflected.

Your review and handwritten comments are needed by September 1, 1992, in order to support the timely completion of the FSER. The contact for this chapter is Jerry Wilson at 504-3145 or Chester Poslunsy at 504-3145.

Original Signed By:

Robert C. Pierson, Director
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal, NRR

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As stated

cc w/o enclosure:
D. Crutchfield

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8.1 Introduction

The staff reviewed the ABWR design descriptions and commitments documented in Chapter 8 of GE's SSAR through Amendment 17. The staff also reviewed GE's SSAR draft revision of April 3, 1992, which has been docketed but has not yet been incorporated into the SSAR. The bases for evaluating the adequacy of ABWR electric power systems presented in SSAR Chapter 8 were the acceptance criteria and guidelines for electric power systems contained in SRP Chapter 8 and Regulatory Guides (RGs) 1.153 (Rev. 0), "Criteria for Power, Instrumentation, and Control Portions of Safety Systems," and 1.155 (Rev. 0), "Station Blackout." The Nuclear Regulatory Commission (NRC) approved these regulatory guides following the issuance of SRP Revision 3, and they apply to the ABWR electric power system design.

The standards, criteria, and guidelines used by the staff are for the most part in English units. Where conversion to metric is warranted, this information is supplied before the English units. For those measurements where direct conversion is ambiguous or misleading the English unit specification is retained. As an example, separation criteria of 5 feet is not converted to metric, as 1.52 meters implies an inappropriate exactness and about 2 meters is misleading.

All conclusions in this section of the SER are contingent upon verification of GE's commitment to amend the SSAR as required (including incorporating information and modifications discussed in this SER). The staff will then reevaluate SSAR Chapter 8.

The staff's initial findings were included in the DSER, SECY-91-355. Open items from that document will be referenced in the discussions below on this SER.

8.2 Offsite Electric Power System

The offsite electric power system is commonly called the "preferred" power source. The staff's evaluation of this system focused on the system's importance as the required supplier for the onsite power system (that is, the Class 1E ac-distribution system), which supplies the safety-related equipment.

For the ABWR, the offsite electric power system comprises the following circuits:

- preferred power circuit - a back-feed circuit from the transmission network to the input terminals of each of the three redundant, onsite Class 1E ac-distribution systems through the main transformer and three unit auxiliary transformers

- alternate preferred power circuit - from the transmission network through one reserve auxiliary transformer to the input terminals of each of the three redundant, onsite Class 1E ac-distribution systems

Because GE shares the ABWR design responsibility for this system with the COL applicants, those parts that are outside the scope of design of the ABWR standard plant, and those parts that are within the scope of design of the ABWR standard plant are described and evaluated as follows.

8.2.1 Preferred Offsite Circuits Outside the ABWR Scope of Design

The following portions of the preferred power circuits are outside the scope of design of the ABWR standard plant:

- preferred power circuit from the transmission network through the main power transformer to the low-voltage terminals of the main transformer, and

- alternate preferred power circuit from the transmission network to the high-voltage terminals of the reserve auxiliary transformer

8.2.1.1 Scope of GE Design of Offsite Preferred Circuits

Section 3.1.2.2.8.2.2 and, Sections 8.2.1, 8.2.2, and 8.2.3 of SSAR Amendments 7 and 10 are inconsistent with regard to which parts of the offsite system are within (or outside) the ABWR standard design scope (DSER (SECY-91-355) Open Item 22). It is the staff's understanding, based on discussions with GE, that GE committed to revise Section 3.1.2.2.8.2.2 of SSAR Amendment 7 so that it is consistent with the above defined scope of design. This is acceptable and is Confirmatory Item 8.2.1.1-1.

8.2.1.2 Definition of Offsite System

GE's draft SSAR submittal of April 3, 1992, indicated that the offsite power system begins at the terminals on the transmission network side of the circuit breakers connecting the switching stations to the offsite transmission system. That draft also indicates that the offsite power system ends at the terminals of the plant's main generator and at the circuit breaker input terminals of the medium-voltage (6.9 kV) switchgear. This description is not consistent with the NRC SRP definition of an offsite system (DSER SECY-91-355 Open Item 27). Specifically, GE's definition appears to exclude the transmission system, as well as the plant's main generator and gas turbine generator. It is the staff's understanding, based on discussions with GE, that GE will revise the SSAR in a future amendment to be consistent with the NRC SRP definition of an offsite system. This is acceptable. The remaining portions of GE's revised SSAR related to system analysis and description and are acceptable. This is Confirmatory Item 8.2.1.2-1.

8.2.1.3 Offsite Power System Interfaces

GE in the draft SSAR submittal dated April 3, 1992, responded to the Open Item 24 from the DSER (SECY-91-355) which defined the interfaces for the offsite circuit for components of the offsite system between and including the main transformer to the utility grid system, and from the reserve auxiliary transformer to the utility grid system. Based on discussion with GE, the staff understands that GE will document similar interfaces in the SSAR in a future amendment. This is Confirmatory Item 8.2.1.3-1.

Section 8.2.3.1 of GE's draft SSAR submittal of April 3, 1992, indicated that a COL applicant "should" meet the interface requirements defined in Section 8.2.3 of the ABWR SSAR. Applicants who reference the ABWR design will be required to meet all interface requirements. Based on discussions with GE, the staff understands that GE will revise the SSAR in a future amendment to indicate that interface requirements "shall" be met by the applicant. This is Confirmatory Item 8.2.1.3-2.

The staff also understands, based on discussions with GE, that GE will revise in a future amendment the SSAR section on interface requirements to include a listing of the regulatory requirements and associated regulatory and industry guidance, which a COL applicant must address in its design scope as part of the COL application. For the offsite system, these should include, as a minimum, the requirements of Criteria 17 and 18 of 10 CFR Part 50, Appendix A as well as the guidelines of IEEE 765-1983. This is Confirmatory Item 8.2.1.3-3.

Interface requirement (2) in Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, indicated that a COL applicant who references the ABWR design is expected to establish the size of the unit auxiliary transformers to ensure a voltage dip of no more than 20 percent during motor starting. It is the staff's understanding, based on discussions with GE, that the sizing of the unit auxiliary transformers is within the ABWR scope of design responsibility. The staff further understands that GE will revise the SSAR in a future amendment to include only COL applicant requirements in the section on interfaces and to reflect the transformer design information as within scope of design information. This is Confirmatory Item 8.2.1.3-4.

Interface requirement (4) in Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, indicated that it is acceptable and recommended to normally power all three divisions of the Class 1E ac-distribution system from the normal preferred power source. This interface requirement is not consistent with design commitments that are currently documented in other sections of the SSAR (see Section 8.2.3.5 of this SER). Based on discussions with GE, the staff understands that GE will delete this requirement (specifically, the second sentence of interface requirement (4) in Section 8.2.3.1 of the draft SSAR revision dated April 3, 1992) when the SSAR is revised in the future. This is Confirmatory Item 8.2.1.3-5.

Interface requirement (5) in Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, indicated that the two offsite circuits will be connected to different transmission systems. It is the staff's understanding, based on discussions with GE, that there is only one transmission system. The staff further understands that GE will clarify the interface requirement in a future amendment to indicate that the main and reserve offsite power circuits will be connected to different transmission circuits or lines (rather than systems) and that the transmission circuits or lines will be independent and separate. This is Confirmatory Item 8.2.1.3-5.

Section 8.2.3.1 of GE's draft SSAR submittal dated April 3, 1992, did not include additional interface requirements defining what is required of the COL applicant in order to have independent and separate transmission circuits and switching stations. Based on discussions with GE, the staff understands that GE will include in the SSAR in a future amendment explicit interface requirements defining independence and separation of transmission lines and switching stations or switchyards. As a minimum, these requirements will include the following commitments.

- The two designated preferred power circuits will not have a common takeoff structure or use common structures for support.

- The two lines from the transmission system that are designated as the preferred power circuits will be designed to minimize their simultaneous loss as a result of failure of any transmission tower or failure from crossing lines.

- The preferred power circuits originating from the transmission system will be designed to minimize their simultaneous failure as a result of failure of a single breaker, switchyard bus, switchgear bus, or cable.

- System studies will be performed to demonstrate that the preferred power supply 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
  - largest load

- The interconnection between the transmission system and the switchyard will consist of a minimum of two transmission lines that are designated as the preferred power supply circuits. Where more than two lines are available from the transmission system, any combination of two lines may be designated and used as the preferred power supply circuits, provided that each combination of two circuits meets the offsite system interface requirements.

- Switchyard equipment will be designed to adequately withstand stresses from the worst-case faults.

- The physical design of the switchyards will minimize the probability that a single equipment failure will cause the simultaneous or subsequent loss of both preferred power supply circuits. This is Confirmatory Item 8.2.1.3-7.

Interface requirement (4) in Section 8.2.3.1 of GE's draft SSAR submittal of April 3, 1992, indicated that the COL applicant will analyze incoming transmission lines to ensure that their expected availability is as good as assumed in performing the plant's probability risk analysis. Based on discussions with GE, the staff contends that the assumptions made in performing the plant's probability risk analysis are within the scope of the ABWR design. The staff understands that GE will explicitly state as part of this interface requirement, the expected availability of incoming transmission lines in a future amendment. This is Confirmatory Item 8.2.1.3-8.

Design commitments documented in the SSAR indicated that the conceptual design of the ABWR offsite preferred power system will include two separate and independent switching stations (i.e., or switchyards). Given that there will be two separate and independent switchyards, the interface requirements within individual switchyards presented in GE's draft submittal of April 3, 1992, go beyond industry-recommended practice for offsite preferred circuits. The staff understands that GE will revise the SSAR as needed to describe the parts of the offsite system switchyard not subject to interface requirements specified in Section 8.2.3 of the draft submittal of April 3, 1992, in a future amendment. This is Confirmatory Item 8.2.1.3-9.

8.2.1.4 Design Certification Material

10 CFR Part 52.47(a)(1)(viii) requires that interface requirements shall be verifiable through inspections, tests, or analyses and that the method to be used for this verification be included as part of the ITAAC. The Design Certification Material for the GE ABWR Design Stage 2 Submittal, transmitted by letter dated April 6, 1992, did not specify the appropriate interface-related ITAAC material for the offsite systems outside the ABWR scope of design. ITAAC must address this interface area. This resolves DSER (SECY-91-355) Open Item 24. This is Open Item 8.2.1.4-1.

8.2.2 Preferred Offsite Circuits Within the ABWR Scope of Design

The following portions of the preferred power circuits are within the scope of design of the ABWR standard plant:

- preferred power circuit from the low-voltage terminals of the main transformer through the three unit auxiliary transformers to the input terminals of each of the three redundant, onsite Class 1E ac distribution systems, and

- alternate preferred power circuit from the high-voltage terminals of the reserve auxiliary transformer to the input terminals of each of the three redundant, onsite Class 1E ac distribution systems

8.2.2.1 Physical Separation (Transformers and Circuits)

Physical Separation of Transformers

By its draft submittal dated April 3, 1992, GE revised the SSAR to indicate that the reserve auxiliary transformer will be separated from the unit auxiliary transformers by a minimum distance of 50 feet and that each transformer will be provided with an oil collection pit and drain to a safe deposal area. In addition, Section 9A.4.6 of SSAR Amendment 14 indicates that the main, unit auxiliary, and reserve transformers will have oil collection pits. Section 9A.4.6 also indicates that each of these transformers will have automatic deluge water spray systems.

The staff concludes that the 50-feet separation between the normal and alternate preferred power circuit transformers, together with each transformer's oil collection pit and automatic deluge water spray system, will minimize to the extent feasible the likelihood of simultaneous failure of both normal and alternate offsite preferred power circuits. Consequently, these specifications meet the requirements of Criterion 17 of 10 CFR Part 50, Appendix A and are acceptable subject to the incorporation of the transformer separation information discussed above being incorporated into a future SSAR amendment. This is Confirmatory Item 8.2.2.1-1.

Design Certification Material

Similarly Design Certification Material for the GE ABWR Design Stage 2 Submittal, transmitted by letter dated April 6, 1992, indicates that the reserve auxiliary transformer and its input feeders will be separated from the main power transformer and its input feeders and from the unit auxiliary transformers by a minimum of 50 feet.

This Tier 1 design description is acceptable, however, specific ITAAC for this subject is required. GE has provided the Phase 3 submittal including proposed ITAAC, which is under staff review. This is Open Item 8.2.2.1-1.

Physical Separation of Circuits

By its draft submittal dated April 3, 1992, GE revised the SSAR to indicate that separation of the normal preferred and alternate preferred power feeds will be accomplished by floors and walls surrounding their routes through the turbine, control, and reactor buildings except within the switchgear rooms where they must be routed to the same switchgear lineups. Based on discussions with GE, the staff understands that normal and alternate circuits in the switchgear rooms will be separated to the maximum extent feasible; that is, the circuits will be routed on opposite sides of the room and will be connected to the switchgear lineup on opposite ends. Also, based on discussions with GE, the staff understands that the isolated phase bus duct and cables located outside the turbine, control, and reactor buildings and associated with either the normal or alternate preferred power circuits will be separated by a minimum of 50 feet from the reserve auxiliary transformer. Likewise, the isolated phase bus duct and cables located outside the turbine, control, and reactor buildings and associated with the alternate preferred offsite circuit will be separated by a minimum of 50 feet from the unit auxiliary and main transformers.

With regard to the physical separation between the normal and alternate preferred power circuits (i.e., power circuits within the GE scope of supply) from the transformers to the input terminals of the Class 1E system, the staff concludes that the 50-foot separation between the transformers and the normal and alternate preferred power circuits will minimize to the extent feasible the likelihood of simultaneous failure of both circuits under operating and postulated accident and environmental conditions. Consequently, these specifications meet the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and are acceptable contingent upon GE's inclusion of appropriate changes to the SSAR in a future amendment to reflect the above information. This is Confirmatory Item 8.2.2.1-2.

Design Certification Material

The physical separation for circuit designs commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.1-2.

8.2.2.2 Physical Separation of Power, Instrumentation, and Control for the Offsite Power System

Based on GE's draft submittal dated April 3, 1992, and discussions with GE, the staff understands that instrumentation and control cables associated with the normal and alternate preferred offsite circuits will be separated as follows:

- The cables associated with the instrumentation and control circuits for the normal preferred offsite circuit will be routed in solid, metal-enclosed raceways corresponding to the load group of their power source.

- The cables associated with the instrumentation and control circuits for the alternate preferred offsite circuit will be routed in dedicated raceways. The alternate preferred offsite instrumentation and control circuit cables will not share raceways with any other cables.

- The separation between the normal and alternate preferred offsite instrumentation and control cables will be the same as the separation between the normal and alternate preferred offsite power circuits (that is, floors, walls, or 50 feet of physical separation).

The staff concludes that these provisions for isolating the instrumentation and control circuits will minimize to the extent feasible the likelihood of simultaneous failure of both normal and alternate offsite preferred power circuits under operating and postulated accident and environmental conditions. Consequently, these provisions meet the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and are acceptable contingent upon GE's inclusion upon GE providing the above information in a future SSAR amendment. This resolves Open Item 23 of the DSER (SECY-91-355). This is Confirmatory Item 8.2.2.2-1.

Design Certification Material

The physical separation of power, instrumentation, and control for the offsite power system design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.2-1.

8.2.2.3 Electrical Independence

Based on GF ' SAR submittal dated April 3, 1992, and discussions with GE, the staf, understands -+ there will be no electrical interconnections between the normal and alternate preferred power, instrumentation, and control circuits except where the power circuits connect to common Class 1E and non-Class 1E switchgear lineups. At the common switchgear, one open and one closed circuit breaker will maintain the electrical independence. These circuit breakers will be interlocked so that the closed breaker must be opened before the open breaker can be closed. Transfer from normal to alternate (or alternate to normal) preferred power circuits will be manual. Instrumentation and control circuits (including their power supply) associated with the normal preferred offsite circuit will be electrically independent from (that is, they will have no electrical interconnection with) the instrumentation and control circuits including their power supply associated with the alternate preferred power supply.

The staff concludes that these provisions for electrical independence of power, instrumentation, and control circuits will minimize to the extent feasible the likelihood of simultaneous failure of both normal and alternate offsite preferred power circuits under operating and postulated accident and environmental conditions. Consequently, these provisions meet the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and are acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.2.3-1.

Design Certification Material

The electrical independence design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.3-1.

8.2.2.4 Testing for the Offsite Power System

This section addresses DSER (SECY-91-355) Open Item 25.

Based on GE's draft submittal dated April 3, 1992, and discussions with GE, the staff understands that all systems, equipment, and components associated with the normal and alternate offsite preferred power circuits within the GE scope of design, except generator breakers, will have the capability to be tested periodically during normal plant operation. Based on this commitment, the staff understands that the design will permit verification of the following offsite power system capabilities:

- The generator breaker can open on demand.
- 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.

- The instrumentation and control systems, equipment, and components associated with the system used to prevent incorrect synchronization of the generator breaker are properly calibrated and perform their required functions.

- All 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 the SSAR for the offsite system circuits.

- The loss of the offsite preferred power supply can be detected.

- Transfer between preferred power supplies can be accomplished.

- The batteries and chargers associated with the preferred power system can meet the requirements of their design loads.

In addition, the staff understands that the design of high- and medium-voltage bus ducts and cables provides ready access for regularly inspecting, cleaning, and tightening terminals, and for inspecting and cleaning insulators. The bus duct design also includes provisions for excluding debris and fluids, and for draining condensate.

The staff concludes that these testability requirements will ensure that electric power systems, equipment, and components important to safety are designed to permit appropriate periodic inspection and testing of important areas and features. Consequently, these provisions meet the requirements of Criterion 18 of 10 CFR Part 50, Appendix A, and are acceptable contingent upon GE providing the above design information in a future SSAR amendment. This resolves DSER (SECY-91-355) Open Item 25 and is Confirmatory Item 8.2.2.4-1.

With regard to periodic testing of the systems, equipment, and components, the staff has the following understandings:

- Periodic verification will ensure that the normal and alternate offsite power circuits are energized and connected to the appropriate Class 1E distribution system division at least once every 12 hours.

- Tests and inspections will be performed at appropriately scheduled intervals for each of the items highlighted above.

- The test and inspection intervals will be established and maintained according to the guidelines of IEEE 338-1977, Section 6.5.

Based on these understandings, the staff concludes that structures, systems, and components important to safety will be tested commensurate with the importance of the safety function to be performed. Consequently, these tests meet the requirements of Criteria 1 of 10 CFR Part 50, Appendix A, and are therefore acceptable, contingent upon inclusion of the specified periodic tests and inspections in appropriate plant procedures and/or plant specific technical specifications. This is COL Action Item 8.2.2.4-1.

Design Certification Material

The testing for the offsite power system design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.2.4-1.

8.2.2.5 Generator Breaker

The low-voltage generator breaker must open on a turbine trip to maintain the normal preferred power supply to the safety buses. The generator breaker cannot be tested during normal plant operation without tripping the main turbine generator.

Based on discussions with GE, the staff understands that the opening of the generator breaker to establish the normal offsite preferred power circuit to safety buses will be verified each time the reactor is shutdown (at refueling intervals in accordance with the plant's technical specifications). In addition, based on information presented in the April 3, 1992, submittal, the staff understands that the generator breaker will open on command with a reliability of 99.67 percent.

The draft SSAR submittal of April 3, 1992, also indicates that during all modes of plant operation (including shutdown, refueling, startup, and run), the normal preferred power supply will be connected to two of the three safety buses, and the alternate preferred power supply will be connected to one of the three safety buses. If the normal preferred supply is lost because the generator breaker fails to open, offsite power will still be available immediately through the alternate preferred power supply to one of the three safety buses and on a delayed basis (within minutes by manual action from the control room) to the two other safety buses through the alternate preferred power supply.

