GE Nuclear Energy

General Electric Company
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Washington, D.C. 20555

Attention: Robert C. Pierson, Director
Standardization and Non-Power Reactor Project Directorate

Subject: **GE Responses to Open Issues for GE-ABWR SSAR, Chapter 8**

Reference: GE Proprietary Responses to Open Issues for GE-ABWR SSAR, Chapter 8, dated November 27, 1991, MFN 154-91

Enclosed are the subject documents which we committed, at the September 16-18, 1991 meeting in San Jose, to be provide by the end of November. The documents are consistent with our understanding of the GE action items discussed with the NRC on September 27, 1991.

Although many of the open issues have already been resolved, we are including a complete set of all of the issues and their associated responses for consistency. We have inserted the symbol "[N/C]" at the beginning of each response that has been previously reviewed and resolved with the NRC at the September meetings.

Please note that some of the material responding to the open issues is designated as General Electric Company proprietary information and is being submitted under separate cover (See Reference).

It is intended that GE will amend the SSAR to include this material, where appropriate.

Sincerely,

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1.000	8.2 OFFSITE POWER SYSTEM Based on information presented on figure 8.3-1 of the ABWR SSA it appears that the offsite power system consists of the following three s s: 1. A back feed from the transmission network through the main transformer, bus duct, and two unit Auxiliary transformers to the Class 1E distribution system input terminals. To initiate this back feed, the main generator must be disconnected from this source by a generator b eaker; 2. An offsite line from the transmission network through the reserve Auxiliary transformer t. the Class 1E distribution system input terminals; and 3. A combustion turbine generator to the Class 1E distribution system input terminals. Section 8.2.3 indicates that these circuits, for the most part, are within the ABWR design scope; however, sections 3.1.2.2.8.2.2, 8.2.1 and 8.2.2 indicate that these circuits are, in total, out of the ABWR Standard Plant scope; thus, description and analysis demonstrating compliance of the offsite circuits to regulatory requirements has not been provided in the ABWR SSAR. To initiate r r review of the offsite system, additional information is required for the following items and/or positions. 1. The inconsistency between sections 3.1.2.2.8.2.2, 8.2.1, 8.2.2, and 8.2.3 of the ABWR SSAR as to what part of the offsite system is within ABWR scope. 2. The description and analysis of the offsite power system's preferred offsite power supplies from the utility-ABWR interfaces to the Class 1E distribution system input terminals which is within the ABWR Standard plant scope. 3. Interface requirements for the offsite circuits from the utility-ABWR	Items 1-3 (N/C): (See the response to Question 435.63.) Items 4-7: The following new section has been added to address separation. 8.1.2.1.1 Separation The locations for the main transformer, unit auxiliary transformers, and reserve auxiliary transformer are shown on Figure 1.2-25. The reserve auxiliary transformer will be separated from the unit auxiliary transformers by 50 feet or shadow fire wall. Reference is made to Figure 1.2-1, and to Figures 8.3-1, 2 and 3 for the single line diagrams showing the method of feeding the loads. Separation of the normal preferred and alternate preferred power feeds is accomplished by floors and walls over their routes through the turbine, control and reactor buildings except within the switchgear rooms where they must be routed to the same switchgear lineups. The normal preferred feeds are routed within the turbine building from the unit auxiliary transformers to the turbine building switchgear and to the control building. From there, the normal preferred feeds continue across the divisions 1 and 3 sides of the control and reactor buildings (right side of buildings in Figure 1.2-1) to the respective safety-related switchgear rooms in the reactor building. The alternate preferred feeds from the reserve auxiliary transformer are routed outside and alongside the turbine building. The feed for the non-safety related switchgear peels off and enters the train A switchgear room at grade to pick up the switchgear at that elevation, and then rises on up to the train B switchgear room above. The other alternate preferred feed, which is for the safety-related buses, continues on outside of the turbine building until it enters the clean access corridor (Figure 1.2-25) just below grade between the turbine and control buildings. It crosses the turbine building in the top of the clean access tunnel and then enters the divisions 2 and 4 side of the control building. From there, it crosses the divisions 2 and 4 sides

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	interfaces out to the utility grid system which is outside the ABWR Standard plant scope.	of the control and reactor buildings (left side of buildings in Figure 1.2-1) to access the switchgear rooms within the reactor building. The normal preferred power feeds are not allowed to be routed in or through the clean access corridor.
	4. Description and analysis of criteria relating to physical and electrical separation between the normal and alternate preferred offsite circuits and between the preferred offsite and the onsite circuits including instrumentation and control circuits. Onsite circuits include Class 1E power supply circuits and the Class 1E distribution system circuits to the loads.	The location of the combustion turbine generator (CTG) is shown on Figure 1.2-26. The standby power feed from the CTG is routed directly to the switchgear rooms in the turbine building.
	5. Interface criteria relating to physical and electrical separation between the normal and alternate preferred offsite circuits and between offsite and onsite circuits including instrumentation and control circuits.	The branch to the reactor building is routed adjacent to the alternate preferred feeds across the control and reactor buildings.
	6. Physical lay out drawings which shows the physical separation of the offsite circuits and separation between onsite and offsite circuits. This shall include the instrumentation and control circuits associated with each offsite circuit.	Item 8 [N/C]: The second paragraphs of sections 8.1.3.1.1.1 and 8.3.1.1.1 have been revised in accordance with section 8.3.4.9. In addition, sections (1), (3) and (4) of 8.3.1.1.7 have been clarified to allow feed from either offsite source during normal plant operation.
	7. The physical and electrical separation between the circuits associated with the combustion turbine generator and other offsite circuits including instrumentation and control circuits.	Item 9 [N/C]: GE questions the validity of this criteria. GDC 17 requires two offsite sources. Yet, any plants (including the ABWR) with more then two divisions could not meet such criteria, because the loss of one of the offsite sources must affect more than one division. Yet less reliable plant designs having only two divisions would meet the criteria. We suggest this item be deleted since it is redundant to SER Issue 8.2.1.
	8. Inconsistencies between response to question 435.48 (or section 8.3.4.9) and section 8.3.1.1.1 as to the normal offsite power feeds to Class 1E division I, II, and III. Similarly, sections 8.1.2.1 and 8.1.3.1.1.1 are inconsistent.	
	9. No single failure ground fault or other aberration in one offsite preferred circuit between the plant switchyard and the Class 1E distribution system input terminals shall cause loss of offsite power to or challenge in any way more than one Class 1E distribution system.	Item 10 [N/C]: There are no restrictions placed on testing of the offsite systems during normal plant operation. Interface 8.3.4.9 provides for continuous feed from both the preferred and alternate power sources. Therefore, the need for testing should be minimal. However, testing procedures and frequency of testing for the offsite circuits is determined by the utility/applicant.
	10. Identification, analysis, and justification for each circuit or component part of the offsite system which will not be tested during normal plant operation.	