Despite the inability to verify the generator breaker function during power operation, the staff concludes that once per refueling test frequency, the reliability of the generator breaker and the availability of the alternate preferred offsite power supply, will minimize to the extent feasible the likelihood of simultaneous failure of both normal and alternate offsite preferred power circuits under operating and postulated accident and environmental conditions. Consequently, the design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon inclusion of surveillance requirements in appropriate plant procedures. This is COL Action Item 8.2.2.5-1.

Design Certification Material

The generator breakers design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is Open Item 8.2.2.5-7.

8.2.2.6 Capacity and Capability of the Offsite Power System

Based on discussions with GE and information presented in the April 3, 1992, draft submittal of SSAR Chapter 8.0, the staff understands that the offsite power system will be designed to provide the following capacity and capabilities:

- Each circuit of the preferred power supply will be designed to provide sufficient capacity and capability to power equipment required to ensure that:

  - Fuel design limits and design conditions of the reactor coolant pressure boundary will not be exceeded as a result of anticipated operational occurrences.

  - In the event of plant design-basis accidents, the core will be cooled, and containment integrity and other vital functions will be maintained.

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

- The secondary winding of the reserve auxiliary transformer, which supplies the Class 1E load groups, will have an oil/air rating greater than or equal to the combined load of the three Class 1E load groups.

- The normal and alternate offsite preferred power circuits will be 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

  - normal and safe steady-state operation of all plant loads,

- starting and acceleration of the limiting drive system with the remainder of the loads in service, and

- reliable operation of the control and protection systems under conditions of degraded voltage

Specifically, when measured at the load terminals, the voltage variation at any voltage level will not exceed the following limits:

- plus or minus 10 percent of the load-rated voltage during all modes of steady-state operation

- minus 20 percent of the motor-rated voltage during motor starting

- Voltage levels at the low-voltage terminals of the auxiliary and reserve 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.

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

- During their operation, certain normal and alternate preferred power circuits are subject to transmission systems or steady-state and transient conditions (such as switching and lightning surges, maximum and minimum voltage ranges for heavy and light load conditions, frequency variation, or stability limits). Such circuits will be designed such that these conditions will not subject the onsite Class 1E systems, equipment, and components to conditions that are beyond the limits for which they are designed and qualified. These design considerations apply to all onsite Class 1E loads and systems that use the services of the preferred power supply during start up, normal operation, safe shutdown, accident, and post-accident operation.

- Performance and operating characteristics of the normal and alternate preferred power circuits will be required to meet operability and design-basis requirements. These requirements include, but are not limited to, the ability to withstand short-circuits, equipment capacity, voltage and frequency transient response, voltage regulation limits, step load capability, coordination of protective relaying, and grounding.

- The generator circuit breaker will be designed to withstand the maximum route mean squared (RMS) and crest momentary currents. Further, the breaker will be designed to interrupt the maximum asymmetrical and symmetrical currents determined to be produced by a bolted, three-phase fault at the location that results in the maximum fault currents.

- The main step-up transformers and the unit auxiliary and reserve transformers will be designed and constructed to withstand the mechanical and thermal stresses produced by external short circuits. In addition, these transformers will meet the corresponding requirements of the latest revisions of ANSI Standard C57.12.00.

- Circuit breakers and disconnecting switches will be sized and designed according to the latest revision of ANSI Standard C37.06, "Preferred Ratings and Related Capabilities for ac High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis."

Based on these above considerations, the staff concludes that the normal and alternate preferred offsite circuits within GE's design scope will have sufficient capacity and capability.

Design Certification Material

The capacity and capability of the offsite power system design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.2.2.6-1.

Based on GE's commitments regarding plant operation, the staff understands that the following operational restrictions will apply:

- Operational restrictions will require the reserve auxiliary transformer to supply one of three Class 1E load groups during normal plant operation.

- Operational restrictions will prohibit the reserve auxiliary transformer from supplying more than one load group during normal plant operation, including when one of the three unit auxiliary transformers is out of service.

- The load on the secondary winding of the reserve auxiliary transformer which supplies the non-Class 1E load groups will be prohibited by operational restrictions from supplying loads greater than the winding's oil/air rating.

- When the reserve auxiliary transformer is supplying non-Class 1E loads normally supplied by the unit auxiliary transformers, electrical and physical independence will be maintained between power, instrumentation, and control circuits associated with the normal and alternate preferred power supplies.

- The load on the unit auxiliary transformers during normal operation when all three unit auxiliary transformers are operable will be prohibited by operational restrictions from supplying loads greater than the oil/air rating of the transformer or its windings.

- The load on the unit auxiliary transformers during normal operation when one of three unit auxiliary transformers is inoperable will be prohibited by operational restrictions from supplying loads greater than two-thirds of the forced oil/air rating of the transformer.

- When one of three unit auxiliary transformers is inoperable, continued plant operation will be appropriately limited (that is, when one of the three safety buses will not have access to both normal and preferred offsite circuits).

- When the reserve auxiliary transformer is inoperable, continued plant operation will be appropriately limited.

Therefore, the normal and alternate preferred offsite circuits meet the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and are acceptable contingent upon GE providing the noted design information in a future SSAR amendment and inclusion of the above commitments in appropriate procedures. Providing the design information resolves DSER (SECY-91-355) Open Item 26 and is Confirmatory Item 8.2.2.6-1 and inclusion of the above commitment in appropriate procedures is COL Item 8.2.2.6-1.

8.2.2.7 Grounding[1]

The ACRS, in an April 13, 1992, letter to the staff discussed a concern that the SSAR Chapter 8 did not discuss any requirements or design considerations for station grounding. Based on discussions with GE, it is the staff's understanding that GE will meet the following the Electric Power Research Institute (EPRI) plant grounding guidelines:

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[1] This was an ACRS Item.

- A station grounding grid, consisting of bare copper cables, will be provided that will limit step-and-touch potentials to safe values under all fault conditions.

- Bare copper risers will be furnished for all underground electrical ducts and equipment, and for connections to the grounding systems within buildings.

- The design and analysis of the grounding system will follow the procedures and recommendations specified by the latest revision of IEEE 665, "Guide for Generation Station Grounding."

- Each building will be equipped with grounding systems connected to the station grounding grid. As a minimum, every other steel column of the building perimeter will connect directly to the grounding grid.

- The plant's main generator will be grounded with a neutral grounding device. The impedance of that device will limit the maximum phase current under short-circuit conditions to a value not greater than that for a three-phase fault at its terminals.

- Provisions will be included to ensure proper grounding of the isophase buses when the generator is disconnected.

- The onsite, medium-voltage ac distribution system will be resistance grounded at the neutral point of the low-voltage windings of the unit auxiliary and reserve transformers.

- The neutral point of the generator windings of the onsite, standby power supply units safety- and non-safety-related, will be through distribution-type transformers and loading resistors, sized for continuous operation in the event of a ground fault.

- The neutral point of the low-voltage ac distribution systems will be either solidly or impedance grounded, as necessary, to ensure proper coordination of ground fault protection.

- The dc systems will be left ungrounded.

- Each major piece of equipment, metal structure, or metallic tank will be equipped with two ground connections diagonally opposite each other.

- The ground bus of all switchgear assemblies, motor control centers, and control cabinets will be connected to the station ground grid through at least two parallel paths.

- One bare copper cable will be installed with each underground electrical duct run, and all metallic hardware in each manhole will be connected to this cable.

- Plant instrumentation will be grounded through separate radial grounding systems consisting of isolated instrumentation ground buses and insulated cables. The instrumentation grounding systems will be connected to the station grounding grid at only one point and will be insulated from all other grounding circuits.

- Separate instrumentation grounding systems shall be provided for plant analog and digital instrumentation systems.

- A lightning protection system will be provided for each major plant structure, including the containment enclosure building. The design and installation of these systems will comply with the National Fire Protection Association's (NFPA's) Lightning Protection Code, NFPA-78, and the

Nuclear Energy Property Insurance Association's (NEPIA's) "Basic Fire Protection for Nuclear Power Plants" document.

- Lightning arresters will be provided in each phase of all tie lines connecting the plant electrical systems to the switching station(s) and offsite transmission system. These arresters will be connected to the high-voltage terminals of the main step-up and reserve transformers.

- Plant instrumentation and monitoring equipment located outdoors or connected to cabling that runs outdoors will be equipped with built-in surge suppression devices to protect the equipment from lightning-induced surges.

Based on these considerations, the staff concludes that plant structures, systems, and equipment will be appropriately grounded. The design is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.2.7-1.

Design Certification Material

The grounding design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.2.2.7-1.

8.2.3 Independence Of Offsite and Onsite Power Systems, Equipment, and Components

The preferred power supply furnishes electric power from the offsite system's transmission network (a common source of electric power) to redundant, onsite Class 1E systems, equipment, and components that are used for safe shutdown and operation of engineered safety features. This common source of electric power may be used during all modes of plant operation to supply power to redundant Class 1E load groups. Because redundant load groups are powered from a common power source, they can be subjected to conditions which may cause their common failure due to single events or failures of this single source of electric power. This section of the staff's evaluation, Independence Between Offsite and Onsite Systems Power Systems, Equipment, and Components, addresses ABWR design provisions for minimizing the probability of (1) common mode failure of redundant onsite Class 1E systems due to single events or failures of this common source of electric power and (2) failure of the onsite system from causing loss of the offsite system in accordance with the requirements of Criterion 17 of 10 CFR Part 50, Appendix A.

The following sections discuss the areas addressed in the staff's evaluation of ABWR design provisions intended to ensure an adequate level of independence between offsite and onsite systems.

8.2.3.1 Independence Of Offsite Circuits and Onsite Class 1E dc Systems

DC control, protection, and instrumentation power for offsite circuits, originally proposed for the ABWR design, were derived from the Class 1E dc system through dc to dc converters that GE considered isolation devices. By the draft SSAR revision of April 3, 1992, GE eliminated all electrical interconnections the ABWR design provided between the offsite circuit's control, protection, and instrumentation power and the onsite Class 1E dc systems, equipment, and components.

From this, the staff concludes that the offsite system circuits will derive their control, protection, and instrumentation power from a non-Class 1E dc system that is independent of the onsite Class 1E dc system. The staff also concludes that this design will ensure that failure in the offsite system will neither challenge nor possibly cause the loss of redundants onsite Class 1E dc systems. Similarly, the design will ensure that any single failure in the Class 1E dc system will not cause loss of offsite power to redundant load groups. The staff further concludes that this design will minimize common-cause failure between offsite and onsite power sources associated with a single load group. It will also minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Therefore, the design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable, upon GE providing the above design information in a future SSAR amendment. This resolves DSER (SECY-91-355) Open Item 28 and is Confirmatory Item 8.2.3.1-1.

Design Certification Material

The electrical independence between offsite circuits and onsite class 1E DC system design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.1-1.

8.2.3.2 Independence During Lost or Degraded Offsite Voltage

The ABWR design incorporates two distinct levels of protection to ensure the independence of offsite and onsite systems during lost or degraded voltage conditions:

(i) Loss of Offsite Voltage (First Level of Protection)

Section 8.3.1.1.7(1) of the April 3, 1992, draft revision to the SSAR indicates that the onsite Class 1E systems will be normally energized from the offsite normal and alternate preferred power system. Should the voltage on the Class 1E bus decay to less than 70 percent of its nominal rated value for a predetermined time, a bus transfer will be initiated. As a result of this transfer, the onsite Class 1E buses will be powered by the onsite standby diesel generators (rather than the offsite normal and alternate preferred power systems). Upon initiation of a bus transfer, a signal will be generated to open the offsite supply breaker to the Class 1E bus.

In the draft SSAR revision of April 3, 1992, the first paragraph of Section 8.3.1.1.7 indicated that the time delay for bus transfer initiation will change from 3 to 0.4 seconds if a loss-of-coolant accident (LOCA) signal is present when a loss of preferred offsite power (LOOP) occurs.

Discussions with GE confirmed that the proposed ABWR design will include a time delay relay to establish the predetermined time before bus transfer initiation. When only a LOOP signal is present, the time delay relay will be set for 3 seconds. When both LOOP and LOCA signals are present, the time delay relay will be set for 0.4 seconds.

The purpose of the time delay is to reduce unnecessary transfer from offsite to onsite sources during offsite power system transients. If voltage on the offsite system drops below 70 percent for less than 3 seconds (or 0.4 seconds when both LOCA and a LOPP signals are present), both the LOOP and time delay relay will reset after voltage recovery and transfer will not be initiated.

(2) Degraded Offsite Voltage (Second Level of Protection)

In the draft SSAR revision of April 3, 1992, Section 8.3.1.1.7(8) indicates that when the bus voltage degrades to 90 percent or less of its rated value and remains degraded throughout a time delay, an undervoltage condition will be annunciated in the control room. Simultaneously, a 5-minute timer will be started, allowing the operator to take necessary corrective action. After 5 minutes, the feeder breaker affected by the degraded voltage will be tripped. Should a LOCA occur during the 5-minute time delay, the affected feeder breaker will be tripped immediately.

In the draft SSAR submittal of April 3, 1992, Section 8.3.1.2.1(3)(d) indicates that the design for degraded offsite voltage will meet the guidelines of Branch Technical Position (BTP) Power Supply Branch (PSB) 1.

For both the first and second levels of protection, the ABWR electric system design will comply with the requirements of IEEE 308-1980 and IEEE 603-1980, as specified by Section 8.3.1.2.1(2)(c) of the April 3, 1992, draft SSAR revision and Section 1.8.2 (Tables 1.8-20 and 1.8-21) of SSAR Amendment 17. Because both levels of protection are required to support safety-related systems, the staff concludes that GE's commitment to IEEE standards indicates that the electric system design will meet the requirements of Section 5.2 of IEEE 308-1980. The staff also concludes that systems, equipment, and components included in the design for both the first and second levels of voltage protection will meet all requirements of IEEE 603-1980.

In addition, it is the staff's understanding based, on the above commitment to IEEE Standards, that safety system equipment (i.e., reactor trip system, engineered safety features, auxiliary supporting features, and other auxiliary features equipment) that require ac electric power from the offsite system to perform their safety function (1) will be designed to perform their required safety function before, during and after the following defined design basis operating conditions and (2) will be qualified by type test, previous operating experience, or analysis, or any combination of these three methods to substantiate that the safety system equipment will be capable of performing their required safety function before, during, and after the following defined design basis operating conditions:

- continuous operation with voltages at the load at either +10 percent or -10 percent of the nominal voltage rating

- operation for 5 minutes with voltages at the load at 70 percent of the nominal voltage rating

- operation for 3 seconds with voltages at the load below 70 percent (e.g., for 3 seconds at 35 percent) of the nominal voltage rating

Based on these commitments, the staff concludes that the proposed design will ensure independence of offsite and onsite systems during lost or degraded voltage conditions. The staff also concludes that the design will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network. This design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, for independence of offsite and onsite power systems, equipment, and components and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.2-1.

Design Certification Material

The electrical independence during loss of, or degraded, offsite voltage design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.2-1.

The staff also understands that both first- and second-level voltage protection will be tested periodically, and that these periodic tests will be included in appropriate plant procedures. This is COL Action Item 8.2.3.2-1.

8.2.3.3 Independence During Parallel Operation of the Offsite and Onsite Systems During Periodic Load Tests of the Diesel Generator

LOCA During Parallel Operation

Section 8.3.1.1.7(4) of SSAR Amendment 4 states that if a LOCA occurs when the diesel generator is being operated in parallel with the preferred power source during testing, and the test is being conducted from the local control panel, control must be returned to the main control room or the test operator must trip the diesel generator breaker. GE subsequently revised Section 8.3.1.1.7(4) of SSAR Amendment 4 in Section 8.3.1.1.7(5) of the draft SSAR revision dated April 3, 1992 (see the response to question 435.19). Through that revision, GE changed the design commitment to indicate that if a LOCA occurs when the diesel generator is being operated in parallel with the offsite system, the diesel generator will automatically be disconnected from the 6.9 kV emergency bus, regardless of whether the test is being conducted from the local control panel or the main control room.

In addition, Section 8.3.1.1.8.8 of the draft SSAR revision dated April 3, 1992, indicates that the ABWR design will include interlocks to the LOCA and LOOP sensing circuits, in order to terminate parallel operation and cause the diesel generator to automatically revert to its standby mode if either a LOCA or a LOOP signal appears during a test. The revision further states that the interlock design will have the capability to be tested periodically.

The staff concludes that the ABWR design will include provisions for automatic switchover from system test mode to operating mode in case of either an accident signal or a loss of preferred offsite power signal, regardless of whether the test is being conducted from the local control panel or the main control room. Therefore, the staff concludes that the design meets the requirements of Section 6.2.6(2) of IEEE 308-1980, will minimize the probability of losing electric power from offsite and onsite sources due to loss of power from the nuclear power unit due to a LOCA, meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-1.

Design Certification Material

The LOCA during parallel operation design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.3-1.

The staff also understands that the interlock design (which terminates parallel operation and causes the diesel generator to automatically revert to its standby mode) will periodically be tested, and that these periodic tests will be included in appropriate plant procedures. This is COL Action Item 8.2.3.3-1.

LOOP During Parallel Operation

In Section 8.3.1.1.7(6) of the draft SSAR revision dated April 3, 1992, GE indicated that the diesel generator circuit breaker will automatically trip on overcurrent if the offsite power supply is lost during the diesel generator paralleling test. In addition, Section 8.3.1.1.8.8 of that revision indicated that interlocks to the LOOP sensing circuits will terminate a parallel operation test, causing the diesel generator to automatically revert to its standby mode if a LOOP signal appears during a test.

When a standby power supply is being operated in parallel with the preferred power supply, Section 5.1.4.3 of IEEE 741-1986 requires that protection be provided to separate the two supplies if either degrades to an unacceptable level. However, this protection shall neither lock out nor prevent the availability of the power supply that is not degraded. In addition, Section 6.2.4.6.3 of IEEE 308-1992 requires provisions to detect a loss of offsite power during testing, when the standby generator is connected to the offsite power source.

The staff concludes that a design complying with these industry-recommended IEEE practices will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power from the transmission network. Consequently, this design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is therefore considered acceptable by the staff.

Based on GE's design commitment that interlocks to the LOOP sensing circuits will be included in the ABWR design to terminate a parallel operation test and cause the diesel generator to automatically revert to its standby mode if LOOP signal appears during a test, the staff concludes that the ABWR design meets the industry-recommended interlock practice as stated in Section 8.3.1.1.8.8 of the draft SSAR revision dated April 3, 1992. Therefore, the design is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-2.

Design Certification Material

The LOOP during parallel operation design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.3-2.

Duration of Parallel Operation

Table 1.8-21 of SSAR Amendment 17 and Section 1.8.2 of SSAR Amendment 12 indicate that the ABWR design complies with IEEE 308-1980. Based on this statement of compliance, the staff understands that the ABWR design will satisfy Section 6.1.3 of IEEE 308-1980, which requires that the design minimize the duration of the connection between the preferred and standby power supplies. In addition, Section 8.3.1.1.8.1 of the draft SSAR revision dated April 3, 1992, indicates that the ABWR design requires that each diesel generator set be operated independently of the other sets and be connected to the utility power system only by manual control during testing or for bus transfer.

The staff concludes that these commitments will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Consequently, this design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable, contingent upon inclusion of the above commitments in appropriate plant procedures. This is a COL Action Item 8.2.3.3-2.

Duration of parallel operation design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.3-3.