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	11. Explicit definition of normal plant operation which states that it means all modes of plant operation including shutdown, refueling, and start up.	Item 11 [N/C]: The explicit definition was added to Subsection 8.3.1.1.1, as requested (see attached mark-up).
	12. Capacity and capability of each offsite circuit to supply connected loads.	Item 12: Refer to the response to SER issue 8.3.3.6.
	13. Definition of criteria applicable to offsite systems similar to Table 8.1-1.	Item 13 [N/C]: (See Section 8.2.2 added in response to Question 435.63.)
2.000	8.2.1 Independence between Offsite and Onsite Systems. The following criteria, specified in section 8.3.2.2.1 for the ABWR design, implies that a single failure of one 125 VDC system may jeopardize and thus cause loss of offsite and onsite power to one safety division but will not jeopardize or cause loss of offsite preferred AC power to any other safety divisions. "The unlikely loss of one 125 VDC system does not jeopardize the supply of preferred and standby AC power to the Class 1E buses of the other load groups." This criteria, with respect to the DC system, meets the staff position that no single failure, ground fault, or other aberration in one offsite preferred circuit between the plant switchyard and the Class 1E distribution system input terminals shall cause loss of offsite power to or challenge in any way more than one Class 1E distribution system, division, or load group and is, therefore, acceptable. However, the offsite system being proposed for the ABWR does not meet this criteria. For example: a. Failure of the single main transformer supplying two of the safety divisions will cause loss of offsite power to more than one safety division. b. Failure of any one of the four unit auxiliary transformers will cause loss of offsite power to more than one safety division.	[N/C] The statement quoted from section 8.3.2.2.1 refers to the individual Class 1E 125 VDC batteries which control the Class 1E switchgear feeding each Class 1E 6.9KV M/C bus. Each divisional bus is feed by its own divisional breakers which are controlled by the 125 VDC battery of that same division. Therefore, it is correct in that no divisional battery failure can effect the feeders of the other divisions. The statement quoted in 8.3.2.2.1 has been clarified as follows: "The unlikely loss of one 125 VDC system does not jeopardize the Class 1E feed supply to the Class 1E buses of the other load groups."

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	To initiate our review in this area, additional information is required for the following items. 1. The extent Class 1E DC power is used for control and protection of the offsite circuits from the switchyard to the terminal connection on the Class 1E system. 2. Descriptive information or analysis demonstrating compliance of the ABWR design to the above stated criteria. 3. Specific identification and documentation of the above and other exceptions to this criteria in the ABWR SSAR with justification.	
2.100	8.2.2 Protective System for the Reactor Internal Pumps (Question 435.4) Section 15.3.1.1.1 of Amendment 10 to the SSAR states 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. Further down in this same section a statement is made that the probability of any additional RIP trips is low (less than 10**(-6) per year). Therefore, this event (i.e., the simultaneous trip of more than three RIPs) is classified as a limiting fault. In order to establish that the probability of any additional RIP trips is less then 10**(-6), additional information or analysis is required from GE in a SSAR amendment to address each of the following items. (a) Probability analysis which demonstrates that a fault on the offsite circuit that occurs anywhere between and including the offsite switchyard and the reactor internal pumps will not cause loss of more than three reactor internal pumps (RIPs). (b) Identify each component part of the power supply to the reactor internal pumps and/or protective systems that is expected to function to assure the	The reference statement in Section 15.3.1.1.1 of the SSAR, specifying that no single failure shall cause an inadvertent trip of more than three RIPs, is a design requirement on the on-site RIP power supply equipment. Faults in the off-site circuit which result in a loss of AC power to plant equipment are analyzed in Section 15.2.6 of the SSAR. The Section 15.2.6 evaluations do address a loss of power to the on-site RIP power supply equipment. An analysis is provided in Appendix 15C to the SSAR which demonstrates that the combined probability of events resulting in a trip of more than three RIPs is less than 1E-6. This analysis includes main generator trips, faults on the common feeder upstream of the 6.9 kV feeders (braking effect), and loss of off-site power, thereby bounding any postulated faults in the off-site circuit. The analysis results, as provided in Amendment 15, are listed below. No. of Pumps Tripped — Probability 1 — 0.113/yr 2 — 0.028/yr 3a (w/o coastdown) — 0.36/yr 3b (w/ coastdown) — Negligible* 4 — Negligible*

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	assumptions used in the probability analysis of item (a) above. (c) Probability analysis which demonstrates that the combined probability of all events (including those described in item (a) above) is less than 10**(-6) for trip of more than three RIPs.	5 Negligible* 6 Negligible* 7 Negligible* 8 Negligible* 9 Negligible* 10 Negligible* * < 1.0E-6/yr As explained in Section 15C.4, the failure of power to the Motor/Generator (M/G) sets does not generally constitute a trip of the RIPs powered by the M/G sets. The response to RAI 435.4 has been modified to be consistent with this information (see attached mark-up).
3.000	8.3 ONSITE POWER SYSTEMS 8.3.1 Compliance with General Design Criteria Item (1)(b) of section 8.3.1.2.2 indicates that the Class 1E Constant Voltage Constant Frequency (CVCF) power supply is in compliance with General Design Criteria (GDC) 2, 4, 17, and 18 in part or in whole, as applicable. Response to question 435.26 provides clarification that there are no noncompliances, but some portions of the GDC's are not applicable at this level (for example, the statement in GDC 17 about two physically independent circuits from the transmission network). It is unclear as to what parts of these GDC's you consider not applicable to the CVCF power supplies. Also it is unclear as to why two physically independent circuits from the transmission network are not applicable to the CVCF power supplies. In order to clarify these and other related items, additional information is required for the following issues. 1. Identification of each part of GDC 2, 4, 17, and 18 which is not considered applicable to the CVCF power supplies and justification for each part that is considered not applicable.	[N/C] Response 435.26 has been modified as follows: "All conformance statements in the analysis sections of Chapter 8 have been modified to state full compliance without the applicability caveat (see attached). There are no non-conformances with the GDCs. The 'as applicable' statements were intended only to differentiate between those portions of the GDCs we interpreted to be applicable to the plant as a whole, rather than to individual systems or components. However, it is better to delete such statements if they are construed to mean any degree of non-conformance." With regard to the CVCF power supplies, they are ultimately fed from their respective 6.9KV divisional buses (see Figures 8.3-1, 8.3-3 and 8.3-6). Each 6.9KV divisional bus is connectable to two offsite sources (prefered and alternate prefered) and two onsite sources (EDG and CTG).