Diesel Generator Protective Relaying with the Diesel Generator Operating in Parallel with the Offsite System

Section 8.3.1.1.6.4 of the draft SSAR revision dated April 3, 1992, indicates that protective relaying of the diesel generator (i.e., generator differential, engine overspeed, low jacket water pressure, loss of excitation, antimotoring (reverse power) overcurrent voltage restraint, high jacket water temperature, and low lube oil pressure) will be used to protect the machine when it is operated in parallel with the normal power system during periodic tests. In addition, Section 8.3.1.1.6.2 of the draft SSAR revision dated April 3, 1992, indicates that each diesel generator will be high-resistance grounded to maximize availability. Section 8.3.1.2.1(2)(c) of the that revision and Section 1.8.2 (Tables 1.8-20 and 1.8-21) of SSAR Amendment 17 indicate that the ABWR electric system design will comply with the requirements of IEEE 308-1980 and IEEE 603-1980. With this commitment to these IEEE standards the staff concludes that the electric system design will satisfy the requirements of Section 5.2 of IEEE 308-1980, and that systems, equipment, and components included in the design for protective relaying will satisfy all requirements of IEEE 603-1980. Because the protective relaying is required to minimize the likelihood of simultaneous loss of both offsite and onsite sources during testing, these measures are required to satisfy all requirements of IEEE 603-1980 during parallel operation of offsite and onsite power supplies.

The staff concludes that the protective relaying design commitments will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies during parallel operation of offsite and onsite supplies for testing. Consequently, these commitments meet the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and are acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-3.

Design Certification Material

The diesel generator protective relaying with the diesel generator operating in parallel with the offsite system design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.2.3.3-4.

The staff also understands that protective relaying of the diesel generator will be tested periodically, and that these periodic tests will be included in appropriate plant procedures. This is COL Action Item 8.2.3.3-3.

Synchronizing Interlocks

Based on discussions with GE, the staff understands that (1) the ABWR design will meet the guidelines of Section 5.1.4.2 of IEEE 741-1986 by including synchronizing interlocks to prevent incorrect synchronization whenever a standby power source is required to operate in parallel with the preferred power supply. .he staff also understands that the synchronizing interlocks will have the capability to be tested periodically.

The staff concludes that a design complying with these industry-recommended IEEE practices will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Consequently, this design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable, upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.3-4.

Design ification Material

The synchronizing interlocks design commitments should be included in the Station Electrical ITAAC nd Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.3-5.

The staff also understands that synchronizing interlocks will be tested periodically, and that these periodic tests will be included in appropriate plant procedures. This is COL Action Item 8.2.3.3-4.

8.2.3.4 Independence of Safety Loads From Operation or Failure of Non-Safety-Related Loads

The ABWR design must minimize the effects that operation or failure of non-safety-related loads may have on safety-related systems. To achieve this design objective, the staff took the position that the Class 1E system should be connected directly to a winding of the offsite power system's transformers that is separate from the winding that feeds the non-Class 1E loads. In other words, Class 1E and non-Class 1E loads should not be powered from the same transformer winding. In addition, the staff stated its position that the offsite preferred power circuits should be arranged so that a single offsite preferred power circuit does not power all three of the redundant Class 1E load groups.

The initial design proposed by GE for the ABWR offsite preferred power system satisfied both of these staff positions. However, by the draft SSAR revision dated April 3, 1992, GE changed the design to use a single transformer winding to supply power to both Class 1E and non-Class 1E loads. As a result, the staff became concerned that operation or failure of non-safety-related loads could adversely affect operation of Class 1E systems.

Based on discussions with GE, it is the staff's understanding that any given single failure of a non-safety-related load or load group will affect only one of the three Class 1E load groups. The ABWR design will consist of three independent non-safety-related system load groups, three safety system load groups, and three transformers. Each non safety system load group will be associated with only one of the three safety system load groups by being powered from the same offsite power system transformer winding. Thus, failure of any one of three transformers due to failure of non-safety-related load groups or failure of any one non-safety-related load group or load can affect only one of the three safety-related system load groups.

In addition to the above design commitments, GE has indicated during discussions with the staff that the ABWR design will include provisions to limit harmonic effect on the power supply to safety system load groups to less than 5 percent for operation and/or failure of reactor internal pumps and other non-safety load groups powered from the same source as the safety system load groups.

Based on the above considerations, the staff concludes that the ABWR design will minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Consequently, this design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.4-1.

Design Certification Material

The independence of non-safety load design commitments during operation and/or failure, should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.4-1.

8.2.3.5 Physical Separation Between Offsite and Onsite Class 1E Circuits

Based on discussions with GE and information presented in Section 8.2.1.3 of the April 3, 1992, draft revision to the SSAR, it is the staff's understanding that the offsite circuits will be physically separated from any Class 1E systems, equipment, components, cables, or loads by floors or walls up to the point where the offsite circuits enter the reactor building. From the point where the alternate preferred circuit enters the Division 2 side of the reactor building to the Class 1E switchgear rooms, and from the point where the normal preferred circuit enters the Division 1 and Division 3 side of the reactor building to the Class 1E switchgear rooms, GE has indicated that by their commitment to IEEE 384 that the offsite circuits will be physically separated from circuits of the Class 1E systems by a minimum physical separation distance of 3 feet horizontal and by 5 feet vertical. In addition, GE has indicated that safety systems whose failure could potentially affect the operation of an offsite circuit will not be located in the same rooms with the normal or alternate offsite circuits, or barriers will be installed to preclude possible interaction between offsite and onsite systems.

The staff concludes that the proposed ABWR design for ensuring physical independence between offsite and onsite circuits minimizes the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Consequently this design meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.2.3.4-2.

Figure 8.3.1 of the draft SSAR revision dated April 3, 1992, indicated that the offsite power connection from the reserve auxiliary transformer (that is, the alternate preferred circuit) is normally supplied through the Division 2 Class 1E equipment areas to the Division 3 Class 1E switchgear. Similarly, GE has indicated that the offsite connection from the unit auxiliary transformers (that is, the normal preferred circuit) is normally supplied through the Division 1 and Division 3 Class 1E equipment areas to the Division 1 and Division 2 Class 1E switchgear. To further minimize the likelihood of interaction between the offsite and onsite systems the staff contends that the normal configuration for the connection of the offsite circuit to the onsite Class 1E distribution system should be configured with the reserve auxiliary transformer normally connected to the Division 2 load groups and the unit auxiliary transformers normally connected to the Division 1 and Division 3 load groups. This is Open Item 8.2.3.4-1.

Design Certification Material

The physical separation between offsite and onsite class 1E circuits design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.2.3.4-2.

8.2.4 Operating Restrictions on the Offsite Preferred Power Circuits

Section 8.3.1.1.1 of the draft SSAR revision dated April 3, 1992, indicates that during normal operation (which includes all modes of plant operation; that is, shutdown, refueling, startup, and run), the normal preferred power supply feeds two of the three Class 1E load groups. The remaining load group is fed from the alternate power source. For COL applicants that implement the ABWR design, Section 8.3.4.9 of the April 3, 1992, draft SSAR revision specifies that the COL operating procedures must include the requirement that one of the three divisional buses must be fed by the alternate power source during normal operation in order to prevent simultaneous deenergization of all divisional buses on the loss of only one of the offsite power supplies. Therefore, the staff understands that the offsite power supply circuits to the Class 1E buses will be arranged so that all three Class 1E divisions are not simultaneously deenergized on the loss of only one of the offsite power supplies when the plant is operating in a normal configuration, that is, with all three unit auxiliary transformers and the reserve auxiliary transformer operable, or with only two of the three unit auxiliary transformers operable (for example when one of the three unit auxiliary transformers is out of service for extended maintenance).

This operating procedural requirement minimizes the probability that any of the remaining supplies will lose electric power as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Consequently, this operating procedure meets the requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable with the operating design commitment being included in appropriate COL procedures. This is COL Action Item 8.2.4-1.

It is the staff's understanding that appropriate limiting conditions for plant operation will apply when the above operating procedural requirement can not be met, (for example, when the reserve auxiliary transformer is inoperable, the allowed outage time will not exceed 72 hours). This is Technical Specification Item 8.2.4-1.

8.2.5 Power Supply for the Reactor Internal Pumps

Section 15.3.1.1.1 of SSAR Amendment 10 stated that, since four buses are used to supply power to the ten reactor internal pumps (RIPs), the worst single failure can only cause three RIPs to trip. In addition, that amendment states that the probability of any additional RIP trips is low (less than 10^{-6} per year). Therefore the simultaneous trip of more than three RIPs was classified by GE as a limiting fault. This was discussed in the staff's DSER (SECY-91-355) as Open Item 29.

The staff subsequently classified this postulated event in the special category of anticipated transients involving a common-mode software failure and developed a special acceptance criteria for the radiological dose calculation. The staff's evaluation of this postulated event in a special category is addressed in Section 15.2 of this SER.

8.3 Onsite Class 1E Power System

Based on discussions with GE and information presented in the draft SSAR revision dated April 3, 1992, the staff understands that the ABWR design of the onsite Class 1E power system consists of the following systems:

• <u>Class 1E Alternating Current (ac) System</u>

The Class 1E ac power system will consist of three independent and redundant Class 1E power systems each with it's associated Class 1E diesel generator power supply and Class 1E ac distribution system. Each of the three Class 1E diesel generator power supplies will consist of all components from the stored energy (fuel) to the connection to the distribution system's supply circuit breaker. Each Class 1E ac distribution system will consist of the following four Class 1E ac distribution systems and their load group:

- 6.9 kV medium voltage
- 480-volt low-voltage
- 120/240-volt low-voltage
- 120-volt I&C

Each of the three Class 1E 6.9 kV ac distribution systems will consist of all equipment in the distribution circuit, from the power side of the offsite and onsite power supply breakers to the 6.9 kV loads. Equipment in each of the three Class 1E 6.9 kV ac distribution circuits will include one 6.9 kV Class 1E ac switchgear, connections to one or more 6.9 kV safety system loads, connections to two Class 1E 480-volt ac distribution systems, and connections through the Class 1E 480-volt ac distribution system to each of the following systems:

- one Class 1E 120-volt ac I&C distribution system,
- one or more Class 1E 120/240-volt ac distribution systems,
- the Class 1E dc power system, and
- one or two Class 1E vital 120-volt ac I&C power systems.

Each of the six Class 1E 480-volt ac distribution systems, for example, two per division, will consist of all equipment in the distribution circuit, from the 6.9 kV side of the 6.9 kV/480-volt transformer to the 480-volt loads. Equipment in each of the six Class 1E 480-volt ac distribution circuits will include one Class 1E 6.9 kV/480-volt transformer, one Class 1E 480-volt load center, connections to one or more 480-volt safety system loads, and connections to one or more Class 1E 480-volt ac motor control centers and their associated 480-volt safety system loads.

Each of the three 120-volt Class 1E ac I&C distribution systems will consist of all equipment in the distribution circuit from the 480-volt side of the 480/120-volt transformer to the 120-volt I&C loads. Equipment in each of the three Class 1E ac I&C distribution circuits will include one Class 1E 480/120-volt transformer, one or more Class 1E 120-volt ac distribution panels, and connection to 120-volt safety system I&C loads.

Each of the Class 1E 120/240-volt ac distribution systems will consist of all equipment in the distribution circuit from the 480-volt side of the Class 1E 480/120/240-volt transformer to safety system loads. Equipment in each of the Class 1E 120/240-volt distribution circuits will include one Class 1E 480/120/240-volt transformer, one or more Class 1E 120/240-volt ac distribution panels, connection to 120- and 240-volt safety system loads, and connection to Class 1E 120-volt ac receptacles.

- <u>Direct Current (dc) Class 1E System</u>

The Class 1E dc power system will consist of four independent and redundant 125-volt Class 1E dc power systems (one each for Divisions I, II, III, and IV). For each of these four dc power systems, the Class 1E dc power system will include the associated Class 1E battery and battery charger power supply, a 125-volt dc Class 1E distribution system, and their load group. Each of the four Class 1E battery power supplies will consist of storage cells, connectors, and connections to the distribution system supply circuit interrupting device. Each of the four Class 1E battery charger power supplies will consist of all equipment from the units connection to the 480-volt ac distribution system to its distribution system's supply breaker. Each of the four Class 1E 125-volt dc distribution systems will consist of all equipment in the distribution circuit, from the power side of the battery interrupting device and the battery charger supply breaker to the 125-volt dc safety system loads. Equipment in each of the four distribution circuits will include one or more Class 1E distribution panels and connections to 125-volt dc safety system loads.

Respectively, Division II and Division III of the 480-volt ac distribution system will feed the Division II and III battery charger power supplies. Division I of the 480-volt ac distribution system will feed the Division I and Division IV battery charger power supplies.

- <u>Class 1E Vital 120-volt ac Instrumentation and Control (I&C) System</u>

  The Class 1E vital 120-volt ac I&C power supply will consist of four independent and redundant vital 120-volt Class 1E ac I&C power systems (one each for Divisions I, II, III, and IV). For each of these four ac I&C power systems, the Class 1E vital I&C system will include the associated Class 1E Constant Voltage Constant Frequency (CVCF) power supply, 120-volt Class 1E ac distribution system, and their load group. Each of the four CVCF power supplies will consist of the power source (including the static inverter, ac and dc static transfer switches, and a regulating step down transformer as an alternate ac power supply) and its connection to the distribution supply circuit interrupting device. Each of the four Class 1E vital 120-volt ac I&C distribution systems will consist of all equipment in the distribution circuit from the power side of the constant voltage constant frequency power supply breaker to safety system I&C loads. Equipment in each of the four Class 1E vital 120-volt ac distribution circuits will include one or more 120-volt ac distribution panels and connections to vital 120-volt safety system I&C loads.

  Each divisional CVCF power supply will be fed from its associated divisional dc power system. (For example, the Division I CVCF power supply will be fed from Division I 125-volt dc distribution system.) In addition, Division II and Division III CVCF power supplies will be fed from

Division II and Division III, respectively, of the 480-volt ac distribution system and Division I and Division IV CVCF power supplies will be fed from Division I of the 480-volt ac distribution system.

The staff concluded that the above design commitments meet the guidelines of IEEE 308-1980 and are acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3-1.

Design Certification Material

Tier 1 design information and ITAAC are required for the onsite Class 1E power system. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3-1.

In addition, the staff understands that operational restrictions will apply to the use of Class 1E receptacles which are powered from each of the Class 1E 120/240-volt distribution systems. These operational restrictions will be included in appropriate procedures to ensure compliance with the capacity, independence, and protection provisions required by Criteria 2, 4, 17, and 18 of 10 CFR Part 50, Appendix A for Class 1E power systems. This is COL Action Item 8.3-1.

To ensure that the ABWR design incorporates sufficient capacity, capability, independence, redundancy, and testability of onsite Class 1E power systems, the staff's evaluation also addressed the areas discussed in the following sections.

8.3.1 Compliance with General Design Criteria

Item (1)(b) of Section 8.3.1.2.1 of SSAR Amendment 10 indicated that the Class 1E ac power system complies with GDC 2, 4, 17, and 18 in part or as a whole, as applicable. GE's response to Question 435.26 (also of Amendment 10) provided clarification that there are no non-compliances, but also indicated that some portions of the GDC do not apply at this level (for example, the statement in GDC 17 about two physically independent circuits from the transmission network). Based on the information presented, the staff could not ascertain which parts of these GDC GE considered not applicable to the Constant Voltage Constant Frequency (CVCF) power supplies.

In discussions with the staff and in draft submittal dated September 4, 1991, GE proposed modifying the response to Question 435.26 and Section 8.3.1.2.1 to indicate full compliance with the GDC. The proposed modification would delete (1) certain conflicting statements in the SSAR, (2) the example of non applicability to GDC 17, and (3) the phase "the substance and intent of" from Section 8.3.1.4.2.1. In addition, GE agreed to revise Item 11 of Section 1.2.1.1.2 of SSAR Amendment 1 to clarify the systems and components to which IEEE 279, "Criteria for Protection Systems for Nuclear Power Generating Stations" (1971) applies and to correct applicable SRP criteria inconsistencies within Table 8.1-1 and between Table 8.1-1 and Section 8.1.3.1.2.

The staff concludes that the ABWR electrical system design will comply with the criteria and guidelines defined in Section 8.0 of this report and is therefore acceptable subject to GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.1-1 and resolves DSER (SECY-91-355) Open Item 30.

8.3.1.1 Compliance with IEEE Standards

In the draft SSAR submittal dated September 4, 1991, GE indicated that there will be no limitation on the use of IEEE 384-1981 "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," for separation in the ABWR design. The NRC staff has not formally reviewed and accepted the changes between the 1974 and 1981 versions of this standard. Thus, to allow the use of an updated IEEE standard which the NRC staff has not formally endorsed, each difference between the old and new standard needs to be identified, justified, and approved for use. The staff stated this position in the DSER (SECY-91-355) and any newer version of IEEE standard referenced by GE in the SSAR must have differences identified, justified, and approved for use on the ABWR in order to ensure that design criteria of the new standard are equally conservative as those included in standards currently approved by the staff. This was Open Item 41 in the DSER (SECY-91-355).

Such an instance arose in the evaluation of the electrical system design for the ABWR. In this instance the staff believed that two new standards provide most of the criteria applicable to the electric power systems.

Because the new standards clarified and amplified guidelines contained in earlier versions they were considered the more relevant base from which to evaluate the ABWR design. Consequently, the staff evaluated the guidelines in the two newer standards with respect to the intent of criteria and guidelines contained in the SRP and existing regulatory guides. This evaluation included identifying, justifying, and approving the differences between old and new standards for use on the ABWR. The electrical design proposed for the ABWR was then evaluated against the newer standards. The standards are:

> IEEE 308-1980, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations,[2]" and IEEE 384-1981.

In addition, IEEE has developed and issued other companion standards to address certain areas that needed more extensive treatment. These standards include

- IEEE 741-1986, "Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations"
- IEEE 765-1983, "Standard for Preferred Power Supply for Nuclear Power Generating Stations"
- IEEE 485-1983, "Recommended Practice for Sizing Large-Lead Storage Batteries for Generating Stations and Substations"

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[2] This standard was revised to be consistent with terminology used in IEEE 603-1980.

- IEEE 946-1985, "Recommended Practice for the Design of Safety-Related dc Auxiliary Power Systems for Nuclear Power Generating Stations"

Like the standards cited above, these other standards have not yet been endorsed by NRC regulatory guide. However, the staff believes that they clarify and amplify current SRP criteria and guidelines and therefore provide a more relevant base from which to evaluate the ABWR design.

In some cases, GE has not referenced these other standards in the ABWR SSAR. The staff proceeded with its review with the understanding that GE intends to use these other standards.

The staff understands that GE will include the statements as design commitments in the SSAR in a future amendment. This is Confirmatory Item 8.3.1.1-2.

8.3.1.2 Compliance with GDC 2 and 4

ABWR SSAR Chapter 8 was modified in response to DSER (SECY-91-355) Open Item 31 and 63 by the draft revision dated April 3, 1992, to include the following statements related to the compliance of the electrical system design to the requirements of GDC 2, "Design Bases for Protection Against Natural Phenomena," and GDC 4, "Environmental and Missiles Design Bases," of 10 CFR Part 50, Appendix A.

- "Electrical equipment and wiring for the Class 1E systems which are segregated into separate divisions are separated so that no design basis event is capable of disabling more than one division of any engineered safety features (ESF) total function."

- "Redundant parts of the system are physically separated and independent to the extent that in any design basis event with any resulting loss of equipment, the plant can still be shut down with either of the remaining two divisions."

- "Class 1E electric equipment and wiring is segregated into separate divisions so that no single credible event is capable of disabling enough equipment to hinder reactor shutdown and removal of decay heat by either of two unaffected divisional load groups or prevent isolation of the containment in the event of an accident."

- "Equipment arrangement and/or protective barriers are provided such that no locally generated force or missile can destroy any redundant reactor protection system (RPS), nuclear steam supply system (NSSS), emergency core cooling system (ECCS), or ESF functions. In addition, arrangement and/or separation barriers are provided to ensure that such disturbances do not affect both high pressure core flooder (HPCF) and reactor core isolation cooling (RCIC) systems."

- "Containment penetrations will be so arranged that no design-basis event can disable cabling in more than one division."

- "The protection system and ESF control logic, and instrument panels/racks shall be located in a safety-class structure in which there are no potential sources of missiles or pipe breaks that could jeopardize redundant cabinets and raceways."

- "The standby ac power system is capable of providing the required power to safely shutdown the reactor after loss of preferred power (LOPP) and/or loss of coolant accident (LOCA) or to maintain the safe shutdown condition and operate the Class 1E auxiliaries necessary for plant safety during and after shutdown with any one of the three power load groups."

Based on the stated capability to safely shut down with one division of electrical equipment, other SSAR commitments regarding physical protection of electrical divisions, and discussions with GE, the staff understands that there will be a limited number of design-basis events (such as a design-basis event fire) for which Class 1E systems, equipment, and components will be protected by the capability to maintain safe plant shut down with any one of the three load groups. The capability of maintaining safe plant shutdown with any one of the three load groups for these limited number of design basis events is addressed in Chapter 15 of this SER.

Therefore, the staff concludes that the electrical design meets GDC 2 and 4 and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.1.2-1.

Design Certification Material

Tier 1 design information and ITAAC are required for demonstration of compliance with GDC 2 and 4. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.1.2-1.

8.3.2 Physical Independence

8.3.2.1 Conduits to Open Tray Separation (Scram Cables)[3]

Section 8.3.1.4.2.3.1 of the draft SSAR revision dated April 3, 1992, documented the following design commitments in response to DSER (SECY-91-355) Open Item 32:

- The reactor protective system scram solenoid circuits, from the actuation devices to the solenoids of the scram pilot valves of the control rod drive (CRD) hydraulic control units, will be run in grounded steel conduits, containing no other wiring.

- Separated grounded steel conduits will be provided for the scram solenoid wiring for each of four scram groups.

- Separated grounded steel conduits will also be provided for both the A solenoid wiring circuits and for the B solenoid wiring circuits of the same scram group.

- Scram group conduits will have unique identification and will be sepa-

[3] The need for separation between scram groups and between scram cables and other cables is addressed in Chapter 7 of this SSAR.

rately routed as Division II and Division III conduits for the A and B solenoids of the scram pilot valves, respectively. This corresponds to the divisional assignment of their power sources.

Based on these design commitments, the staff understands that the conduits containing the circuits for the A solenoids of the scram pilot valves will be separated from their B solenoid counterpart by a minimum separation distance of about 2-1/2 centimeters (1 inch) from the conduits containing the circuits for the B solenoids of the scram pilot valves in accordance with divisional separation requirements.

- The conduits containing the scram solenoid group wiring of any one scram group will also be physically separated by a minimum distance of 2-1/2 centimeters (1 inch) from the conduit of any other scram group. This separation from conduits or metal-enclosed raceways associated with any of the four safety-related electrical divisions or any non-safety-related (non-divisional) circuits.

- The scram group conduits will not be routed within the confines of any other tray or raceway system.

- The conduits containing the scram solenoid group wiring of any one scram group will also be physically separated from non-enclosed raceways associated with any of the four safety related electrical divisions or any non-safety-related (non-divisional) circuits in accordance with IEEE 384 and RG 1.75, Revision 2.

The staff's understands (based on the clarifying interpretations of IEEE 384 contained in Section 8.3.1.1.5.1 of the draft SSAR revision dated April 3, 1992) that separation in accordance with IEEE 384 means that conduits containing scram solenoid group circuit wiring will be separated from any non-enclosed raceway containing either safety or non-safety-related circuits by a vertical separation distance of 5 or more feet and by a horizontal separation distance of 3 or more feet.

Based on the above design commitments, the staff concludes that the physical independence of the reactor protection system scram solenoid circuits meets the guidelines of RG 1.75, as well as the independence and protection requirements of Criteria 4 and 17 of to 10 CFR Part 50 Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.1-1.

Design Certification Information

The design commitments for conduits to open tray separation should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.1-1.

8.3.2.2 Separation of Neutron Monitoring Raceways[4]

Section 8.3.1.3.1.3 of the draft SSAR revision dated April 3, 1992, indicates that neutron monitoring cables will be routed in their own divisional conduits and cable trays, separate from all other power, instrumentation, and control cables.

Based on this commitment and discussions with GE, the staff understands that neutron monitoring cables will be routed in their own dedicated raceways from termination to termination. These dedicated raceways will be separated from raceways containing all other Class 1E or non Class 1E power, instrumentation, and control cables by the same separation provided between scram and other cables described in Section 8.3.2.1 of this SER.

The staff concludes that the physical independence of the neutron monitoring circuits meets the guidelines of RG 1.75, as well as the independence and protection requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.2-1.

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[4] The need for separate/dedicated raceways for Neutron Monitoring cables is addressed in Chapter 7 of this SER.

Design Certification Information

The separation of neutron monitoring raceways design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.2-1.

8.3.2.3 Separation of dc Emergency Lighting Raceways

In Section 9.5.3 of the draft SSAR revision dated April 3, 1992, GE indicated that dc emergency lighting cables will be routed in their own divisional conduits and cable trays, separate from all other power, instrumentation, and control cables. The commitment will ensure independence between safety-related standby and dc emergency lighting systems that are powered from the same electrical system division,

Based on the above commitment and discussions with GE, the staff understands that the dc emergency lighting cables will be routed in their own dedicated raceways from termination to termination and the raceways dedicated for the dc emergency lighting cables will be separated from raceways containing all other Class 1E or non-Class 1E power I&C cables by the same separation provided between scram and other cables described in Section 8.3.2.1 of this SER.

The staff concludes that the physical independence of the dc emergency lighting circuits meets the guidelines of RG 1.75 (Rev. 2), as well as the independence and protection requirements of GDC 4 and 17 of Appendix A to 10 CFR Part 50, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.3-1.

Design Certification Information

The separation of DC emergency lighting raceways design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.3-1.

8.3.2.4 Separation of Containment Electrical Penetrations

Separation Between Class 1E Penetrations of Independent Divisions

Item (7) of Section 8.3.1.4.1.2 of SSAR Amendment 10 indicated that electric penetration assemblies of different Class 1E divisions will be separated by distance, placed in separate rooms or provided barriers, and/or located on separate floor levels. The use of separate rooms or barriers and/or location on separate floor levels exceeds separation guidelines for penetrations and is acceptable. Separation by distance may also meet separation guidelines; however, information as to what constitutes the minimum allowable distance between penetrations was not clearly defined in Amendment 10 to the SSAR (DSER SECY-91-355 Open Item 33).

In the draft SSAR revision dated April 3, 1992, item (7) of Section 8.3.1.4.1.2 similarly indicated that electrical penetration assemblies of different Class 1E divisions will be separated by 3-hour fire-rated-barriers (that is location separate rooms or on separate floors). Separation by distance (without barriers) will be allowed only within the inerted containment. Section 8.3.1.1.5.1 of the April 3, 1992, draft revision to the SSAR further indicated that penetration assemblies will be located around the periphery of the containment and at different elevations to facilitate reasonably direct routing of cables to and from the equipment.

The staff concludes that the proposed design for separation of penetration assemblies of different Class 1E divisions meets the guidelines of Section 6.5 of IEEE 384-1981, the independence requirements of GDC 17 of Appendix A to

Design Certification Information

The separation of DC emergency lighting raceways design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.3-1.

8.3.2.4 Separation of Containment Electrical Penetrations

Separation Between Class 1E Penetrations of Independent Divisions

Item (7) of Section 8.3.1.4.1.2 of SSAR Amendment 10 indicated that electric penetration assemblies of different Class 1E divisions will be separated by distance, placed in separate rooms or provided barriers, and/or located on separate floor levels. The use of separate rooms or barriers and/or location on separate floor levels exceeds separation guidelines for penetrations and is acceptable. Separation by distance may also meet separation guidelines; however, information as to what constitutes the minimum allowable distance between penetrations was not clearly defined in Amendment 10 to the SSAR (DSER SECY-91-355 Open Item 33).

In the draft SSAR revision dated April 3, 1992, item (7) of Section 8.3.1.4.1.2 similarly indicated that electrical penetration assemblies of different Class 1E divisions will be separated by 3-hour fire-rated-barriers (that is location separate rooms or on separate floors). Separation by distance (without barriers) will be allowed only within the inerted containment. Section 8.3.1.1.5.1 of the April 3, 1992, draft revision to the SSAR further indicated that penetration assemblies will be located around the periphery of the containment and at different elevations to facilitate reasonably direct routing of cables to and from the equipment.

The staff concludes that the proposed design for separation of penetration assemblies of different Class 1E divisions meets the guidelines of Section 6.5 of IEEE 384-1981, the independence requirements of GDC 17 of Appendix A to

10 CFR Part 50, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.4-1 and resolves DSER (SECY-91-355) Open Item 33.

Design Certification Information

The separation between class 1E penetrations of independent divisions design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.4-1.

Separation of Class 1E from Non-Class 1E Penetrations

This was addressed as DSER (SECY-91-355) Open Item 34.

Section 8.3.1.4.1.2 of the draft SSAR revision dated April 3, 1992, indicated that separation between penetrations containing non-Class 1E circuits and penetrations containing Class 1E or associated Class 1E circuits will be in accordance with IEEE 384. Based on discussions with GE the staff understands that separation in accordance with IEEE 384 means that penetrations containing non-Class 1E circuits will be separated from penetrations containing Class 1E or associated Class 1E circuits by a vertical separation of 5 or more feet and by a horizontal separation distance of 3 or more feet.

The staff concludes that the proposed separation of penetration assemblies containing non-Class 1E circuits from those containing Class 1E or associated Class 1E circuits meets the protection and independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. Therefore, this design is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.4-2.

Design Certification Information

The separation between Class 1E and non-Class 1E penetrations design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.4-2.

Separation of Class 1E Penetrations from Non-Class 1E Cables or Other Divisional Cables

DSER (SECY-91-355) Open Item 35 addressed this subject.

Based on discussions with GE, the staff understands that penetrations containing Class 1E circuits will be separated from other divisional cables by routing through separate rooms and/or different floor levels outside containment and by maintaining a minimum separation of 3 feet horizontal and 5 feet vertical distance inside the inerted containment. In addition, the staff understands that separation between penetrations containing Class 1E circuits and non-divisional cables will be maintained at a minimum horizontal distance of 3 feet and a vertical distance of 5 feet both inside and outside of containment.

The staff concludes that the proposed design for separation between penetrations containing Class 1E circuits and other divisional or non-divisional cables meets the protection and independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.4-3.

Design Certification Information

The separation between Class 1E penetrations to non-Class 1E cables or to other divisional cables design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.4-3.

8.3.2.5 Separation and Protection of Cables Located Outside Cabinets and Panels

Section 8.3.1.1.5.1 of the draft SSAR revision dated April 3, 1992, documents the following design commitments related to separation of Class 1E cables in response to DSER (SECY-91-355) Open Item 36.

1. Enclosed solid metal raceways are required for separation between different safety division safety-related or associated cables and between safety-related or associated cables and non safety related cables, if the vertical separation is less than 5 feet, the horizontal separation distance is less than 3 feet, and the cables are in the same fire area;

2. Both groupings of cables requiring separation as specified in item 1 must be enclosed in solid metal raceways.

Based on the above design commitments and discussions with GE, the staff understands that all power, control, and instrumentation cables (including fiber optic cables) located outside cabinets and panels throughout the plant will be supported in raceways in accordance with IEEE-recommended practice for support of cable systems. When Class 1E (or Class 1E associated) cables of different safety divisions are separated from each other or from non-Class 1E cables by less than 5 feet vertical or 3 feet horizontal, the cables will be supported in enclosed solid metal raceways (such as rigid or flexible metal conduits or totally enclosed cable trays).

In addition, Section 8.3.1.2.1(2)(f) of the draft SSAR revision dated April 3, 1992, and Section 1.8.2 (Table 1.8-21) of SSAR Amendment 17 indicate that the ABWR electric system design will comply with the requirements of IEEE 384-1981. The staff further understands that separation distance will be at least 1 inch between solid metal raceways containing Class 1E (or Class 1E associated) cables of different safety divisions or between solid metal raceways containing Class 1E (or Class 1E associated) cables and non-Class 1E cables.

The staff concludes that this commitment reasonably ensures that failure of Class 1E (or Class 1E associated) cables in any one division (located outside of cabinets and panels and in any single raceway) will not cause failure of Class 1E (or Class 1E associated) cables in a different safety division. Similarly failure of non-Class 1E cables (located outside of cabinets and panels and in any single raceway) will not adversely affect Class 1E (or Class 1E associated) cables. Consequently, the staff concludes that the design meets the requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. This design is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.5-1.

Design Certification Information

The separation/protection of cables located outside cabinets/panels design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.5-1.

8.3.2.6 Separation of Cables inside Cabinets and Panels

In response to DSER (SECY-91-355) Open Item 37, Sections 8.3.1.4.1, 8.3.1.4.1.2, 8.3.1.4.2, 8.3.1.3.1.3, and 8.3.1.4.2.2.3 of Amendment 10 to the SSAR and the draft SSAR revision dated April 3, 1992, document the following design commitments related to separation of power, control, and instrumentation cables inside panels, racks, cabinets, and other enclosures located in the main control room and other areas of the plant:

- Single panels or instrument racks will not contain circuits or devices of the redundant protection or ESF systems, except under the following conditions:

  - Certain operator interface control panels may have operational considerations which dictate that redundant protection system or ESF system circuits or devices must be located in a single panel. These circuits and devices will be separated horizontally and vertically by a minimum distance of 15 centimeters (6 inches) or by steel barriers or enclosures.

- The input and output circuits of isolation devices will be separated horizontally and vertically by a minimum distance of 6 inches or by steel barriers or enclosures.

- Class 1E circuits and devices will also be separated from the non-Class 1E circuits and devices which are present inside a panel. These circuits and devices will be separated from each other horizontally and vertically by a minimum distance of 6 inches or by steel barriers or enclosures.

- If two panels containing circuits of different separation divisions are less than 3 feet apart, there will be a steel barrier between the two panels. Panel ends closed by steel end plates will be considered to be acceptable barriers provided that terminal boards and wireways are spaced a minimum of 1 inch from the end plate.

- Penetration of separation barriers within a subdivided panel will be permitted, provided that such penetrations are sealed or otherwise treated so that fire generated by an electrical fault could not reasonably propagate from one section to the other and disable a protective function.

Based on the commitment to meet the guidelines of IEEE 384-1981 and RG 1.75, Revision 2 the staff further understands that Class 1E or non-Class 1E power circuits located inside panels and cabinets will be limited to those required to operate systems, equipment, or components located inside the panels and cabinets. (Power cables will not be permitted to traverse from one side of a panel or cabinet to the other without being terminated inside the panel). In addition these circuits will be routed inside rigid or flexible conduits that will be physically separated from instrumentation and control cables by minimum horizontal and vertical distances of 6 inches or by steel barriers or additional enclosures.

The staff concludes that these commitments reasonably ensure that failure of Class 1E (or Class 1E associated) cables in any one division (located inside of cabinets or panels) will not cause failure of Class 1E (or Class 1E associated) cables in a different safety division. Similarly failure of non-Class 1E cables (located inside cabinets or panels) will not adversely affect Class 1E (or Class 1E associated) cables. The design therefore meets the requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.6-1.

Design Certification Information

The separation of cables inside cabinets/panels design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.6-1.

8.3.2.7 Separation of Cables Approaching and/or Exiting Cabinets/Panels

The response to Question 435.30 in SSAR Amendment 0, DSER (SECY-91-355) Open Item 40, stated that cable spreading areas do not apply to the ABWR and are not included in the plant layout because the majority of the I&C signals will be multiplexed to the control room. This response implied that the 1-foot by 3-feet separation guidelines allowed by Section 5.1.3 of IEEE 384-1974 (Section 6.1.3 of IEEE 384-1981) will not apply to the ABWR. The guidelines of Position C12 of RG 1.75 Revision 2, also will be irrelevant. The ABWR SSAR did not clearly address the criteria for the separation and protection of cables approaching or exiting cabinets and panels (as in non-hazard areas).

Based on discussions with GE information subsequently presented in Section 8.3.1.4 of the draft SSAR revision dated April 3, 1992, the staff understands that the following design commitments apply:

- I&C and optical cables (including metallic and fiber-optic cables) will be treated the same with respect to separation and protection throughout the plant,

- each division of Class 1E power, instrumentation, and control cables will be routed to the control room complex through a cable chase or other means, so that redundant division areas will be separated by a 3-hour fire-rated barrier,

- each cable chase will be ventilated,

- separation between Class 1E and non-Class 1E cables within the cable chase will be the same as separation of cables located outside cabinets and panels as described in Section 8.3.2.4 of this SER,

- Class 1E, Class 1E associated, or non-Class 1E power circuits routed in a cable chase or the control room area will be limited to those required to operate systems, equipment, or components located in the control room area (power cables will be not be permitted to traverse through from one side of the control room area to the other without being terminated in the control room area),

- Class 1E, Class 1E associated, or non-Class 1E power circuits routed in a cable chase or the control room area will be routed inside rigid or flexible conduits that will be physically separated horizontally and vertically by a minimum distance of 6 inches or by steel barriers or additional enclosures from any I&C cables,

- power cables may be routed in flexible metallic conduit under the raised floor of the control room,

- separation between redundant Class 1E and between Class 1E and non-Class 1E power, instrumentation, and control cables within the control room area will be the same as separation of cables located outside cabinets and panels as described in Section 8.3.2.5 of this SER,

- redundant Class 1E power, instrumentation, and control cables will enter cabinets and panels through separate apertures,

- Class 1E and non-Class 1E power, instrumentation, and control cables will enter cabinets/panels through separate apertures,

- cable chases and the control room area will be non hazard areas (as defined in Section 6.1.. of IEEE 384-1981),

- cable chases and the control room area will not contain potential hazards such as high energy switchgear, power distribution panels, transformers, or rotating equipment; potential sources of missiles; pipe failure hazards, or fire hazards.

The staff concludes that these commitments reasonably ensure that failure of Class 1E (or Class 1E associated) cables in any one division (located in a cable chase or the control room area) will not cause failure of Class 1E (or Class 1E associated) cables in a different safety division. Similarly failure of non-Class 1E cables (located in a cable chase or the control room area) will not adversely affect Class 1E (or Class 1E associated) cables. The design therefore meets the requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.7-1.

In addition, based on GE's design commitment to meet the guidelines of IEEE 384-1981, the staff understands, that administrative control of operations and maintenance activities will control and limit introduction of potential hazards into cable chases and the control room area. These administrative controls will be included in appropriate plant procedures. This is COL Action Item 8.3.2.7-1.

Design Certification Information

The separation of cables approaching and/or exiting cabinets/panels should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.7-1.

8.3.2.8 Independence and Physical Separation of Equipment

This discussion addresses DSER (SECY-91-355) Open Item 36.

Based on discussions with GE and information presented in the draft SSAR revision dated April 3, 1992, the staff understands that all redundant Class 1E electrical power supply and distribution systems, equipment, and components from the power supply through the power distribution panels will be separated by a 3-hour rated fire and missile barrier. Such separation will ensure that any failure of or within one division of the Class 1E power system or its associated load group will not cause a loss of function in another division of the Class 1E power system.

The staff concludes that the ABWR design will provide an adequate level of independence between redundant Class 1E systems, equipment, and components and their associated load groups. The design will meet the requirements of GDC 17 of 10 CFR Part 50, Appendix A, and it is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.8-1.[4].

The independence/physical separation of equipment design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.8-1.

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[4] Section 8.3.3.5 of this report addresses acceptable redundant circuits independence and protection from distribution system power panels to connected equipment loads which are not separated by fire or missile barriers.