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	2. Clarification as to why the GDC 17 requirement for two independent power sources is not applicable to the CVCF power supplies. 3. Clarification for each non applicable criteria shown in table 8.1-1. 4. Inconsistencies within Table 8.1-1 and between Table 8.1-1 and section 8.1.3.1.2 as to applicable criteria. 5. Identification with justification for each part of the criteria listed in section 8.1.3.1.2 that is considered not applicable to some part of the electrical system. 6. Identification with justification for each part of the design of the Instrumentation and Control system that is considered to meet the substance and intent of (versus compliance with) IEEE 279, 10 CFR 50 Appendix A, General Design Criteria 3, 17, 21, 22, and NRC Regulatory Guides 1.75 (IEEE 384) and 1.53 (IEEE 379). (Reference: section 8.3.1.4.2.1) 7. Clarification of the systems or components to which IEEE-279 apply (reference: item (11) of section 1.2.1.1.2).	The above modification closes all items except #4 and #7 which are addressed as follows: Item 4 [N/C]: Subsection 8.1.3.1.2 and Table 8.1-1 have been modified for consistency. (See attached mark-up) Item 7 [N/C]: The second sentence in Subsection 1.2 1.1.2(11) has been clarified as follows: "For Class 1E systems or components (i.e. IEEE 279 applies), single failures of either active or passive electrical components..."
3.100	8.3.1.1 Compliance with Criteria 2 and 4 Chapter 8 of the ABWR SSAR contains the following statements in relation to the compliance of electrical system design to the requirements of criterion 2, Design Bases for Protection Against Natural Phenomena, and criterion 4, Environmental and Missiles Design Bases, of Appendix A to 10 CFR Part 50. It appears that each statement can be incorrectly interpreted to mean that protection need only be provided for two of the three (or four) independent safety related electrical divisions. (1) "In some instances spatial separation is provided such that no single event may disable more than one of the redundant divisions or prevent safe shutdown of the plant. Electrical equipment and wiring for the Class 1E systems which are segregated into separate divisions are separated so that no	The second sentence of the third paragraph in SSAR section 8.1.3.1.1 [Issue quoted paragraph (2)] has been modified per the following: "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 and single failure, sufficient remaining safety systems will be available to effect a safe plant shutdown for all allowable modes of plant operation." Also, many of the paragraphs quoted have been modified or deleted because spatial separation by distance alone (i.e., without barriers), is not allowed without justification. Three-hour fire-rated barriers are required between redundant divisions in areas outside the inerted containment and the control room. Within those areas, the separation requirements of IEEE 384 and Regulatory Guide 1.75 apply. Any exceptions are analyzed and justified in

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	design basis event is capable of disabling any ESF total function." (ref: section 8.3.1.1.5.1)	9A.5.
	(2) "Redundant parts of the system are physically separated to the extent that a single credible event...cannot cause loss of power to redundant load groups." (ref: section 8.1.3.1.1.1)	
	(3) "Where spatial separation cannot be maintained in hazardous areas (e.g., potential missile areas), physical isolation between electrical equipment of different divisions is achieved by use of a 6-inch minimum thickness reinforced concrete barrier." (ref: section 8.3.1.4.1)	
	(4) "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, removal of decay heat from the core, or isolation of the containment in the event of an accident." (ref: section 8.3.1.4.1.1)	
	(5) "Equipment arrangement and/or protective barriers are provided such that no locally generated force or missile can destroy any redundant RPS, NSSS, ECCS, or ESF functions. In addition, arrangement and/or separation barriers are provided to ensure that such disturbances do not affect both HPCF and RCIC systems." (ref: section 8.3.1.4.1.1)	
	(6) "Containment penetrations will be so arranged that no design basis eventcan disable cabling in more than one division." (ref: section 8.3.1.4.2.3.2.(7)	
	(7) "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." (ref: section 8.3.1.4.2.2.3)	
	(8) "In any compartment containing an operating crane...there must be a minimum horizontal separation of 20 feet or a 6 inch thick reinforced	

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concrete wall between trays containing cables from different divisions." (ref: section 8.3.1.4.2.2.2(3))

(9) "In rooms or compartments having heavy rotating machinery....or in rooms containing high pressure feed water piping or high pressure steam lines...minimum separation of 20 feet or a 6-inch thick reinforced concrete wall is required between trays containing cables of different divisions." (ref: section 8.3.1.4.2.2.2(1))

Based on a review of the above statements, it appears that barriers between redundant safety divisions (versus barriers from the effects of a credible event such as a locally generated missile) is the design basis for electrical systems meeting the protection requirements of criteria 2 and 4 of Appendix A to 10 CFR Part 50. The design basis for protection of safety systems is not clear. It is not clear that following any design basis event with any resulting loss of equipment and single failure, sufficient remaining safety systems will be available to effect a safe plant shutdown for all allowable modes of plant operation.

4.000 8.3.2 PHYSICAL INDEPENDENCE

8.3.2.1 Conduits To Open Trays

Section 8.3.1.4.2.3.1 and response to question 435.35 indicate that physical separation, for conduits containing scram solenoid group circuit wiring, will be by a minimum separation distance of one inch from either metal enclosed raceways or non-enclosed raceways. The one inch of separation between a conduit and enclosed raceways complies with Regulatory Guide 1.75 separation guidelines and is therefore acceptable. The one inch of separation between a conduit and non-enclosed raceways, however, does not comply with separation guidelines of Regulatory Guide 1.75. The staff is therefore concerned that the proposed one inch of separation may not provide sufficient independence between redundant systems and/or protection to safety systems in accordance with the requirements of Criterion 17 of Appendix A to 10 CFR Part 50. To resolve this concern, additional information is required for the following

Items 1 & 2 [N/C]: The text of sections 8.3.1.4.2.3.1(6)&(7) and the response to question 435.35 (section 20.3) have been modified in accordance with the attached.

Item 3: The SRP requires that Regulatory Guide 1.75 be addressed, yet that guide specifically endorses IEEE 384-1974. We assumed the augmentations of the guide would apply equally to IEEE 384-1981 as well, though some section numbers within the IEEE document were changed in the newer version. To clarify the apparent contradiction, we have added this assumption statement to response 435.32 (see attached). IEEE 384-1981 is identified as the correct version for the ABWR certification, as indicated in response 435.33 and Table 1.8-21 [see SSAR page 1.8-62 (Amendment 12)].