8.3.2.9 Equipment Cable and Raceway Identification

This section addresses DSER (SECY-91-355) Open Item 39.

Identification of Power, Instrumentation, and Control Equipment, and Cables and Raceways

Based on information presented in Section 8.3.1.3 of the draft SSAR revision dated April 3, 1992, the staff understands that the ABWR electrical system design related to identification of power, control, and instrumentation systems, equipment, and components will meet the following commitments:

- The background of the nameplate for a division's equipment will be the same color as the electrical cable jacket markers and the cable raceway markers associated with that division.

- All exposed Class 1E and associated circuit raceways will be marked with the division color at 15 feet intervals on straight sections, at turning points, at points of entry to and exit from rooms and enclosed areas, at discontinuities, at pull boxes, and at origins and destinations of equipment.

- Class 1E and associated circuit cable raceways will be marked before their cables are installed.

- Before or during installation of all cables for Class 1E systems and associated circuits each will be marked with the division color at intervals of approximately 5 feet.

- Before or during installation cables for Class 1E systems and associated circuits that are routed in conduits (which may not be marked at 5 feet intervals inside conduits) will be marked with the division color during installation at points of entrance to and exit from conduits at pull boxes, equipment, or enclosures where cables will or can be exposed.

- All equipment, cable and raceway markings will be of sufficient durability to be legible throughout the life of the plant (60 years) and to facilitate initial verification that the installation is in conformance with the design separation criteria.

- All cables will be tagged with a permanent marker at each end with a unique identifying number (cable number) in accordance with the design drawings or cable schedule.

- The method used for identification will readily distinguish between redundant Class 1E systems, between Class 1E and non-Class 1E systems, and between associated cables of different redundant Class 1E systems.

- Associated cables will be uniquely identified as such by a longitudinal stripe or other color-coded method.

- The color of the cable marker for associated cables will be the same color as the related Class 1E cable.

- Individual conductors (located inside panels or cabinets) exposed by stripping the jacket will be color coded or color-tagged at intervals not to exceed 1 foot such that their division will still be discernable. Exceptions are permitted for individual conductors within cabinets or panels where all wiring is unique to a single division. Any non-divisional cable within such cabinets will be marked appropriately to distinguish it from the divisional cables.

- Class 1E wire bundles or cables will be identified in a distinct permanent manner at a sufficient number of points to readily distinguish between redundant Class 1E wiring and between Class 1E and non-Class 1E wiring.

- For a cabinet or compartment containing only Class 1E wiring of a single division, no distinctive identification will be required.

The staff concludes that the ABWR proposed design for identification of raceways and cables will meet the guidelines of Section 6.1.2 of IEEE 384-1981. The design will ensure that cables will be installed in their associated raceways in accordance with design-basis protection and independence requirements. The design is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.2.9-1.

Design Certification Material

The identification of power, instrumentation, and control equipment and cables/raceways design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.9-1.

Identification of Neutron-Monitoring, Scram Solenoid, and dc Emergency Lighting Cables/Raceways

Section 8.3.1.3 of SSAR Amendment 10 indicated that cables of the Neutron-monitoring system will be run in their own divisional conduits and cable trays separate from all other power, instrumentation, and control cables. Scram solenoid and dc emergency lighting cables will be similarly routed in their own conduits or cable trays separate from other cables. In addition, scram solenoid cables will be run in separate conduits for each rod scram group.

The following unique voltage class designations and markings will be used to help distinguish the neutron-monitoring and scram solenoid cables from other cable types

- Neutron monitoring cables will be marked with a VN designation.
- Scram solenoid cables will be marked with a VS designation.

The staff concludes that the proposed design for identification of raceways and cables does not meet the guidelines of Section 6.1.2 of IEEE 384-1981 and position C10 of RG 1.75 (Rev. 2). The design does not include permanent color raceway and cable markings to ensure that neutron monitoring, scram solenoid, and dc lighting cables will be installed in their associated raceways in accordance with design basis protection and independence requirements. This is Open Item 8.3.2.9-2.

Design Certification Material

The identification of neutron-monitoring, scram solenoid, and DC emergency lighting cables/raceways design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.2.9-3.

8.3.3 Protection of Electrical Systems, Equipment, and Components[5]

8.3.3.1 Protection of Electric Penetrations

This section addresses DSER (SECY-91-355) Open Item 43.

Item 7 of Section 8.3.1.4.1.2 of SSAR Amendment 10 indicates that power circuits passing through electric penetration assemblies are protected against overcurrent by redundant interrupting devices. In addition, GE's response to Question 435.31(b) of SSAR Amendment 10 indicates that the ABWR design requires that redundant interrupting devices be provided for electrical circuits passing through containment penetrations, if the maximum available fault current (including failure of upstream devices) is greater than the continuous current rating of the penetration.

Based on these design requirements, the proposed design will include redundant interrupting devices on all I&C circuits as well as power circuits that pass through containment. In addition, current limiting devices will not be used

[5] Protection of Class 1E cable systems from non-Class 1E cable systems by spatial separation or barrier is addressed as part of Section 8.3.2 of this report. Protection of Class 1E cable systems by isolation devices is addressed in Section 8.3.4 of this report.

when calculating maximum available fault current at the penetration. Worst case failure or shorting of the upstream or current limiting devices will be assumed as a given in the calculation.) The staff therefore concludes that the proposed design meets RG 1.63 (Rev. 3).

In addition, based on discussions with GE, and information presented in Section 8.3.4.4 of the draft SSAR revision dated April 3, 1992, the staff understands

- that the thermal capability of all electrical conductors within containment penetrations will be preserved and protected by two independent devices which meet requirements of IEEE 603-1980,

- the two independent devices will be located in separate panels or will be separated by barriers,

- the two independent devices will be independent such that failure of one will not adversely affect the other,

- the two independent devices will not be dependent on the same power supply to accomplish their safety function of protecting the containment penetration,

- analysis will demonstrate that with failure of either one of two devices (that is short or open between input and output of a current limiting device or protective device fails open or closed) the maximum available fault current will be less than the maximum continuous current capacity of the conductor within the penetration and the maximum continuous current capacity rating of the penetration,

- fault current clearing-time curves of the electrical penetrations' primary and secondary current interrupting devices plotted against the thermal capability (I^2t) curve of the penetration will show proper coordination of these curves,

- a simplified one-line diagram will be available showing the location of the protective or current limiting devices in the penetration circuit, the maximum available fault current of the circuit, and specific identification and location of power supplies used to provide external control power for tripping primary and backup electrical penetration breakers (if utilized), and

- the devices will be capable of being functionally tested and calibrated.

The staff concludes that the proposed design for containment electrical penetration protection will meet the guidelines of RG 1.63 (Revision 3), will meet the requirements of GDC 50 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.1-1.

In addition, the staff understands that the protective and current limiting devices will periodically be tested to demonstrate their functional capability to perform their required safety functions and that these periodic tests will be included in appropriate procedures. This is COL Action Item 8.3.3.1-1.

The protection of electric penetrations design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.1-1.

8.3.3.2 Design/Qualification of Electrical Equipment

This section addresses DSER (SECY-91-355) Open Item 45.

Section 8.3.1.2.4 of the draft SSAR revision dated April 3, 1992, indicates all Class 1E equipment is designed to operate in normal service environment as well as during and after any design basis event, in the accident environment expected in the area in which it is located. In addition, by committing to meet the guidelines of IEEE 308-1981 (Table 1.8-21 of SSAR Amendment 17), GE indicated that all Class 1E power system equipment will be qualified in accordance with IEEE 323-1974 to substantiate that it will be capable of meeting the performance requirements specified in the design basis.

Based on this commitment and discussions with GE, the staff understands that within this context Class 1E equipment includes all structures, systems, equipment, components, pipes, loads, and other equipment not categorized as Class 1E, if failure of that equipment could possibly prevent Class 1E systems, equipment, components, and circuits (including connected loads) from performing their required safety functions. The staff further understands that each type of Class 1E equipment will be

- qualified by analysis, successful use under similar conditions, or by actual test to demonstrate its ability to perform its function under normal and design basis event environmental and operational conditions,

- designed and qualified to survive the combined effects of temperature, humidity, radiation, and other conditions associated with a LOCA environment or other design-basis event environments at the end of their qualified or design life,

- qualified to IEEE 3/ /-1987, "Recommended Practices for Seismic Qualifications of Class 1E Equipment for Nuclear Power Generating Stations," electric equipment will be tested and analyzed to demonstrate its ability to meet its performance requirements during and following the design-basis seismic event,

- located in seismic Category I structures,

- seismically supported,

- designed and qualified without exception to operate in a normal, accident, and post accident environments for any design basis event, and

- will be designed and qualified to operate within allowable design basis limits for example to operate for 5 minutes when subject to voltage below

90 percent, to operate for a predetermined time when voltage is below 70 percent or, to operate continuously when subjected to voltage variations of $\pm$ 10 percent of nominal.

All structures, systems, equipment, components, pipes and loads that are not Class 1E and whose failure could possibly prevent Class 1E systems, equipment, components, and circuits including connected loads from performing their required safety function will be appropriately designed and qualified to not fail in the normal and design basis event environment for which the structures, systems, equipment, components, pipes and loads will be expected to function. In addition, variations of voltage, frequency, and waveform in the Class 1E power systems during any mode of plant operation will not degrade the performance of any safety-related system load below an acceptable level. The dc system equipment and loads will be designed and qualified to perform their required safety-related function while operating with voltages between 100 to 140 volts at the dc system's 125-volt distribution panels.

The staff concludes that Class 1E systems, equipment, and components will be protected from design-basis events. The electrical system design therefore meets GDC 2 and 4 and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.2-1.

Design Certification Material

The design/qualification of Class 1E electrical equipment design commitments should be included in the Station Electrical or in the equipment qualification ITAAC, ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.2-1.

8.3.3.3 Seismic Qualification of Light Bulbs

In response to DSER (SECY-91-355) Open Item 45, GE provided the draft SSAR revision dated April 3, 1992, Section 8.3.2.2.2 identified an exception to the requirement that all Class 1E equipment be seismically qualified. GE indicated that safety-related dc standby lighting system circuits from the power source to the lighting fixtures are Class 1E circuits which will be routed in seismic Category I raceways. The lighting fixtures themselves will not be seismically qualified, but will be seismically supported. The bulbs cannot be seismically qualified.

To justify this exception, GE indicates that bulbs can only fail open, and therefore do not represent a hazard to the Class 1E power source.

Based on discussions with GE, the staff understands that lighting fixtures will be seismically qualified. The light bulb may fail during or following a seismic event thereby extinguishing the light; however, the light bulb will not fail in a manner that could cause failure to other safety-related systems, In addition, the bulb will be replaceable and will not become a hazard to personnel or safety-related equipment during or following a seismic event.

The staff concludes that Class 1E systems will be adequately protected and the design of dc safety-related standby lighting systems will meet the requirements of GDC 4 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.3-1.

Design Certification Material

The seismic qualification of light bulbs design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.3-1.

8.3.3.4 Submergence

Item (6) of Section 8.3.1.4.2.3.2 of SSAR Amendment 10 states that any RPS or ESF electrical equipment or raceway located in the suppression pool level swell zone will be designed to satisfactorily complete its function before being rendered inoperable due to exposure to the environment created by the level phenomena. In response to staff Question 435.36 SSAR Amendment 10, GE identified electrical equipment that may be submerged as a result of suppression pool level swell phenomena or as a result of a LOCA. GE further indicated that the design specifications associated with this electric equipment would require that electrical terminations be sealed such that equipment operation would not be impaired by submersion. However, GE did not specifically address the qualification of this equipment in accordance with the guidelines of Section 4.7 of IEEE 308-1974. This was DSER (SECY-91-355) Open Item 46.

Based on information presented, it appeared that electrical equipment subject to submergence was not qualified and only partially designed for submergence. This conclusion contradicted Section 8.3.1.2.1 of Amendment 10 to the SSAR which stated that all Class 1E equipment is qualified.

The staff was concerned that equipment failure due to submergence could adversely affect the safe operation of the plant and could adversely affect Class 1E power sources serving this equipment.

GE indicated in Section 8.3.1.4.2.3.2 of the draft SSAR revision dated April 3, 1992, that the only Class 1E equipment located in the suppression pool level swell zone will be suppression pool temperature monitors, which have their terminations sealed such that their operation will not be impaired by submersion due to pool swell or a LOCA. Consistent with their Class 1E status, these devices will also be qualified to the requirements of IEEE 323 for the environment in which they are located.

Based on discussions with GE, the staff understands that all Class 1E equipment subject to submergence in the suppression pool level swell zone will either be designed and qualified to perform its required safety function without failing while submerged or will be appropriately protected from submergence and will be appropriately designed and qualified to perform its required safety function without failing in the normal and design basis event environment for which the equipment is expected to operate.

The staff concludes that the proposed design of Class 1E equipment subject to submergence meets the protection and independence requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.4-1.

Design Certification Material

The submergence design commitments for Class 1E electrical equipment in the suppression pool should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.4-1.

8.3.3.5 Redundant Class 1E Systems Subject to Common Design Basis Environments

Section 8.3.3.1 of SSAR Amendment 10 stated that electrical cable installation is such that direct impingement of fire suppressant will not prevent safe reactor shutdown. It was not clear whether impingement of fire suppressant would or would not cause failure of cable systems. The staff was concerned that cables and other electric equipment might not be designed and qualified to perform their safety function while being subjected to the direct impingement of fire suppressant.

The draft information provided by GE on September 4, 1991, indicates that cables and other electric equipment will not be designed and qualified to perform their safety function while being subjected to the direct impingement of fire suppressant. In justifying this lack of design and qualification, GE indicates that redundant divisions are provided. In the event that the cable system or equipment in one division fails due to fire suppressant impingement, and single failure occurs in a second division, safe shutdown of the plant can be achieved by the third division. This is DSER (SECY-91-355) Open Item 47.

In the draft SSAR revision dated April 3, 1992, GE indicated that where fire suppressant impinged on cables of more than one division, each case had been analyzed and found to be acceptable for the worst case failure mode.

After reviewing information presented in Chapter 8 of the draft SSAR revision dated April 3, 1992, and Section 9A.5 through Amendment 20 to the SSAR, the staff is unable to reach conclusions as to the acceptability of the level of protection to be afforded Class 1E power systems due to failure of redundant Class 1E components that can be subjected to environments of the same design basis event (including fire, fire suppressant, and non-seismic structures) for which they may not be designed or qualified. Information and design commitments presented in Chapter 8 and Section 9A.5 are inconsistent. This is Open Item 8.3.3.5-1.

Protection of redundant Class 1E systems subject to common design basis environments design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.5-2.

8.3.3.6 Associated Circuits

Based on discussions with GE and information presented in Section 8.3.1.1.5.1 of the draft SSAR revision dated April 3, 1992, the staff understands that the ABWR electrical system design related to associated circuits will meet the following commitments:

- Associated cables will be physically separated from each other in the same manner as those Class 1E circuits with which they are associated;

  or

  Associated cables will be physically separated the same manner as those Class 1E circuits with which they are associated, from the Class 1E equipment to and including an isolation device.

- Associated circuits (including their isolation devices or their connected loads without isolation devices) will be subject to all requirements placed on Class 1E circuits.

- Associated power circuits will be limited to power circuits related to the fine motion control rod drive motors.

The staff also understands that the ABWR design for associated circuits will meet the following staff position.

> Non-Class 1E circuits that are powered from a Class 1E power supply division and are considered isolated through isolation devices described in IEEE 384 (such as fuses, breakers, power packs) shall be physically and electrically independent of non Class 1E circuits that are powered through an IEEE 384 isolation device from a different Class 1E power supply division.

The staff concludes that ABWR design Class 1E systems, equipment, and components will be adequately protected from associated circuits and non-Class circuits powered through an isolation device from a Class 1E power supply. addition sufficient independence will be maintained between redundant Class 1E systems, equipment, and components. The design therefore meets the requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.6-1 and resolves DSER (SECY-91-355) Open Item 38.

Design Certification Material

The associated circuits design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.6-1.

8.3.3.7 Diesel Generator Protective Relaying Bypass

Section 8.3.1.1.6.4 of SSAR Amendment 10 indicates that protective relaying will trip the diesel generator and will be retained under accident conditions. This relaying will include the generator differential, bus differential, engine over speed, low diesel cooling water pressure (two out of two sensors), and low differential pressure of secondary cooling water (two out of two sensors). Other protective trips will be bypassed during LOCA conditions.

In Section 8.3.1.1.6.4 of the draft SSAR revision dated April 3, 1992, GE responded to DSER (SECY-91-355) Open Item 49, indicated that only the generator differential relays and engine overspeed trip would be retained under accident conditions. Other protective relays, such as loss of excitation, antimotoring (reverse power) overcurrent voltage restraint, low jacket water pressure, high jacket water temperature, and low lube oil pressure are automatically removed from the tripping circuits during LOCA conditions.

GE also committed to comply with the guidelines of Position C7 of RG 1.9 (Rev. 2) and Section 5.2 of IEEE 308-1980 or 1981? contained in Section 8.3.1.2.1(2)(b) of the draft SSAR revision dated April 3, 1992, and Table 1.8-21 of SSAR Amendment 17. The staff understands that the following design commitments apply:

- the design of the bypass circuitry will meet all the requirements of IEEE 603-1980,
- abnormal values of all bypassed parameters will be alarmed in the control room so that the control room operator can react appropriately to the abnormal condition on the diesel generator unit,
- the trip bypass function will be capable of being reset manually (capability for automatic reset is not acceptable), and
- the protective relaying and its bypass circuitry will have the capability to be tested periodically.

The staff concludes that there is reasonable assurance that the protective relaying (to be installed on Class 1E diesel generators to protect the diesel generator from failure) will be bypassed during accident conditions so that the diesel generator will not be prevented from performing its required safety function under accident conditions due to operation or failure of the protective scheme. This design meets the guidelines of Position C7 of RG 1.9 (Rev. 2) and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.7-1.

In addition, the staff understands that the protective relays and their bypass circuitry will be periodically tested and that these periodic tests and expected operator actions following an abnormal diesel generator alarm will be included in appropriate plant procedures. This is COL Action Item 8.3.3.7-1.

Design Certification Material

The diesel generator protective relaying bypass design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.7-1.

8.3.3.8 Thermal Overloads

GE's response to Question 435.60 in SSAR Amendment 10 indicates that thermal overload protection for Class 1E motor operated valves (MOVs) is in effect only when the MOVs are in test mode. The thermal overload protection is bypassed at all other times by means of closed contacts in parallel with the thermal overload contacts.

GE responded to DSER (SECY-91-355) Open Item 50, in Section 8.3.1.2.1(2)(g) and Section 8.3.2.2.2(2)(f) of the draft SSAR revision dated April 3, 1992, where they indicated that the thermal overload protection for Class 1E MOVs will be in effect during normal plant operation but the overloads will be bypassed under accident conditions as specified by Position 1.(b) of RG 1.106 (Rev. 1).

GE also committed to comply with the guidelines of RG 1.106 (Rev. 1) as stated in SSAR Sections 8.3.1.2.1(2)(g), and 8.3.2.2.2(2)(f), and to comply with GE's commitment to comply with Section 5.2 of IEEE 308-1980 is stated in SSAR Section 8.3.1.2.1(2)(b) of the draft SSAR revision dated April 3, 1992, and in Table 1.8-21 of SSAR Amendment 17. The staff understands that the bypass initiation system circuitry will meet all of the requirements of IEEE 603-1980 and the thermal overload and its bypass circuitry will have the capability to be tested periodically.

The staff therefore concludes that there will be reasonable assurance that the thermal overload protection to be installed on Class 1E motor operated valves will be bypassed during accident conditions so that the Class 1E valve motor will not be prevented from performing its required safety function under accident conditions due to operation or failure of the thermal overload devices. The design meets the guidelines of RG 1.106 (Rev. 1) and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.8-1.

In addition, the staff understands that the thermal overloads and their bypass circuitry will periodically be tested, and that these periodic tests will be included in appropriate plant procedure. This is COL Action Item 8.3.3.8-1.

Design Certification Material

The thermal overloads design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.8-1.

8.3.3.9 Breaker Coordination

Section 8.3.1.1.2.1 of SSAR Amendment 10 states that tripping of the Class 1E bus feeder breaker is normal for faults that occur on its Class 1E loads. The staff disagrees with this statement. Class 1E load breakers should be coordinated with the Class 1E bus feeder breaker so that faults which occur on its

Class 1E loads will, to the extent possible, not cause the bus feeder breaker to trip. This design minimizes the potential for loss of safety-related equipment. This was DSER (SECY-91-355) Open Item 51.

The draft information provided by GE on September 4, 1991, revised the SSAR to remove the statement that tripping of the bus supply breaker is normal for faults that occur on its Class 1E loads. Also in discussions with the staff, GE indicated that they would clarify the SSAR to state that the Class 1E load and bus supply breakers are coordinated. This is acceptable and is Confirmatory Item 8.3.3.9-1.

8.3.3.10 Protective Relaying

This section addresses DSER (SECY-91-355) Open Item 52.

Experience with protective relay applications has established that relay trip set points will drift with conventional relays. Set point drift at nuclear power plants has resulted in premature tripping of redundant, safety-related pump motors when they were required to be operative. While the staff recognizes basic need for proper fault protection for feeders and equipment (and while such protection may be required for some design-basis events such as fire), the total non-availability of redundant safety systems due to spurious trips of protective relays is not acceptable. GE in response to this concern (Question 435.58 of SSAR Amendment 10) indicated that loads, such as motors, will be designed with sufficient current carrying capability or overload margins so that set points of protective devices can be set sufficiently above the operating current point of loads to allow for set point drift. The use of loads, such as motors, with sufficient overload margins resolves the staff's concern if one assumes the following:

- Specific design parameters clearly define the overload margin requirements with respect to protective device trip set points, the margin between the trip set point and operating current point of loads, set point drift, and the margin between the trip set point and overload rating of loads.

- The protective device trip set point is periodically verified and calibrated.

- The protective device is periodically subjected to a functional test to demonstrate that its does not trip at its design rating (the normal operating current of load plus margin) and that it does trip when subjected to a fault current.

The staff was concerned that the ABWR design may not satisfy the above assumptions.

Based on GE's design commitment to meet the guidelines of RG 1.153 stated in Sections 8.3.1.2.1(2)(j) and 8.3.2.2.2(2)(j) of the draft SSAR revision dated April 3, 1992, the staff understands that

- protective relaying design will meet the above defined assumptions (that is, there will be protective device trip set point margin and capability to functionally test and calibrate the protective relaying),

- protective relaying as well as all other components, equipment, and systems within the Class 1E power system (that have no direct safety function and are only provided to increase the availability or reliability of the Class 1E power systems) including the diesel generator protective relaying and thermal overload protective devices which are bypassed during accident conditions, will meet those requirements of IEEE 603-1980 that assure that the consequences of any operation or failure is acceptable to the Class 1E power system, and

- an analysis will be performed that demonstrates that the consequences of any operation or failure of protective relaying or other components, equipment, and systems (which have no direct safety function) is acceptable to the Class 1E power system.

The staff concludes that when these components, equipment, or systems are used their operation as failure will not significantly reduce the capability of the

Class 1E power system to perform its safety function when required. The proposed design therefore meets the requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A, and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.10-1.

In addition, the staff understands that the protective relaying will periodically be tested and that these periodic tests will be included in appropriate plant procedures. This is COL Action Item 8.3.3.10-1.

Design Certification Material

The protective relaying design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.10-1.

8.3.3.11 Fault Interrupting Capacity

This discussion addresses DSER (SECY-91-355) Open Item 53.

Section 8.3.1.1.5.2(4) of SSAR Amendment 10 stated that the interrupting capacity of switchgear, load centers, motor control centers, and distribution panels is compatible with the short-circuit current available at the Class 1E buses. It was not clear that the interrupting capacity of this equipment would be equal to or greater than the maximum available fault current to which it would be exposed for all modes of operation (for example, with the diesel generator operating in parallel with the grid).

Section 8.3.1.1.5.2(4) of the draft SSAR revision dated April 3, 1992, indicates that the interrupting capacity of switchgear, load centers, motor control centers, and distribution panels will be equal to or greater than the maximum available fault current to which the equipment is exposed under all modes of operation.

The staff therefore concludes that these design commitments will provide reasonable assurance that Class 1E equipment will have sufficient capacity and capability to interrupt the worst case fault. This item is therefore considered resolved upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.11-1.

Design Certification Material

The fault interrupting capacity design basis environments design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.11-1.

8.3.3.12 Control of Design Parameters for Motor Operated Valves

Valve problems such as excess friction or excessively tight packing can result in an operational condition where the current drawn will exceed the design rating or capability of the insulation system used in the valve motor winding. Operating experience has shown that excessive current, if undetected during operation, can cause premature or unexpected failure when the valve is next operated. The ABWR SSAR did not present methods, design provisions, alarms, or procedures to ensure that the valve motor will not be operated with excessive currents without operator knowledge (or will always be operated within their design limits).

The draft information provided by GE on September 4, 1991, indicates that thermal overloads will provide protection at all times for non-Class 1E MOVs and will provide protection during testing or maintenance for Class 1E MOVs. At all other times, the Class 1E MOVs will not be protected. The staff is concerned by this lack of protection for Class 1E MOVs to ensure that the valve motor windings will not be overloaded and damaged when used during normal plant operation. This was DSER (SECY-91-355) Open Item 54.

Section 8.3.1.2.1(2)(g) of the draft SSAR revision dated April 3, 1992, indicates that Class 1E MOVs which are required to open or close to satisfy their safety function, will have the thermal overload protective devices on the valves' motors in force during normal plant operation. The thermal overload protective device for these valves will be bypassed under accident conditions per Regulatory Position 1.(b) of Revision 1 of RG 1.106.

The staff therefore concludes that the proposed ABWR design, which keeps the thermal overload in force during normal plant operation as well as during test and maintenance, will provide reasonable assurance that the MOV will not be operated with excessive currents without operator knowledge (or will be operated within their design limits). The staff's concern is therefore considered resolved contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.12-1.

Design Certification Material

The control of design parameters for MOV design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 information, which are under staff review. This is open item 8.3.3.12-1.

8.3.3.13 Fire Protection of Cable Systems

Section 8.3.3.2 of SSAR Amendment 10 indicates that spatial separation is used as a method of preventing the spread of fire between adjacent cable trays of different divisions (for example, inside primary containment). The design objective should be to separate cable trays of different divisions with structural fire barriers such as floors, ceilings, and walls. Where such barriers are not possible, divisional trays should be separated spatially by 3 feet horizontally and 5 feet vertically. Where this 3 by 5-ft spatial separation is not possible, fire rated barriers are used to separate divisional cable trays.

For a fire initiated by a cable fault within one division, these separation strategies are acceptable, since they meet the guidelines of RG 1.75 (Rev. 2) and, will provide reasonable assurance that a fire in one division will not propagate to a redundant division. This was DSER (SECY-91-355) Open Item 24.

In the draft SSAR revision dated April 3, 1992, GE revised Section 8.3.3.2 of SSAR Amendment 10 to indicate that separation is achieved by using totally enclosed raceways when spacial separation is less than 3 by 5-ft. This 3 by 5-feet spacial separation meets the guidelines of RG 1.75 (Rev. 2), and will provide reasonable assurance that a fire initiated in one division will not propagate to a redundant division, and is acceptable[6], contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.13-1.

Design Certification Material

Tier 1 design information and ITAAC are required for fire protection of cabling systems. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.3.13-1.

8.3.3.14 Electrical Protection for Scram and MSIV solenoids [Electrical Protection Assemblies (EPAs)[7]]

A generic letter issued to all operating BWRs requires two independent electrical protection assemblies (EPAs) dated September 24, 1980, on the output of RPS power supplies. This is to satisfy the single-failure criterion for non-fail-safe type failures, which may be caused by under-voltage, over- voltage, and under-frequency conditions.

GE's response to Question 435.7 included in SSAR Amendment 10 indicates that EPAs will not be used in the ABWR design because of special design features.

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[6] For design basis event exposure fires, the adequacy of the design to prevent the spread of fire between redundant systems is addressed in the Section 9.5.1 of this SER.

[7] The need for EPAs was established as part of the staff's evaluation of Instrumentation and Control (I & C) Systems. I & C Systems are addressed in Chapter 7 of this SER.

These special features include voltage and frequency monitoring of automatic transfer of power supply input sources when the voltage or frequency exceeds preestablished limits, control room alarm for abnormal conditions, operator action in response to alarm of abnormality, and design and qualification of equipment to preclude failure after operating for a sufficient period of time under voltage and frequency extremes.

The staff's review of these special features, has determined that they should provide reasonable assurance that any abnormality in voltage and frequency (which can cause failure of fail-safe-type equipment) will be promptly disconnected by alarms and operator action. The special features, however, do not meet the single failure criterion. Failure of the special features to alarm or failure of the operator to take prompt appropriate action are single failures which may cause a non-fail-safe type failure. The capability to scram the reactor could thus be compromised. This was DSER (SECY-91-355) Open Item 55.

Based on discussions with GE, the staff understands that one EPA will be installed in each of the distribution circuits between the constant voltage constant frequency (CVCF) power supply and the RPS scram and MSIV solenoid valves (the fail-safe-type equipment). The CVCF will alarm on any abnormality in voltage or frequency (which can cause failure of fail-safe-type equipment) and will be a Class 1E circuit, and the CVCF alarm system and EPAs will the be designed with capability of being tested periodically.

The staff concludes that single failure of the EPA or the Class 1E CVCF power supply will not cause a non-fail-safe type failure of RPS scram or MSIV solenoid valves. This design therefore provides reasonable assurance that failure of the power supply will not cause failure of fail safe type equipment, and is acceptable.

In addition, the staff understands that the CVCF alarm system and the EPA's will be tested periodically. These periodic tests and the required operator responses to the CVCF alarms will be included in appropriate plant procedures. This is COL Action Item 8.3.3.14-1.

Design Certification Material

The electrical protection for scram and MSIV solenoids design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.3.14-1.

8.3.3.15 Safety Bus Grounding

On every bus shown in Figure 8.3-1 of the draft SSAR revision dated April 3, 1992, there is shown one circuit connected to ground through a circuit breaker. The circuit breaker or bus grounding device provides a safety ground on buses during maintenance operations. The bus grounding device includes the following interlocks:

- Under-voltage relays must be actuated.
- Related breakers must be in the disconnect position.
- Voltage for bus instrumentation must be available.

The staff feels that the proposed grounding device should be included in the design because it may be an important protection enhancement for personnel performing maintenance on safety-related buses; and however, the staff was concerned that the proposed interlocks may not be sufficient to prevent inadvertent closing of the device during non-maintenance operation. This was DSER (SECY-91-355) Open Item 44.

Based on information presented in Section 8.3.4.14 of the draft SSAR revision dated April 3, 1992, the staff understands that administrative controls will be provided by the COL applicant to keep these circuit breakers racked out (that is in the disconnect position) whenever corresponding buses are energized. These administrative controls will be included in appropriate plant procedures. This is COL Action Item 8.3.3.15.

The staff understands that annunciation will be provided in the design to alarm in the control room whenever the breakers are racked in for service.

The staff considers this item resolved, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.15-1.

Design Certification Material

The safety bus grounding design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is open item 8.3.3.15-1.

8.3.3.16 Control of Access to Class 1E Power Equipment

Based on GE's design commitment to meet the requirements of IEEE 308-1980, the staff understands that Class 1E power system power supplies and distribution equipment (including diesel generators, batteries, battery chargers, CVCF power supplies, 6.9 kV switchgear, 480-volt load centers, and 480-volt motor control centers) will be located in areas with access doors that can be administratively controlled. In addition, ac and dc distribution panels will be located in the same or similar areas as Class 1E power supplies and distribution equipment, or the distribution panels will be designed to be locked so that access to circuit breakers located inside the panel can be administratively controlled. The plant physical design of the ABWR will permit the administrative control of access to Class 1E power equipment areas.

The staff concludes therefore that controlled access to Class 1E equipment will be included in the ABWR design in accordance with the requirements of IEEE 308-1980 and is acceptable upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.3.16-1.

Design Certification Material

Tier 1 design information and ITAAC are required for access to Class 1E equipment. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.3.16-1.

In addition, the staff understands that there will be administrative control of access to Class 1E power equipment areas and/or distribution panels and that these administrative controls will be included in appropriate plant procedures. This is COL Action Item 8.3.3.16-1.

8.3.4 Electrical Independence

Based on discussions with GE and information included in the draft SSAR revision dated April 3, 1992, the staff has the following understandings with respect to electrical independence:

- Within each load group the protective actions (that is operation of equipment for the purpose of accomplishing a safety function) will be independent of the protective actions provided by redundant load groups.

- There will be no provision for automatically transferring loads from one Class 1E ac power supply (for example, the diesel generator) to a redundant supply.

- Each onsite Class 1E power supply (for example, the diesel generator) will have provisions for automatic connection to one Class 1E load group, but will have no automatic connection to any other redundant load group. If nonautomatic (manual) interconnecting means are furnished, provisions that prevent paralleling of the redundant onsite Class 1E power supplies will be included.

    - The ABWR electrical system design will not include provisions for the manual connection of the onsite Class 1E power supply associated with one load group to any other redundant load group (except for the spare battery chargers) will not be included in

        + The ABWR design will include design provisions to allow one spare battery charger to be connected to either of two divisions and another spare battery charger to be connected to either of two other divisions.

+ The spare chargers for the dc power supply may be manually connected to either of two designated divisions, but only when their loads are switched to the same division. Key interlocks will mechanically ensure that these standby chargers can only be used in one division at a time.

+ GE modified the ABWR design to eliminate the capability to power non-Class 1E loads from more than one Class 1E division. There will be no loads in the ABWR design which can accept source power from more than one Class 1E division.

- The ABWR electrical system design will not have interconnections between redundant divisions except as noted in Sections 8.2.2.3 and 8.3.4.1 of this SER.

- The divisional battery charger will normally be fed from its divisional 480-volt motor control center bus.

• Each standby power system division includes the diesel generator, its auxiliary systems, and the distribution of power to various Class 1E loads through the 6.9-kV and 480-volt systems. Each of these divisions will be segregated and separated from the other divisions, and no automatic interconnection will be provided. Each diesel generator set will operate independently of the other sets.

• Control power (for the 480-volt auxiliaries) will be from the Class 1E 125-volt dc power system of the same division.

• Each dc system load group will have its own battery charger with no provision for automatic interconnection with other redundant load groups.

• There will be no provision for automatically interconnecting redundant dc system load groups.

- No provision will be made for automatically or manually transferring loads between Class 1E dc power sources.

- The ABWR design will not have interconnections between redundant divisions of the dc system.

- Each battery power supply will be independent of other redundant battery supplies.

- Each battery charger will be independent of other redundant battery chargers.

- The ac and dc switchgear power circuit breakers in each division will receive control power from their respective load groups to provide the following assurances:

  - Loss of one 125-volt dc system will not jeopardize the Class 1E power supply to the Class 1E buses of the other load groups.

  - The differential relays in one division and all the interlocks associated with these relays will be from one 125-volt dc system. There will be no cross connections between the redundant dc systems through protective relaying.

The staff concludes that the ABWR design for electrical independence between redundant systems meets the requirements of GDC 17 of 10 CFR Part 50, Appendix A. This design is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4-1.

Design Certification Material

Tier 1 design information and ITAAC are required for electrical independence. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.4-1.

In addition, the staff understands that the keys for the above described interlocks will be administratively controlled by the COL applicant and these administrative controls will be included in appropriate procedures. This is COL Action Item 8.3.4-1.

8.3.4.1 Interconnections[8]

Figure 8.3-8 of SSAR Amendment 10 shows two interconnections between redundant safety divisions:

1. The Division III 480-volt bus is connected to the Division I 480-volt bus through circuit breakers and a mechanical interlock. Section 8.3.2.1 of SSAR Amendment 10 indicates that this interconnection is used to transfer the 250-volt dc normal battery charger between Division I and Division III load centers.

2. The Division III 480-V motor control center (MCC) is connected to Division I 480 V MCC through battery chargers, breakers, and key interlocked breakers. Section 8.3.2.1 of SSAR Amendment 10 indicates that this interconnection is used for selection of the normal or standby battery chargers.

This was DSER (SECY-91-355) Open Item 56.

In Section 8.3.2.1.4 and Figure 8.3-7 of the draft SSAR revision dated April 3, 1992, GE eliminated the interconnection between Division III and Division I (item 1 above), which was to be used to transfer the 250-volt dc battery charger between Class 1E divisions. In the new proposed design power for the non-safety-related 250-volt dc battery charger is simple from either the non-safety-related load group A or C turbine building load centers. With

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[8] Chapter 7 of this SER addresses design requirements for I&C system isolation devices. These devices are to be used to maintain independence between Class 1E and non-Class 1E circuits (such annunciators or data loggers and computer circuits) and between redundant Class 1E trip channels.

the elimination of the interconnection, this item is considered resolved, subject to GE providing the above design information in an SSAR amendment. This is Confirmatory Item 8.3.4.1.

In regard to the interconnection described in item 2 above, Section 8.3.2.1.2 and Figure 8.3-7 of the draft SSAR revision dated April 3, 1992, indicate that electrical interconnections will exist between Division I and Division II and between Division I and Division III, so that two redundant divisions can share one standby charger. Similarly, Division I and Division II, Division III and Division IV, and Division I and Division III can be interconnected through the standby charger.

With respect to electrical interconnection between redundant safety divisions, it is the staff position that two independent open disconnect links, locked open breakers, or other equivalent open devices shall be maintained between the redundant divisions. Accordingly, the staff understands that key interlocks will be installed which will mechanically ensure that two open devices are always maintained between redundant divisions in accordance with the above staff position.

The staff concludes that the proposed design for interconnecting redundant divisions will maintain independence between redundant divisions by using two open devices. Failure of one device will not challenge or cause failure of the remaining redundant divisions. Therefore, this design meets the independence requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.1-1.

In addition, the staff understands that the keys for the interlock described above will be controlled administratively and these administrative controls will be included in appropriate procedures. This is COL Action Item 8.3.4.1-1.

Design Certification Material

The interconnections design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.4.1-1.

8.3.4.2 Constant Voltage Constant Frequency Power Supplies

Section 8.3.1.1.4.2 of SSAR Amendment 10 indicated that each of the four independent trip systems of the reactor protection logic and control system are powered by four CVCF control power buses (one each for Divisions I, II, III, and IV). This section also stated that each of these buses is independently supplied from an inverter which, in turn is supplied from one of four independent and redundant ac and dc power supplies. Subsequent sections and Figure 8.3-6 of SSAR Amendment 10, however, indicate that the ac supply for Division I and Division IV originates from a single 480-volt motor control center (C14). A single 480-volt motor control center is not "independent and redundant" as stated in Section 8.3.1.1.4.2. This was DSER (SECY-91-355) Open Item 57.

Draft information provided by GE on September 4, 1991 and also on November 26, 1991 and April 3, 1992, revised the SSAR to indicate that there are four independent and redundant dc systems and three (versus four) independent and redundant ac systems[9]. This design is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.2-1.