Tables 1.8-21 and 8.1-1 have been reviewed to determine the disconnects between the versions of IEEE standards referenced in the SSAR (as required by

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items.

1. Identification with justification for the one inch of separation.

2. The contradiction between response to question 435.35 (or item 6 of section 8.3.1.4.2.3.1) and response to question 435.33 (or section 8.3.1.2.1) with regard to allowable separation between conduit and non enclosed raceways. Response 435.33 prohibits by reference to IEEE 384 while response 435.35 specifically allows one inch of separation. (Separation by one inch between enclosed and non enclosed raceways is a known area of non-compliance with the guidnlines of Regulatory Guide 1.75 which is allowed by the ABWR design. This non compliance should be justified within the ABWR SSAR. It should not be considered as an interface requirement to be resolved by others as indicated in section 8.3.4.5).

3. The contradiction between response to question 435.33 and 435.32 in the useof IEEE Standard 384-1981 versus 384-1974.

4. Extent of use of IEEE Standard 384-1981 in the design of ABWR.

5. Requirements relating to separation contained in letter SECY- 89-013.

GE RESPONSE

the Licensing Review Basis Document), verses those versions endorsed by regulatory guides. The results are as follows:

CH.8 IEEE	NRC R.G.	R.G. DATE	SSAR DATE
308*	1.32	1974	1980
317	1.63	1983	1983
338	1.118	1977	1977
384*	1.75	1974	1981
387*	1.9	1977	1984
450*	1.129	1975	1987
484*	1.128	1975	1987

* Denotes date disconnect

GE had already performed a comparison study for IEEE 384-1974 verses IEEE 384-1981, and a copy was sent to the NRC. However, GE does not intend to make similar comparison studies for the other IEEE standards. GE believes this is an NRC responsibility.

Item 4 [N/C]: As explained in Item 3 above, and in response 435.33, IEEE 384-1981 is the certification standard, but is assumed to be augmented by Regulatory Guide 1.75. There are no limitations on the extent of use of this standard in the ABWR Standard Plant Design. In fact, the 3-hour barriers separating designated fire areas/divisions exceeds the criteria of RG 1.75 and IEEE 384.

Item 5 [N/C]: SECY-89-013 requires that "...designers of standard plants...must demonstrate that safe shutdown of their designs can be achieved, assuming that all equipment in any one fire area has been rendered inoperable by fire and that reentry to the fire area for repairs and for operator actions is not possible."

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		This requirement necessitated 3-hour fire barrier protection be provided to the walls separating redundant divisional areas. Such barriers thus defined the fire area boundaries. A reference to 9.5.1.0 has been placed at the end of the first paragraph in Subsection 8.3.1.1.5.1 (page 8.3-3). This ties SECY-89-013 with the 3-hour fire barrier requirement.
5.000	8.3.2.2 Containment Penetrations Item (7) of section 8.3.1.4.1.2 indicates that electric penetration assemblies of different Class 1E divisions are seperated by distance, separate rooms or barriers, and/or location on separate floor levels. 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 has not been clearly defined. To clarify what constitutes minimum separation distance, additional information is required for the following items. 1. Clarification of the response to question 435.31(a) as to: a. Minimum allowable distance between redundant penetrations. b. Minimum seperation distance between penetrations containing non-Class 1E circuits and penetrations containing Class 1E or associated Class 1E circuits. 2. Minimum allowable separation distance between penetrations (containing Class 1E circuits) and other divisional or non divisional cables.	[N/C] The response to 435.31(a) and section 8.3.1.4.1.2(7) have been modified to more specifically state the separation criteria for the penetrations. Such separation criteria exceeds that of IEEE 384-1981, as explained in the modified response (see attached).
6.000	8.3.2.3 Class 1E Equipment Section 8.3.1.1.5.1, Physical Separation and Independence, states that divisional separacion for Class 1E equipment (which includes RPS and other	[N/C] Subsection 8.3.1.4.2.3.1(9) stated that NMS and RC&IS "cables will not be placed in any enclosure which will unduly restrict capability of removing probe connectors for maintenance purposes." Placement of cables within flex conduit, as stated in 9A.5.5.5, is consistent with this requirement. However,

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	ESF systems) is achieved through the use of barriers, spatial seperation, and totally enclosed raceways. This combination of methods for achieving separation meets the guide- lines of section 4.3 of IEEE Standard 384-1974 and is acceptable. Section 8.3.1.4 indicates that barriers (used to maintain divisional separation) are fire rated where feasible. Also section 8.3.1.1.5.1 indicates that raceways embedded in concrete walls, ceiling, or floors will be used as barriers to maintain divisional separation. The use of fire rated barriers and embedded conduit meets the intent of IEEE standard 384-1974 for separation of divisional cables and is acceptable. Section 8.3.1.4.2.2.2, however indicates an exception to the combination of barriers, spatial separation, and totally enclosed raceways as the criteria for maintaining divisional separation. In plant areas with potential hazards (such as high-pressure feed water piping or high pressure steam lines) redundant raceways separated by 20 feet without barriers or being totally enclosed is allowed to be used to maintain divisional separation. Also item (9) of section 8.3.1.4.2.3.1 indicates that cables associated with the four redundant divisions of the start up range monitoring system and the two divisions of the rod control and information system located under the vessel will not use barriers, spatial seperation, or totally enclosed raceways. However section 9A.5.5.5 indicates that flexible metallic conduit is allowed to be used on these cables under the vessel. To clarify or resolve these inconsistencies and to establish consistent separation criteria, additional information is required for the following items. 1. Clarification of the criteria to be used as the licensing and/or design basis for separation between (a) redundant divisional raceways (or cables) and (b) divisional or associated divisional and non-divisional raceways (or cables). 2. Identification of each exception to the licensing and/or design basis criteria for separation. 3. Detailed design description and analysis justifying each exception	to avoid misinterpretation, the statement in 8.3.1.4.2.3.1(9) has been modified to state "cables will be enclosed and separated as defined in 9A.5.5.5." Item 1 [N/C]: IEEE 384 and Regulatory Guide 1.75 have already been identified as the design basis criteria for separation, as indicated in the resolutions to previous issues, and throughout Chapter 8. This is also reiterated within the same subsection referenced in this issue [8.3.1.4.2.2.2(4)&(5)]. In addition to the separation criteria, the plant is designed such that complete burnout within a fire zone can be assumed per SECY-89-013. Items 2&3 [N/C]: We have already identified and justified any exceptions to separation criteria in Appendix 9A.5.5, and/or within the appropriate sections where they are discussed. For example, the NRC acknowledged the exception identified for the leakage detection instrumentation in the main steam tunnel, 8.3.1.4.2.2.2(1). [See also 9A.5...7] It was noted these cables are placed in conduit, though they cannot be physically seperated to the same extent as other cables mentioned in (1), yet they do meet separation requirements of IEEE 384. Furthermore, simultaneous failure of all cables in the group was analyzed and found to be acceptable. However, the NRC did not state whether this is acceptable. The examples referenced in the question are not inconsistencies, but are part of the exceptions and justifications requested by these items. The response to 435.35 was modified, as explained in the response to SER issue 8.3.2.1.