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[9] Because ac power to Divisions I and IV is supplied from the 6.9-kV Division I bus through a single 6.9-to 480-volt ac transformer and motor control center to the vital ac system's CVCF power supplies and the dc system's battery charger power supplies for Division I and IV. Division I and IV ac and dc systems may be subject to a single common failure of the 6.9 kV to 480-V transformer. The acceptability of this lack of independence between Divisions I and IV of I&C equipment is addressed in Chapter 7 of this SER.

Design Certification Material

Tier 1 design information and ITAAC are required for constant voltage, constant frequency power supplies. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.4.2-1.

8.3.4.3 Power Supply Circuits for Safety/Relief Valves (SRVs)

Section 19E.2.1.2.2.2 of SSAR Amendment 10 indicated that portions of each safety relief valve (SRV) control circuit use non-safety grade power. This power is taken from the Class 1E dc system through dc to dc converters or isolation devices connected to each of the four redundant and independent Class 1E dc system buses. Section 19E.2.1.2.2.2 implied that control power for each SRV comes from a minimum of two different Class 1E power source divisions. One source directly from the Class 1E dc bus, and the other from a different Class 1E dc bus through the dc-to-dc converter. The staff was concerned that the proposed design for powering the SRV may not provide sufficient independence between the redundant dc power sources, as required by GDC 17. This was DSER (SECY-91-355) Open Item 58.

Draft information provided by GE on September 4, 1991, modified SSAR Section 19E.2.1.2.2.2 to delete reference to the use of non-safety grade power taken from safety grade batteries for a portion of each SRV control circuit. In addition, the information indicated that non-divisional power is not utilized in either the SRV or the automatic depressurization system (ADS) functions.

The staff understands that SRVs will be powered only from Class 1E sources and that there will be no electrical interconnection between power supplies. This design is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.3-1.

Design Certification Material

Tier 1 design information and ITAAC are required for power supplies and circuits for safety/relief valves. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.4.3-1.

8.3.4.4 Isolation Between Safety Buses and Non-Safety Loads

Section 8.3.1.1.2.1 of SSAR Amendment 10 indicated that isolation breakers will be provided between the Class 1E and non-Class 1E buses. In addition zone-selective interlocking will be provided between each isolation breaker and its upstream Class 1E bus feeder breaker. Section 8.3.1.2.1 of SSAR Amendment 10 indicates that even though the isolation breaker is only fault-current actuated and does not meet the guidelines of Position 1 of RG 1.75 (Rev. 2), the zone selective interlocking technique met the intent of this RG. GE therefore concluded that this design met the recommendations of RG 1.75 (Rev. 2).

With respect to protecting Class 1E systems from failure of non-Class 1E systems and components, the staff agrees with GE that coordinated breakers with zone selective interlocking meet the intent of Position 1 of RG 1.75 (Rev. 2), as well as the protection requirements of GDC 2 and 4. However, with respect to the independence requirement of Criterion 17, the staff disagreed with the GE's assessment (DSER (SECY-91-355) Open Item 48). Figure 8.3-5 of SSAR Amendment 10 showed non-safety-related computers and transient recorder loads with provisions included in their power supply design for automatically transferring these loads from Class 1E Division I to Division III and from Class 1E Division II to Division III. In addition, it appeared that the power supply design may have included provision for automatic transfer of loads between Divisions I and Division II. This design did not meet the guidelines of RG 1.6 or the intent of Position 1 of RG 1.75 (Rev. 2).

Subsequently, in Section 8.3.1.1.1 of the draft SSAR revision dated April 3, 1992, GE eliminated automatic transfer of loads between redundant divisions by indicating that only Class 1E Division I will have a non-safety-related load. With this revision the staff's original concern is considered resolved contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.4-1.

In regard to the new design described in Section 8.3.1.1.1 of the draft SSAR revision, dated April 3, 1992, GE indicated that this non-Class 1E Division I load will be a power center that supplies power to the fine motion control rod drive motors that are considered non-safety related but important to safety because of their backup scram function. The non-Class 1E Division I load will also be isolated from Class 1E systems by a Class 1E fault-actuated breaker, a zone-selective interlock, a power center transformer, and a design requirement that the circuits associated with the fine motion control rod drive motors on the load side of the power transformer must be classified non-safety-related (so that they can never be routed as associated with cables of any safety related division). Upon loss of power from the safety-related source, the non-Class 1E Division I load will automatically be transferred between the Class 1E Division I power supply and a non-Class 1E power supply. This load will only be manually transferred from the non-Class 1E to the Class 1E power supply will be transferred automatically between the Class 1E Division I power supply and a non-Class 1E power supply on the loss of power from the safety related source, and (4) will only be manually transferred from the non-Class 1E to the Class 1E power supply.

The staff understands from discussions with GE and information presented in Section 8.3.1.1.1 of the draft SSAR dated April 3, 1992, that the following design commitments apply: the fault interrupt capability of breakers supplying Class 1E loads, including the Division I non-Class 1E load, will be coordinated with the fault interrupting capability of each load's upstream supply breaker so that failure of a greater part of the Class 1E division due to the single failure of a load will be minimized to the extent feasible,

- the non-safety load will have zone selective interlocks to provide additional assurance that failure of a portion of a Class 1E division due to the single failure of the non-Class 1E load will be minimized to the extent practical,

- the circuits associated with the fine motion control rod drive motors from the output of the load center transformer will be classified as non safety and will be physically and electrically independent of all safety related circuits (that is the circuit cables will not be routed in the same raceway with cables of any safety related division or in the same raceway with cables that are considered isolated from a safety related division by devices defined in Section 7.2.2.2 of IEEE Std 384-1981),

- the fault interrupt capability of all Class 1E breakers, fault interrupt coordination between the supply and load breakers for each Class 1E load and the Division 1 non-Class 1E load, and the zone selective interlock feature of the breaker for the non Class 1E load will have the capability of being tested,

- except for the fine motion control rod drive motor load connected to Division 1, non-safety loads will not be powered from any Class 1E ac, dc, or vital I&C ac power systems,

- the Division 1 onsite and offsite power supplies will have sufficient capacity and capability with margin to supply all Class 1E loads and the additional non-safety loads during all modes of plant operation, and

- analysis will demonstrate that failure of the fine rod control rod drive motors and/or failure of the system that isolates it from the Class 1E power system will not degrade the Class 1E power system below and acceptable level.

The staff therefore concludes that this design adequately protects safety systems from the failure of the non-safety-related rod control loads, the Class 1E power system has sufficient capability and capacity to supply

Class 1E loads in addition to the non safety rod control loads, and sufficient independence has been provided between redundant divisions in accordance with the requirements of GDC 4 and 17 of 10 CFR Part 50, Appendix A. The proposed ABWR design for isolating the non-safety fine motion control rod drive motor loads from the Class 1E power system meets the intent of IEEE 603-1980, 308-1980, and 384-1981 and is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.4.4-2.

In addition, the staff understands that the design permits periodic calibration and testing of the fault interrupt capability of all Class 1E breakers, fault interrupt coordination between the supply and load breakers for each Class 1E load and the Division 1 non-Class 1E load, and the zone selective interlock feature of the breaker for the non-Class 1E load. These periodic calibrations and functional tests will be included by the COL applicant in appropriate plant procedures. This is COL Action Item 8.3.4.4-1.

Design Certification Information

The isolation between safety buses and non-safety loads design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.4.4-1.

8.3.5 Lighting Systems

In its DSER (SECY-91-355), the staff identified 17 concerns in Open Item 59. GE provided a response in the draft SSAR revision dated April 3, 1992. The staff understands that there will be four independent lighting systems, including a normal ac lighting system, the standby ac lighting system, the emergency dc lighting system, and the guide lamp lighting system.

The normal ac lighting system will be used to provide up to 50 percent of the lighting needed for operation, inspection, and repairs during normal plant operation. Normal lighting will be installed throughout the plant in nonessential equipment areas. Normal lighting will not be installed in passageways and stairwells. The normal lighting system will be part of the plant's non-safety-related system and as such will be supplied by the non-safety-related power system buses and will be energized as long as power from an offsite power source is available. Normal lighting will not be available following a loss of offsite power event. In addition, as a non-safety-related system the normal lighting system will not be designed and qualified to seismic Category I requirements. As such, if will not be expected to provide light following a seismic event.

The standby ac lighting system will be provided for the operation and maintenance of equipment during the loss of normal power (and the normal lighting system). This standby system will be installed in both essential and non-essential plant areas, and will comprise both non-safety-related and safety-related ac standby lighting systems.

The non-safety-related ac standby lighting system will comprise lighting powered from three nonessential load groups. Each nonessential load group will be supplied from a different plant investment protection (PIP) bus, which can be connected to the nonessential standby power supply combustion turbine generator (CTG). The non-safety-related standby lighting system will supply a minimum of 50 percent of the lighting needs of the nonessential equipment areas. It will also supply 100 percent (50 percent from each of two non-essential load groups) of the lighting needs in passageways and stairwells leading to nonessential equipment areas, and up to 50 percent of the lighting needs in essential equipment areas and in passageways and stairwells leading to essential equipment areas. In addition the non-safety-related standby lighting system will supply 100 percent (50 percent from each of two nonessential load groups) of the lighting needs for plant security lighting. The non-safety- related lighting in the essential equipment areas and the passageways and stairwells leading to them will be supplied from the same nonessential load group as the essential load group in the same area.[10]

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[10] Each unit auxiliary transformer can supply an essential and nonessential distribution system and load group. For example, the unit auxiliary transformer that supplies power to Division I of the Class 1E system and its

The safety-related ac standby lighting system will comprised lighting from three essential safety divisions. The Class 1E divisional bus, will supply power to each lighting system. This bus will be connected to the safety-related standby power supply diesel generator (DG) in its respective division. Each safety-related standby lighting system will supply a minimum of 50 percent of the lighting needs of the essential equipment areas in its respective division. This system will also supply 50 percent of the lighting in passageways and stairwells leading to essential equipment areas in its respective equipment areas. In addition, the Division I safety-related standby lighting system will supply a minimum of 50 percent of the lighting needs of Division IV essential equipment areas (including the Division IV battery room and other Division IV I&C areas). The Division II and Division III safety related standby lighting systems will each supply a minimum of 50 percent of the lighting needs of the main control room. The safety-related standby lighting system circuits from their power source to the lighting fixtures will be Class 1E and will be routed in seismic Category I raceways. The lighting fixtures will also be qualified seismically. The light bulb may fail during or following a seismic event thereby extinguishing the light. However, the light bulb will not fail in a manner that might possibly cause other safety-related systems to fail. The bulb also will be replaceable following a seismic event, and it will not become a hazard to personnel or safety equipment during or following a seismic event.

The dc emergency lighting system will provide dc-powered backup lighting to prevent total blackout in areas which are or may be occupied during periods when ac lighting is lost until the normal or standby lighting systems are energized. The dc emergency lighting system will consist of safety-related and non-safety related dc emergency lighting systems.

The safety-related dc emergency lighting system will provide the emergency lighting needed in the main control room, the remote shutdown panel room, the emergency diesel generator areas and control rooms, and the essential electrical equipment rooms. Lighting power for these essential areas is supplied

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essential distribution system and load group will also supply a nonessential distribution system and load group.

from the Class 1E 125-volt dc system in the same division as the area. The lighting power for the main control room will be supplied from the Division II and III Class 1E 125-volt dc systems. The safety-related dc emergency lighting system circuits from their power supplies to the lighting fixtures will be Class 1E, and will be routed in seismic Category I raceways, separate from all other cables. The lighting fixtures will also be seismically qualified. The light bulb may fail during or following a seismic event, thus extinguishing the light. However, the light bulb will not fail in a manner that may possibly cause other safety systems to fail. The bulb will also be replaceable following a seismic event, and it will not become a hazard to personnel or safety-related equipment during or following a seismic event.

The non-safety-related dc emergency lighting system will provide the emergency lighting needs to the radwaste building control room, the combustion turbine generator area and control room, the non-essential electrical equipment areas, and the lighting needed for plant security. Lighting power for the radwaste building control room will be supplied from the nonessential 250-volt dc system. Lighting power for the nonessential electrical equipment rooms will be supplied from the nonessential 125-volt dc system in the same nonessential load group as the equipment in the room. Lighting power for the nonessential combustion turbine generator area and control room will be supplied from one of the nonessential 125-volt dc systems. The non-safety-related dc emergency lighting system circuits will be classified as non Class 1E and will be routed in non seismic raceways. Lighting power for plant security will be supplied from one or more of the nonessential 125-volt dc systems, in order to maintain continued operation of the security lighting system for at least 30 minutes in the event of an of ac power interruption.

The guide lamp light system will illuminate stairways, exit routes, and major control areas such as the main control room and remote shutdown panel areas. Each guide lamp will have a self-contained battery pack unit containing a rechargeable battery with an 8-hour capacity. Each unit will also contain a charger and an initiating switch, which energizes the fixture from the battery in the event of loss of the ac power supply and de-energizes the fixture upon return of ac power to the standby light following a time delay of 15 minutes.

The guide lamps will be supplied ac power from the same power source that supplies the standby lighting system in the area in which they are located. The guide lamp light system will be seismically qualified in safety-related areas.

GE has provided information pertaining to the design of the normal, standby, emergency, and guide lamp lighting systems to demonstrate that the lighting is adequate in essential plant areas as well as passageways to and from these areas. The staff understands that the ABWR design for each of these lighting systems will meet or exceed the lighting level requirements of the Illuminating Engineering Society (IES) Lighting Handbook and will have the capability of being functionally tested on a periodic basis.

The staff concludes that these systems will provide adequate levels of light to permit required operation and maintenance of equipment in essential equipment areas and passageways to and from these essential areas under normal operating conditions. This design is acceptable contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.5-1.

In addition, the staff understands that the normal, standby, emergency, and guide lamp lighting systems installed in essential areas and in passageways leading to and from these areas will be tested periodically. In addition light bulbs will be replaced when their expected design life has been exceeded. The periodic testing and replacement of light bulbs will be included in appropriate plant procedures. This is COL Action Item 8.3.5-1.

For other off-normal conditions, it is not clear that the design adequately considers lighting needs for essential areas and for passageways to and from these essential areas where plant operations are or may be required by emergency procedures. For example, under certain failures, it appears that the main control room may have only a portion (50 percent) of its lighting. Therefore, GE needs to further address the adequacy of the lighting in essential areas under postulated design basis event conditions. This is Open Item 8.3.5-1.

Design Certification Material

The lighting system design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.5-2.

8.3.6 Design Control

8.3.6.1 Control of the Electrical Design Process

Recently, a number of problems have been identified with the electrical system design at nuclear power plants. Although the majority of these problems arose as a result of modifications performed after plant licensing, some were (and all could have been) the result of poor original design. Generic Letter 88-15 dated September 12, 1988, addressed a number of these problems that have occurred primarily as a result of inadequate control over the design process. These problems have occurred in areas of electrical system design which have historically well-established, comprehensive design criteria and guidelines available for the design engineer such as circuit breaker coordination and fault current interruption capability. The adequacy of the design is a function of the designers proper exercise of the well-established design criteria and guidelines.

Based on information presented in Sections 8.3.4.17 and 8.3.5 in the draft SSAR revision dated April 3, 1992, the staff understands that purchase specification for both safety and non-safety related equipment will contain a list of appropriate common industrial standards to ensure quality manufacturing. Based on this commitment, the staff concludes that this concern (DSER SECY-91-355 Open Item 60) is resolved contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.6.1-1.

Design Certification Material

The control of the electrical design process design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.6.1-1.

8.3.6.2 Control of the Electrical Design Bases

The design bases described and presented in the ABWR SSAR should, for the most part, be useable as the bases by which the NRC issues a plant combined operating license. However, a review of the bases presented in Chapter 8 and other related chapters, revealed numerous inconsistencies as noted in DSER (SECY-91-355) Open Item 61. Consequently, it appears that GE used a deficient process to control the dessgn bases presented in the ABWR SSAR.

GE has indicated that a formal engineering review and update of the SSAR is in progress to identify and correct inconsistencies within and between sections of the SSAR. As stated previously, all conclusions in Section 8 of this SER are contingent upon elimination of conflicting information. This is Confirmatory Item 8.3.6.2-1.

8.3.7 Testing and Surveillance

This subject was addressed by DSER (SECY-91-355) Open Item 62.

Based on discussions with GE and GE's design commitment that the ABWR electrical system design meets IEEE 308-1980 guidelines, the staff understands that the following guidelines apply:

- The ABWR electrical system design will provide controls and indicators in the main control room,
- The design will include provisions for control and indication outside the main control room for,

(-) Circuit breakers that switch Class 1E buses between the preferred and the standby power supply,

(-) The standby power supply, and

(-) Circuit breakers, contractors, and other equipment as required for safety systems that must function to bring the plant to a safe shutdown condition,

- Operational status information will be provided for Class 1E power systems,

- Class 1E power systems required to be controlled from outside the main control room will also have operational status information provided outside the central control room at the equipment itself, at its power supply, and at an alternate central location,

- The operator will be provided with accurate, complete, and timely information pertinent to the status of the execute features in the control room,

- Indication will be provided in the control room of protective actions and execute features unavailability,

- Electric power systems and equipment will have the capability of being periodically tested,

- Testability of electrical systems and equipment will not be so burdensome operationally that required testing at intervals of 1, 2, or 3 months cannot be included in the technical specifications if deemed necessary.

Except as noted below the staff concludes, that the electrical system design will permit sufficient testability in accordance with the requirements of Criteria 17 and 18 of 10 CFR Part 50, Appendix A. This design is acceptable.

contingent upon inclusion of appropriate inspections, tests, and/or analyses (as part of ITAAC) which include the above design commitments as acceptance criteria. This is Confirmatory Item 8.3.7-1.

In addition, the staff understands that the electrical systems and equipment will periodically be tested in accordance with the guidelines of Section 7 of IEEE 308-1980 and that these tests will be included in appropriate plant procedures. This is COL Action Item 8.3.7-1.

Section 8.3.1.1.5.3, of SSAR Amendment 10 indicated that the ABWR design of Class 1E equipment permits periodic testing of the chain of system elements from sensing devices through driven equipment. This testing ensures that Class 1E equipment is functioning according to design requirements. This section also implies that the requirements of the single-failure criterion described in IEEE 379-1977, "Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems," will be met with respect to testing of Class 1E equipment.

The staff interpreted these statements to mean that one complete electrical system division may be taken out of service for maintenance, testing, or repair during any mode of plant operation and still leave the remaining electrical systems in compliance with the single-failure criterion. The staff, therefore, concluded that the design provision for testability of electrical systems (as interpreted) meets the sufficient testability requirement of Criterion 17 and is acceptable.

To confirm the interpretation, the staff further evaluated the capability of the electric power system to be tested during normal plant operation while meeting single failure requirements with remaining systems for any design basis event.

Based on discussions with GE and the design commitment indicating that the ABWR design will meet Section 5(4) of IEEE 338-1975 which is endorsed by RG 1.118 (Rev. 2), the staff understands that on-line testing will be greatly enhanced by the design which utilizes three independent divisions. Any one of these divisions can safely shut down the plant. That is the electrical system design will meet the single-failure criterion with respect to safe shutdown capability). However, the design will <u>not</u> meet the single-failure criterion with respect to all required safety-related systems for all design-basis events with one of the three electrical system divisions out of service. The staff also understands that an acceptable level of reliability for the remaining operable safety systems will exist when one train is taken out of service for a specified period of time for preplanned or unplanned maintenance while the single-failure criterion is not met. An acceptable level of reliability will be established for the remaining operable safety systems by a probability risk analysis. However, the ABWR SSAR did not present design commitments for what constitutes an acceptable level of reliability based on results of a probability risk analysis. This is Open Item 8.3.7-1.

The testing/surveillance design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC, which are under staff review. This is Open Item 8.3.7-2.