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	identified. If design basis criteria for separation is IEEE Standard 384, separation for example between open tray and totally enclosed raceways with less than 3 feet of horizontal separation or 5 feet of vertical separation must be addressed as part of items 2 and 3 above. Response to question 435.35 states that each scram conduit will be physically separated by at least one (1) inch from non-enclosed raceways. For any separation of 5 feet to one inch between a conduit and non-enclosed raceway the design does not meet separation guidelines of IEEE Standard 384-1974 and must be justified by analysis.	
7.000	8.3.2.4 Cables in Cabinets/Panels Section 8.3.1.1.5.1 states that divisional cables to and from the containment and to and from the dedicated divisional equipment in the reactor building are routed in separate cable raceways for each division. Section 8.3.1.1.5.1 further states that divisional cable routing is maintained up to the terminal cabinets in the main control room. This statement implies that separate cable raceways for each division may not be maintained within cabinets and implies that non safety cables may be routed in the same raceway with divisional cables within cabinets or that redundant divisional cables may be routed in the same raceway within cabinets. This statement contradicts other sections of the ABWR SSAR which require separate raceways from terminal to terminal including inside of cabinets or other types of enclosures. To resolve this inconsistency and other concerns, additional information is required for the following items. 1. Inconsistency between section 8.3.1.1.5.1 and 8.3.1.4.2.2.3 as to required separation between redundant circuits within a cabinet. 2. Criteria for separation between safety (or associated) and non safety cables and between divisional cables within cabinets or any other type of enclosure located inside and outside the main control room. 3. Marking of cables inside of cabinets and/or panels (ref: section	Item 1: There is no inconsistency between the referenced sections, because the statement in 8.3.1.1.5.1 refered to routing in raceways, which is external to the control room area. However, separation is also mainteined within the control room panels in accordance with Reg Guide 1.75 and IEEE 384. The operator interface for the main control complex does require circuits of multiple divisions, or Class 1E versus non-Class 1E circuits, in close proximity. Separation criteria for these areas are addressed in 8.3.1.1.5.1. Fire-rated barriers cannot be provided in the control room itself, but the remote shutdown system (the redundant system for the control room), provides acceptable risk for complete burnout of the control room. A reference to 8.3.1.4.2.2.3, which discusses separation within the control room panels, was added to 8.3.1.1.5.1 (see attached mark-up). Item 2 (N/C): The requested separation criteria for all types of enclosures is delineated in the whole of section 8.3.1.4, and particularly 8.3.1.4.2 and its subsections. Item 3: The following replaces Subsection 8.3.1.3.2.1(3): Cables shall be marked in a manner of sufficient durability to be legible

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	8.3.1.3.2.1(3)). 4. In addition, section 8.3.1.4.2.2.3 includes the statement that the purpose of criteria for physical separation of cables in panels is to preclude the possibility of fire propagating between redundant circuits and preventing safe shutdown of the plant. The staff feels that this statement of purpose may be misleading in that it does not fully delineate the requirements of GDC 2, 4, and 17. The purpose for physical separation is to preclude failure of non-safety circuits from causing failure of any safety circuit and to preclude failure of one safety circuit from causing failure of any other redundant safety circuit (i.e. to preclude common cause failure of safety circuits). The purpose for having physical separation in panels should be clarified in the ABWR SSAR.	throughout the life of the plant, and at intervals not to exceed 5 feet, to facilitate initial verification that the installation is in conformance with the separation criteria. Such markings shall be colored, as delineated in 8.3.1.3.1, to uniquely identify the division (or non-division) of the cable. Generally, individual conductors exposed by stripping the jacket are also color coded or color tagged (at intervals not to exceed 1 foot) such that their division is still discernable. Exceptions are permitted for individual conductors within cabinets or panels where all wiring is unique to a single division (or is non-divisional). Item 4 [N/C]: The purpose for physical seperation has been rewritten as suggested (see attached mark-up).
8.000	8.3.2.5 Associated circuits Section 8.3.1.1.5.1, Physical Separation and Independence, states, in part, that associated cables are treated as Class 1E circuits. The staff interprets this statement to mean that associated cables or circuits will meet all requirements placed on Class 1E circuits. All components in the associated circuit's current loop (loads, cables, connectors, switches, relays, protective devices, etc.) will meet Class 1E requirements. Each exception to this interpretation should be identified and justified in the ABWR SSAR.	As of November, 1991, the only "associated circuits" (as defined in IEEE 384) are in the safety related lighting subsystems (see newly added sections 9.5.3.2.2.1 and 9.5.3.2.3.1 in proprietary submittal). References to such circuits have therefore been deleted in all areas of Chapter 8 except 8.3.1.3.2, and a new interface requirement placed in 8.3.4.13. These have been retained to define criteria for additional associated circuits, should they be added prior to the implementation design stage. "Note 1" has also been added in 8.3.1.3.2 to clarify criteria (3) and (4) of IEEE 384-1981, Section 5.5.1. With the exception of the safety related standby and emergency lighting fixtures, all components which interface with Class 1E circuits are also qualified as Class 1E, unless they are specifically isolated via approved isolation devices. Such isolated circuits and components then become non-Class 1E. The last paragraph of section 8.3.1.4.1.3 has been modified to more specifically identify these exceptions.
9.000	8.3.2.6 Cable/Raceway identification	Item 1: The color coding methods for cables and raceways are delineated in 8.3.1.3.1 and 8.3.1.3.2 (including 8.3.1.3.2.1). [See Amendment 10, page

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	In regard to marking of cables and raceways, response to question 435.29 indicates that the identification criteria specified in section 8.3.1.3.1 and 8.3.2.3.2.1 fully complies with the requirements of Regulatory Guide 1.75 (revision 2) and IEEE 384-1974. The staff reviewed this criteria with respect to the guidelines of position 10 and 11 of Regulatory Guide 1.75 (revision 2) and section 5.1.2 of IEEE 384-1974 and as a result identified a number of concerns. To resolve these concerns, additional information is required for the following items. 1. The method for color coding power, instrumentation and control cables and raceways. 2. The method for distinguishing between Non-Class 1E circuits associated with different redundant divisions. 3. The durability of markings. 4. The marking of cables throughout the entire cable length from terminal connection to terminal connection including inside cabinets and/or panels.	8.3-11->13.] Additional clarification has been added to both sections as follows: "Cables shall be marked in a manner of sufficient durability to be legible throughout the life of the plant, and to facilitate initial verification that the installation is in conformance with the separation criteria. "Such markings shall be colored to uniquely identify the division (or non-division) of the cable. Generally, individual conductors exposed by stripping the jacket are also color coded or color tagged (at intervals not to exceed 1 foot) such that their division is still discernable. Exceptions are permitted for individual conductors within cabinets or panels where all wiring is unique to a single division (or is non-divisional)." Also, in 8.3.1.3.1, "All cable trays are marked with their proper..." has been changed to "All Class 1E cable trays are marked with the division color, and with their proper..." Item 2: The method for distinguishing between non-Class 1E circuits associated with different redundant divisions is delineated in 8.3.1.3.2, and has been clarified as follows: "Associated cables are uniquely identified by a longitudinal stripe or other color coded method, and the date on the label. The color of the cable marker for associated cables shall be the same as the related Class 1E cable." Item 3 [N/C]: A durability statement has been added to sections 8.3.1.3.1 and 8.3.1.3.2.1(3) consistent with IEEE 384 (see attached). Item 4 [N/C]: These concerns are already addressed in issue 8.3.2.4, and in Items 1 & 2 above.
10.000	8.3.2.7 Cables Approaching and/or Exiting Cabinets/Panels	[N/C] The NRC's stated implication is not consistent with the NRC's concerns stated in SER section 8.3.2.4, nor SSAR section 8.3.1.1.5.1. That section

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	Response to question 435.30 states that cable spreading areas are not applicable to the ABWR and are not in the plant layout because the majority of the signals will be multiplexed to the con' ol room. Thus, it has been implied that the 1 foot-3 foot separation guidelines allowed by section 5.1.3 of IEEE Standard 384-1974 will not be applicable to ABWR nor will the guidelines of position C12 of Regulatory Guide 1.75. Criteria for the separation and protection of cables approaching and/or exiting cabinets/panels has not been addressed in the ABWR SSAR. To initiate our review in this area, additional information is required for the following items. 1. Routing criteria and protection to be provided electrical and/or optical cables used to carry multiplexed or other type of signals to the control room. 2. Criteria for routing of safety or non-safety power cables in any room with instrumentation and control cables. 3. Inconsistency between item (5) of section 8.3.1.4.2.2.2 and response to question 450.30. 4. Cable separation in cable tunnels.	specifies that IEEE 384, Reg Guide 1.75 and GDC 17 criteria is applicable to all divisional equipment, including interconnecting cabling. In addition, 3-hour fire rated barriers separate divisions in all areas of the plant except as noted in Item 4 below. Item 1 [N/C]: The requirements delineated in 8.3.1.1.5.1 do not distinguish between metallic or fiber-optic cables, and thus are applicable to both. The following sentence was added at the end of the first paragraph of 8.3.1.1.5.1: "Class 1E to non-Class 1E separation is designed in accordance with the requirements of IEEE 384." Cable raceways are seperate, according to voltage levels, as described in 8.3.1.4.1.1(4). The "V1" level [paragraph (d)] has been modified to include fiber-optic cables (see attached). Item 2: The physical arrangement of raceways keeps power cables seperate from I&C signal cables, as described in 8.3.1.4.1.1(4). The following sentence has been added to 8.3.1.4.1.1(3): "Class 1E and non-Class 1E cables are separated in accordance with IEEE 384 and RG 1.75 (see Figures 9A.4-1 through 9A.4-16). Item 3 [N/C]: Section 6.1.3.1 of IEEE 384-1981 changes the term "cable spreading room" to "nonhazard area". Paragraph (5) of 8.3.1.4.2.2.2 has been modified to state specific requirements that all safety equipment or cable areas shall meet or exceed the requirements of IEEE 384 (see attached mark-up). Item 4 [N/C]: The building structures for the ABWR Standard Plant are laid out in such a manner that cable tunnels are not required for divisional cables. Cable chases, which are designed in accordance with IEEE 384, do exist within the buildings. Except for the instrument sensor cables for the turbine stop valve closure and turbine control valve fast closure [see 7.2.2.2.4(4)], Class 1E cable runs occur only between the reactor and control buildings; all others are non-Class 1E.

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		Each divisional cable duct between and throughout these buildings is entirely separate and isolated from redundant divisions by three-hour rated fire barriers. Exceptions occur only within the control room complex itself, and within the primary containment, and for leak detection thermocouples. Yet these exceptions still meet the requirements of Reg Guide 1.75 and IEEE 384 by providing metal barriers and/or spatial separation between divisions. Special cases within the reactor building are analyzed as acceptable (in accordance with SECY-89-013) in 9A.5. The control room complex fire analysis is provided in 9A.4.2.4.1. Class 1E cables are separated from non-Class 1E cables in accordance with the requirements of IEEE 384 and RG 1.75 in all areas of the plant, including cable chases.
11.000	8.3.3 PROTECTION 8.3.3.1 Electric Penetrations Item 7 of Section 8.3.1.4.1.2 indicates that power circuits going through electric penetration assemblies are protected against over current by redundant interrupting devices. In addition, response to questions 435.31(b) indicates that it is an ABWR design requirement that redundant interrupting devices be provided for electrical circuits going 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 the above design requirements, it appears that the proposed design will include redundant interrupting devices on all instrumentation and control circuits as well as power circuits that pass through containment. In addition, when calculating maximum available fault current at the penetration, current limiting devices will not be used in the calculation (i.e. worst case failure or shorting of the upstream or current limiting devices will be assumed as a given in the calculation). Based on the above interpretation, the staff concludes that the proposed design meets Regulatory Guide 1.63 (revision 3) and is acceptable. To confirm the above interpretation and to resolve other related concerns, additional information is required for the following items.	[N/C] The NRC stated assumption that "...the proposed design will include redundant interrupting devices on all instrumentation and control circuits as well as power circuits that pass through containment" is not correct. Some circuits do not have high fault current available, such as thermocouple circuits. Item 1 [N/C]: The requested information was added to 8.3.1.4.1.2(7), but with the high available fault current stipulation. Item 2: 8.3.4.4 has been modified to specify the requirements for proper coordination of thermal capability curves and protection of the penetration conductors (see attached). Item 3 [N/C]: Section 5.4 of IEEE 741-1986 specifies that 1) "Where a penetration assembly can indefinitely withstand the maximum current available due to a fault inside containment, no special consideration is required.[5.4.2]" and 2) "Electrical penetrations requiring special consideration shall be provided with dual primary protection operating separate interrupting devices, or primary and backup protection operating separate interrupting devices.[5.4.2.1]" and 3) "The time-current curves of