8.3.8 Capacity and Capability

8.3.8.1 Non-Safety DC Power Systems

In response to DSER (SECY-91-355) Open Item 64, GE provided Sections 8.3.2.1.3 and 8.3.2.1.4 of the draft SSAR revision dated April 3, 1992, including a description of the non-Class 1E 125-and 250-volt dc systems. The 125-volt dc non-Class 1E system will provide power to non-safety-related switchgear, valves, converters, transducers, controls, and instrumentation. The non-Class 1E 125-volt dc system will have three load groups with one battery, charger, and bus per load group. The 250-volt dc non-Class 1E system will provide power for non-safety-related computers and the turbine turning gear motor. The 125- and 250-volt dc systems will provide power only to non-safety-related loads and will be physically and electrically independent of the Class 1E ac and dc systems.

Staff concerns relating to interactions between safety and non-safety-related systems associated with the common dc power supply have been resolved, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.1-1.

Design Certification Material

The non-safety dc power systems design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.1-1.

8.3.8.2 Capacity of the Class 1E 125-volt dc Battery Supply

This section addresses DSER Open Item 65.

Based on discussions with GE and information presented in Section 8.3.2.1.3.2 of the draft SSAR revision dated April 3, 1992. The staff understands that each of the four Class 1E 125-volt batteries will

- be capable of starting and operating its required steady state and transient loads,

- be immediately available during both normal operations and following the loss of power from the alternating current system,

- have sufficient stored energy to provide an adequate source of power for starting and operating all required LOCA or LOPP loads and circuit breakers for two hours with no ac power,

- have sufficient stored energy to provide power in excess of the capacity of the battery charger when needed during all modes of plant operation and when the battery is being restored to its fully charged state following restoration of alternating current to the battery charger,

- be sized in accordance with industry recommended practice defined in

IEEE 485-1978,

- have a capacity design margin of 5 to 15-percent to allow for less than optimum operating conditions,
- have a 25-percent capacity design margin to compensate for battery aging,
- have a 4-percent capacity design margin to allow for the lowest expected electrolyte temperature of 21 °C (70 °F),
- have a number of battery cells that matches the battery-to-system voltage limitations (that is, the number of cells should be 58),
- base the first minute of the batteries' duty cycle on the sum of all momentary, continuous, and noncontinuous loads that can be expected to operate during the one minute fol a LOCA or LOPP,
- be installed in accordance with industr ecommended practice defined in IEEE 484-1987,
- meet the recommendations of Section 5 of IEEE 946, and
- be designed so that the each battery's capacity can periodically be verified.

In addition, to having sufficient stored energy to operate all required LOCA and LOOP loads and circuit breakers for 2 hours, the staff understands that the Division 1 battery will have sufficient stored energy to provide an adequate source of power to start and operate all required loads and circuit breakers for 8 hours with no ac power. Further the heating/ventilation system will maintain battery electrolyte temperature above 21 °C (70 °F)[11].

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[11] The capability of the heating and ventilation system to maintain a battery electrolyte temperature of 21 °C (70 °F) is addressed in Chapter 11 of this SER.

The staff concludes that the Class 1E batteries will have sufficient capacity to supply required loads following a LOCA or LOOP and a station blackout event. This designs meets the capacity requirements of Criterion 17 of 10 CFR Part 50, Appendix A, and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.2-1.

In addition, the staff understands that the capacity and capability of the dc system batteries and the capability of the batteries to supply power to their connected loads will periodically be tested in accordance with the recommendation of IEEE 450-1985. These periodic tests will be included in appropriate plant procedures. This is COL Action Item 8.3.8.2-1.

Design Certification Material

The capacity of the Class 1E 125-volt DC battery supply design parameters for motor operated valves design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.2-1.

8.3.8.3 Use of Silicon Diode in the dc System

Figure 8.3-7 and GE's response to Question 435.51 in SSAR Amendment 10 indicate that a silicon diode (SID) with a voltage drop of 10 volts would be installed in series with the output of the battery and battery charger. During normal operation (when battery charger output voltage is set at 140 volts to equalize the charge) the switch in parallel with the silicon diode will be open so that the voltage from the battery charger to the dc bus will remain at 130 volts (140 volts minus the 10-volt drop across the silicon diode), while 140 volts is supplied to the battery to equalize the charge.

In response to DSER (SECY-91-355) Open Item 66, GE provided the draft SSAR revision dated April 3, 1992, which removed the use of the silicon diode from the ABWR design and restated the commitment to design the dc system distribution equipment, component, and loads to function at 140 volts during equalization charge.

This item is therefore considered resolved, contingent upon revision of the SSAR indicating the removal of the silicon diode from the ABWR desig . This is Confirmatory Item 8.3.8.3-1.

8.3.8.4 Class 1E ac Standby Power System (Diesel Generator)

Based on discussions with GE and, information presented in the draft SSAR revision dated April 3, 1992, and the staff understands that each standby (diesel generator) power source will

- be capable of energizing or starting and accelerating to rated speed, in the required sequence, all the required safety system loads,
- be capable of attaining rated frequency and voltage within 20 seconds after receipt of a start signal,
- have a continuous load rating of 6.25 MVA @ 0.8 power factor,
- have a short time rating[12] of 110 percent of the continuous load rating for a 2-hour period out of any 24-hour period, without exceeding the manufacturer's design limits or the maintenance interval established for the continuous rating,
- be available following the loss of the preferred power supply within a time consistent with the requirements of the safety function under normal and accident conditions,
- have stored energy (fuel) at the site in its own storage tank with the capacity to operate the standby diesel generator power supply, while supplying post-accident power requirements to a unit for seven days,

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[12] Operation at this rating does not limit t e use of the diesel generator unit at its continuous rating.

- have stored energy (fuel) at the site in its own day tank with the capacity to operate the standby diesel generator power supply while supplying post accident power requirements for 8 hours,

- have a fuel transfer system with the capability to automatically replenishing the day tank from the storage tank in order to maintain the 8-hour fuel capacity of the day tank,

- be capable of operating in its service environment during and after any design basis event, without support from the preferred power supply,

- be capable of starting, accelerating, and being loaded with the design load, within an acceptable time

  - from the diesel engine's normal standby condition,

  - with no cooling available, for a time equivalent to that required to bring the cooling equipment into service with energy from the diesel generator unit,

  - on a restart with an initial engine temperature equal to the continuous rating full load engine temperature,

- be capable of accepting design load following operation at light or no load for a period of 4 hours,

- be capable of maintaining voltage and frequency at the generator terminals within limits that will not degrade the performance of any of the loads comprising the design load below their minimum requirements, including the duration of transients caused by load application or load removal,

- be capable of carrying its continuous load rating for 22 hours followed by 2 hours of operation at its short time rating,

- start from each automatic and remote manual signal and then accelerate to rated voltage and frequency, and then properly sequenc its loads if there is no offsite power availab'e or operate at no load if offsite power is available,

- start but not sequence its loads by a local manual start signal, and

- be capable of being manually started, with automatic acceleration to rated voltage and frequency, while allowing the bus to be manually energized without ac or dc external electric power.

The staff also understands that the following design commitments apply:

- The maximum loads expected to occur for each division (according to nameplate ratings) will not exceed 90 percent of the continuous power output rating of the diesel generator.

- Each diesel generator's air receiver tanks will have sufficient capacity for five starts without recharging.

- Following one successful manual start of the diesel generator without ac or dc external power, each diesel generator's air receiver tanks will have sufficient air remaining for four more starts.

- Following one unsuccessful manual or automatic start of the diesel generator with and without ac or dc external power, each diesel generator's air receiver tanks will have sufficient air remaining for three more successful starts without recharging.

- Automatic load sequence will begin at $\leq$ 20 seconds and will end at $\leq$ 65 seconds.

- Following application of each load during load sequencing, voltage will not drop more than 25 percent from nominal voltage measured at the bus.

- Following application of each load during load sequencing frequency will not drop more than 5 percent from nominal frequency measured at the bus.

- Frequency will be restored to within 2 percent of nominal, and voltage will be restored to within 10 percent of nominal within 60 percent of each load sequence time interval.

- During recovery from transients caused by step load increases or resulting from the disconnection of the largest single load, the speed of the diesel generator unit will not exceed the nominal speed plus 75 percent of the difference between nominal speed and the overspeed trip setpoint or 115 percent of nominal, whichever is lower.

- The transient following the complete loss of load will not cause the speed of the unit to attain the overspeed trip setpoint.

- Bus voltage and frequency will recover to 6.9 kV±10-percent at 60±2-percent Hz within 10 seconds following trip and restart of the largest load.

- Each of the above design commitments will have the capability of being periodically verified.

The staff concludes that the diesel generators and their load sequencers meet the capacity, capability, and testability requirements of Criterion 17 of 10 CFR Part 50 Appendix A. This design is acceptable contingent upon GE and resolving DSER (SECY-91-355) Open Item 67 and providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.4-1.

The staff also understands that each of the above design commitments will be verified periodically and that testing or analysis will be performed periodically to demonstrate the capability of the diesel generator to supply the actual full design basis load current for each sequenced load step. The periodic verification, testing and analysis will be included in appropriate plant procedures. This is COL Action Item 8.3.8.4-1.

In addition, the staff's review of the standby power system proposed in the ABWR SSAR, identified inconsistencies between Sections 8.3.1.1.8.2 and 8.3.1.1.8.3 of SSAR Amendment 10 with regard to the design capability of the diesel generator to start and attain rated voltage and frequency. Section 8.3.1.1.8.2 of SSAR Amendment 10 SSAR indicates a 13-second design capability, while Section 8.3.1.1.8.3 indicates a 20-second capability.

SSAR Amendment 17 corrected the inconsistency by changing the 13-seconds start time for the diesel generator to 20 seconds, with the sequence start times for loads changing accordingly. GE indicated that this change was made to be consistent with EPRI/ALWR requirements.

In Section 8.3.1.1.8(4) of draft SSAR revision dated the April 3, 1992, GE indicated that the accident analysis requires the RHR and HPCF injection valves to be open 36 seconds after the receipt of a high drywell or low reactor vessel level signal. Since the motor operated valves are not tripped off the buses, they start to open, if requested to do so by their controls, when power is restored to the bus at 20 seconds. This gives them an allowable travel time of 16 seconds.

By changing the allowable start time for the diesel generator from 13 to 20 seconds has changed the allowable travel time for the RHR and HPCF injection valves to move from the close to open position from twenty-three to sixteen seconds. The capability of these valves to open in 16 seconds under the operating conditions that can be expected during accident conditions, and the acceptability of the reduced valve opening time, are discussed in Chapter 5 and Chapter 6 of this SER.

Design Certification Material

The Class 1E ac standby power system design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.4-1.

8.3.8.5 Constant Voltage Constant Frequency Power Supply Capacity

Based on GE's the commitment that the ABWR design will meet the guidelines of IEEE 308, information presented in the draft SSAR revision dated April 3, 1992, and discussions with GE, the staff understands that each of the four redundant Class 1E CVCF power supplies will have a capacity based on the largest combined demands of the various continuous loads, plus the largest combination of noncontinuous loads that would likely be connected to the power supply simultaneously during normal or accident plant operation, whichever is higher. The design will also permit periodic verification of this capacity for each of the CVCF power supplies.

The staff concludes that the ABWR design for the CVCF power supply will have sufficient capacity to supply required loads, and will be testable. This design meets the capacity, capability, and testability requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.5-1.

The staff also understands that the above capacity commitment for the CVCF power supplies will periodically be verified. This verification will be included in appropriate plant procedures. This is COL Action Item 8.3.8.5-1.

8.3.8.6 Battery Charger

Based on GE's commitment that the ABWR design will meet the guidelines of IEEE Std 308, information presented in the draft SSAR revision dated April 3, 1992, and discussions with GE, the staff understands that each of the four redundant Class 1E dc battery chargers will have a capacity based on the largest combined demands of the various continuous steady-state loads, plus charging capacity to restore the battery from the design minimum charge state to the fully charged state within the time stated in the design-basis, regardless of the status of the plant during which these demands occur. The dc battery chargers will have a disconnecting device in the incoming ac power feed and its dc-power output circuit for isolating the charger. The dc batter charges will be designed to prevent the ac power supply from becoming a load on the battery. The dc battery chargers will also have provisions to isolate transients from the ac system from affecting the dc system and conversely will be sized in accordance with the guidelines of IEEE 946-1985, and the design will include the capability to periodically verify the required capacity for each of the battery charger power supplies.

The staff therefore concludes that the ABWR design for the dc system battery chargers will have sufficient capacity to supply required loads, will be testable. This design meets the capacity, capability, and testability requirements of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.6-1.

The staff also understands that the above capacity commitment for the battery charger power supplies will periodically be verified and that this verification will be included in appropriate plant procedures. This is COL Action Item 8.3.8.6-1.

Design Certification Material

The battery charger design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.6-1.

8.3.8.7 Distribution Systems

GE committed that the ABWR design will meet the guidelines of IEEE 308, in the draft SSAR revision dated April 3, 1992. The staff understands that each Class 1E distribution circuit will be capable of transmitting sufficient energy to start and operate all required loads in that circuit for all plant conditions described in the design basis and the design will also permit periodic verification of this required capacity for each distribution circuit.

The staff concludes that the ABWR design for the Class 1E distribution systems will be capable of supplying sufficient energy to safety-related system loads for their operation, and will be capable of being tested. This design meets the capacity, capability, and testability requirement of GDC 17 of 10 CFR Part 50, Appendix A, and is acceptable, contingent upon GE providing the above design information in a future SSAR amendment. This is Confirmatory Item 8.3.8.7-1.

The staff also understands that the above capacity commitment for each distribution circuit will periodically be verified and that this verification will be included in appropriate plant procedures. This is COL Action Item 8.3.8.7-1.

Design Certification Material

The distributions systems design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.8.7-1.

8.3.9 Station Blackout

On July 21, 1988, 10 CFR Part 50, was amended to include a new Section 50.63, entitled "Loss of All Alternating Current Power" (Station Blackout). The Station Blackout (SBO) rule requires that each light-water-cooled nuclear power plant be able to withstand and recover from an SBO of a specified duration. Guidance for conformance to the SBO rule is provided by RG 1.155 (Rev. 0), "Station Blackout," (2) the Nuclear Management and Resources Council, Inc. (NUMARC) 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," and NUMARC 87-00 "Supplemental Questions/Answers and Major Assumptions" dated December 27, 1989 (issued to the industry by NUMARC on January 4, 1990).

Also, the NRC developed Policy Issue, SECY-90-016, dated January 12, 1990, was approved by the Commission on June 26, 1990. This policy requires that the evolutionary ALWRs meet the SBO rule by including an alternative ac power source (i.e., combustion turbine generator) of diverse design, capable of powering at least one complete set of shutdown loads. EPRI has also included a requirement that the evolutionary ALWR design include a large-capacity, diverse, alternative ac power source (i.e., combustion turbine generator) with the capacity to power one complete set of normal safe shutdown loads and to back up the diesel generator.

For SBO, the staff has reviewed Section 19E.2.1.2.2 of SSAR Amendment 10 and GE's submittals dated November 26, 1991, and March 13, 1992. SBO was also addressed by DSER (SECY-91-355) Open Item 68. GE has resolved this item as discussed below, subject to providing an amendment to the SSAR. This is Confirmatory Item 8.3.9-1.

8.3.9.1 Reestablishment of ac Power to the Class 1E Distribution System

The staff understands that

- Any one of the three divisions of RHR will be sufficient to safely shut down the plant[13].

- Restoration of ac power to any one division at the end of the 8-hour coping period will (with margin) be capable of maintaining the plant within required design limits and to permit completion of plant shutdown.

- The three independent diesel generators will be designed with bypass valves for their dc solenoids such that each can be started manually without dc power (assuming the dc batteries are discharged following 8 hours of coping).

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[13] The capability of the heating and ventilation system to maintain a battery electrolyte temperature of 21 °C (70 °F) is addressed in Chapter 11 of this SER.

- The combustion turbine generator will be able to be started by a smaller self-contained diesel with its own battery.

- Ac power from any one of the three diesel generators will be capable of being manually connected to required loads within its associated division without dc control power.

- Ac power from the offsite preferred system or from the combustion turbine generator will be capable of being manually connected to required loads within each of the three Class 1E ac divisions without dc control power.

The staff therefore concludes that the ABWR design for reestablishing ac power meets the SBO rule and is acceptable.

Design Certification Material

Tier 1 design information and ITAAC are required for design features addressing the SBO Rule. GE has submitted proposed Tier 1 design information and ITAAC, which are under staff review. This is Open Item 8.3.9.1-1.

8.3.9.2 Coping Capability

The staff understands that

- the plant design is to be such that specified temperature limits will not be exceeded in the RCIC or Control Rooms for at least eight hours following station blackout,

- equipment required for the SBO event located in the RCIC room will be designed and qualified to a temperature in excess of 151 °F (66 °C) (the specified temperature limit),

- equipment required for the SBO event located in the control room will be designed and qualified to a temperature in excess of 122 °F (the specified temperature limit),

- the initial temperature in the heat-up calculations of 104 °F (40 °C) for the RCIC Room will prevent the equipment from reaching the design temperature of 151 °F (66 °C) for at least 8 hours,

- the initial temperature in the heat-up calculations of 79 °F (26 °C) for the Main Control Room will prevent the equipment from reaching the design temperature of 122 °F (50 °C) for at least 8 hours,

- environments expected during and following the 8-hour coping time throughout the plant for the station blackout event will not exceed the environment for which equipment is designed and qualified,

- the Division I battery will be sized with sufficient capacity to supply all required SBO loads without load shedding, and

- the RCIC systems will have sufficient capacity and capability to maintain the plant in a safe shutdown condition for 8 hours.

In addition, the staff understands that administrative controls will be included to assure that Division II, Division III, and Division IV battery system loads will be shutdown assuming Division I battery system instrumentation loads are functioning properly. These administrative controls will be included in the appropriate plant specific emergency operation procedure for station blackout. This is COL Action Item 8.3.9-1.

The staff concludes that the ABWR design will be capable of coping with the SBO event. The SBO coping capability design commitments should be included in the Station Electrical ITAAC and Tier 1 information. GE has submitted the proposed ITAAC and Tier 1 design information, which are under staff review. This is Open Item 8.3.9.2-1.

8.3.9.3 Combustion Turbine Generator (CTG)

The staff understands that the ABWR design will include a fully qualified alternative ac power source. The staff understands that this alternate ac power source will

- be a combustion turbine generator,
- be provided with a fuel supply sampled and analyzed consistent with applicable standards that is separate from the fuel supply for the onsite emergency ac power system (that is, a separate day tank supplied from a common storage tank),
- be capable of operating during and after a station blackout without any ac support systems powered from the preferred power supply or the blacked-out units Class 1E power sources affected by the event,
- be designed to power all the normal and Class 1E shutdown loads necessary within 1 hour or less of the onset of the station blackout, such that the plant is capable of maintaining core cooling and containment integrity,
- be protected from design basis weather events (except seismic and tornado missiles) to the extent that there will be no common mode failures between offsite preferred sources and the combustion turbine generator power source,
- be subject to quality assurance guidelines commensurate with its importance to safety,
- have sufficient capacity and capability to supply one division of Class 1E loads,
- have sufficient capacity and capability to supply the normal non-Class 1E loads used for safe shutdown,

- undergo factory testing similar to those required for the Class 1E diesel generator,

- not supply power to nuclear safety related equipment except on condition of complete failure of the emergency diesel generators and all offsite power,

- not be a single point vulnerability with onsite emergency ac power sources, and

- be subject to site acceptance testing, periodic preventative maintenance, and inspections.

The staff concludes that the ABWR design for the Alternate ac power supply will comply with RG 1.155, and meets the SBO rule. This design is acceptable contingent upon GE's inclusion of appropriate ITAAC which include the above design commitments as acceptance criteria. This is Open Item 8.3.9.3-1.