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	1. Descriptive information which explicitly states that electrical circuits includes all instrumentation and control circuits as well as power circuits. 2. Clarification of interface requirements presented in section 8.3.4.4 to clearly state the criteria or design requirements that must be demonstrated by (a) fault current clearing-time curves for protective devices, (b) thermal capability curves of the penetration, (c) location of protective devices, and (d) power supplies for protective devices. 3. Descriptive information which clearly indicates how penetration protective devices will conform to each requirements of section 5.4 of IEEE Standard 741-1986, IEEE Standard Criteria for Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Systems, that is recommended by position 1 of Regulatory Guide 1.63 (revision 3). 4. Criteria which would permit use of one current limiting device and one protective device as the redundant protective devices needed to meet the guidelines of position 1 of Regulatory Guide 1.63.	the dual primary protection or the primary and backup protection shall coordinate with the time-current capability curve of the electrical penetration to be protected.[5.4.2.2]" This has already been provided per Items 1 and 2 above. Item 4: In accordence with Section 5.4.2 of IEEE 741-1986, no special consideration is required if fault current is limited to that which the penetration assembly can indefinitely withstand. Therefore, if adequate current-limiting devices exist in the circuit, redundant protective devices are not required. However, where there is potential for overcurrent due to failure of upstream devices (i.e., the current-limiting device itself), it is considered good design practice (though not required by Regulatory Guide 1.63 / IEEE 741) to include a current interrupting device in the circuit. Adequate protection is provided for all penetrations, including those for the RIPs, by the interface requirements defined in SSAR Section 8.3.4.4 (as modified per Item 2 above).
12.000	8.3.3.2 Safety Buses On every bus shown in figures 8.3-1, 8.3-2, and 8.3-3, there is one circuit shown connected to ground through a circuit breaker. The circuit breaker or bus grounding device is used to provide a safety ground on buses during maintenance operations. Interlocks for the bus grounding device as stated in response to question 435.47(e) include: 1. Under voltage relays must be actuated; 2. Related breakers must be in the disconnect position; and 3. Voltage for bus instrumentation available. The staff feels that the proposed grounding device may be an important	Item 1 [N/C]: A description of the grounding devices and their associated interlocking logic has been added to subsection 8.3.1.1.1 (see attached). Item 2 [N/C]: The addition of any grounding device will, by its existence, contribute to some measure of degradation in reliability. However, the interlock constraints (including those associated with the racking out/disconnect position of the breaker itself) place the breakers in a state of semi-existance (i.e., "racked out") while the bus is energized, such that the bus reliability is not unecceptably degraded. Item 3 [N/C]: An interface requirement has been added to assure administrative controls are in place to keep these circuit breakers racked out (i.e., in the disconnect position) while the buses are energized

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	enhancement for performing maintenance on safety buses and should be included in the design; however, the staff is concerned that the above proposed interlocks may not be sufficient in and of themselves to prevent inadvertent closing of the device during non-maintenance operation. To resolve this concern, additional information is required for the following items. 1. Description and analysis for the proposed design. 2. Justification that the level of reliability of the safety bus has not been degraded by the addition of the device. 3. Interface requirements, alarms, or other controls which will be implemented to assure the device will not be inadvertently closed.	Furthermore, an annunciator will sound whenever these breakers are racked in for service. This precaution, in addition to the other interlocks provided, should preclude any probability the breakers could be inadvertently closed during non-maintenance operation of the power system. See new section 8.3.4.14 attached.
13.000	8.3.3.3 Qualification Section 8.1.3.1.2.2 indicates, by reference to compliance with Regulatory Guide 1.32, 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 events. Section 8.3.1.2.4 and 8.3.3.1 include the following items (it appears) in support of compliance with this Regulatory Guide 1.32 requirement. 1. Class 1E equipment essential to limiting the consequences of a LOCA are designed to operate in normal service and post accident environments; 2. Electric equipment is seismically qualified; 3. All class 1E cables are moisture and radiation resistant and highly flame resistant; 4. Separate certification proof tests are performed to demonstrate 60 year life, radiation resistance, environmental capability, flame resistance, and gas evolution of cables;	Item 1 [N/C]: The first paragraph on 8.3.1.2.4 has been revised to say "...all Class 1E equipment is designed to operate during and after any design basis event, in the accident environment expected in the area in which it is located. All Class 1E electric equipment is qualified to IEEE 323 (see Section 3.11)." Item 2 [N/C]: Compliance with IEEE 308 for the physical independence of electric power systems is committed in the last paragraph of 8.3.1.4.1, as appropriate to this section. Full compliance to Regulatory Guide 1.32 (hence, to IEEE 308) is stated in Subsection 8.1.3.1.2.2(3) and Table 8.1-1. However, the certification standard is IEEE 308-1980, not IEEE308-1974, as shown in Table 1.8-21. Corresponding sections referenced for the 1980 version are 5.3, 5.4 and 5.9, respectively. Section 4.7 of 308-1974 simply states that equipment should be qualified by type testing, operating experience, or analysis. Section 5.9 of 308-1980 requires that equipment be qualified in accordance with IEEE 323-1974, which delineates all of these methods including their combinations (see IEEE 323-1974, Section 5). Therefore, Section 5.9 of 308-1980 is more stringent than Section 4.7 of 308-1974.

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	5. Each power cable has a radiation resistant covering; 6. Conductors are specified to continue to operate at 100% relative humidity with a life expectancy of 60 years; and 7. Class 1E cables are designed to survive the LOCA ambient conditions at the end of a 60 year life span. Each of the above items meets in part the guidelines of Regulatory Guide 1.32; however, based on the information presented, it is not clear that all cables, for example, are designed and qualified to survive the combined effects of temperature, humidity, radiation, etc. associated with a LOCA environment or other design basis event environments at the end of their qualified and/or design life. Clarification of the design and qualification requirements for cables as well as other Class 1E equipment to survive normal and accident environments (including identification with justification of exceptions to the design and qualification requirements) should be provided in the ABWR SSAR. In addition, section 8.3.1.2.4 indicates that all Class 1E equipment which is essential to limiting the consequences of a LOCA is designed for operation in normal service environment and to operate in the post accident environment expected in the area in which it is located. Also, this section indicates that electric equipment is qualified to IEEE 344 (i.e. electric equipment will be demonstrated to meet its performance requirements during and following the design basis seismic event by test and/or analysis). Based on information presented, the design and qualification commitment for electric equipment in the proposed ABWR design is not clear with respect to the capability of equipment to survive the combined effects of a LOCA environment. To clarify and resolve this and other issues, additional information is required for the following items. 1. Explicit design commitment that all Class 1E electric equipment will be	Item 3 [N/C]: Separation criteria for the equipment in the drywell is discussed in 9A.5. Environmental qualification for all equipment in all locations, including the drywell, is discussed in section 3.11 and Appendix 3I. A reference to 3.11 (which in turn references Appendix 3I) is already included in 8.3.1.2.4. Item 4 [N/C]: The last sentence of 8.3.1.4.1.2(2) [which mentioned the drywell was not considered a hostile area] has been changed to: "Cable routing in the drywell is discussed in association with the equipment it serves, in the 'special cases' section 9A.5." Item 5 [N/C]: The term "hostile area" was intended to mean those areas which could be potentially exposed to the energy of a postulated reactor coolant (steam or water) pressure boundary pipe rupture. This criteria is defined in Appendix 3I and tables 3I.3-1 through 3I.3-21. Item 6 [N/C]: Plant Design specifications for electrical equipment require such equipment be capable of continuous operation for voltage fluctuations of +/- 10%. In addition, Class 1E motors must be able to withstand voltage drops to 70% rated during starting transients. [These two sentences have been added to SSAR Subsection 8.3.1.1.5.2(1)].

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	designed and qualified for operation in its normal service environment and to operate in the accident and post accident environment expected in the area in which it is located for any design basis event. 2. Compliance of the ABWR design with sections 4.2, 4.3, and 4.7 of IEEE Standard 308-1974. 3. Expected normal and accident environment, separation criteria, protection afforded Class 1E equipment and cables, and qualification of equipment for any environment in the drywell. 4. For the expected worst case accident environment in the drywell, clarification of why the drywell is not considered a potentially hostile area. 5. Criteria for establishing hostile areas. 6. Design and qualification of equipment to operate for 5 minutes when subject to voltage at 90 percent of rated voltage and to operate for a predetermined time at 70 percent.	
14.000	8.3.3.4 Submergence Item (6) of section 8.3.1.4.2.3.2 states that any electrical equipment and/or raceway for RPS or ESF located in the suppression pool level swell zone will be designed to satisfactorily complete their function before being rendered inoperable due to exposure to the environment created by the level phenomena. In response to staff question 435.36, the licensee identified electrical equipment that may be submerged as a result of suppression pool level swell phenomena or as a result of a LOCA. The licensee further indicated that the design specifications associated with this electric equipment would require terminations be sealed such that equipment operation would not be impaired by submersion. The qualification of this equipment in accordance with the guidelines of section 4.7 of IEEE Standard 308-1974 was, however, not specifically addressed. Based on information presented, it appears that	[N/C] There is no contradiction between the response to 435.36 and 8.3.1.2.1. Quite the opposite is true, in that the sealed terminations preclude flooding effects on operation of the devices, which in this case are thermocouples. However, 8.3.1.4.2.3.2(6) was erroneous and has been corrected per the attached markup. Section 4.7 of IEEE 308-1974 is superceded by section 5.9 of IEEE 308-1980 which requires Class 1E equipment be qualified to IEEE 323-1974. This explicit commitment has been added to response 435.36 in accordance with the NRC request (see attached mark-up). It should be realized that, as indicated in response 435.36, the only electrical devices (besides plant lighting equipment) in the wetwell area are thermocouples and instrument piping for level monitors (the instruments

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	electrical equipment subject to submergence is not qualified and only partially designed for submergence. This conclusion contradicts section 8.3.1.2.1 of the ABWR SSAR which states that all Class 1E equipment is qualified. It is the staff concern that equipment failure due to submergence may adversely affect the safe operation of the plant and may adversely affect Class 1E power sources serving this equipment. To resolve this concern, additional information is required for the following items. 1. The apparent contradiction between section 8.3.1.2.1 and response to question 435.36 in regard to qualification of equipment. 2. Analysis demonstrating that failure of unqualified equipment due to submergence will not adversely affect safety or Class 1E power sources. 3. Explicit commitments to qualification in conformance to Section 4.7 of IEEE Std 308-1974.	themselves are outside the wetwell). Most of these thermocouples are submerged all the time. The remaining ones are designed specifically to be submerged as the pool level swells. Thus, concerns about "equipment failure" or "adverse affects on Class 1E power sources." due to pool swell are not warrented.
15.000	8.3.3.5 Impingement of fire Suppressant Section 8.3.3.1 states that the cable installation is such that direct impingement of fire suppressant will not prevent safe reactor shutdown. Based on this statement it is not clear whether impingement of fire suppressant will or will not cause failure of cable systems. Clarification of the design and qualification of cables to perform their safety function while being subjected to the direct impingement of fire suppressant should be provided.	[R/C] The plant is designed with three-hour rated fire barriers separating redundant divisions. Therefore, a complete loss of function can be assumed within any one fire area, with acceptable consequences (i.e., safe shutdown). No safety function is required of any cable once it is exposed to fire. Under such circumstances, the redundant divisions would assume the safe shutdown function. In addition, the fire barrier system confines smoke, hot gases, and fire suppressant to the division of the fire; as stated in the fourth requirement/compliance paragraphs of Subsection 9.5.1.0. (Also, see Subsection 9.5.1.0.10.) This is the intent of the statement in 8.3.3.1, which has been modified for clarification (see attached mark-up). Class 1E cables are qualification tested to withstand severe environmental stress, as indicated in 8.3.3.1, and consistent with IEEE 323. They are also hose-stream tested, and will be tied down in metal trays. Even though redundant divisions are available, the cables should perform their functions while being subjected to direct impingement of fire suppressant. However,

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		because of the redundancy available in separate fire zones, specific testing in this regard is not required, nor considered necessary.
16.000	8.3.3.6 Isolation between Safety Buses and Non-Safety Loads Section 8.3.1.1.2.1 indicates that Isolation breakers are provided between the Class 1E and non-Class 1E buses. In addition to normal over current tripping of the isolation breaker, zone selective interlocking is provided between each isolation breaker and its upstream Class 1E bus feeder breaker. Section 8.3.1.2.1 indicates that even though the isolation breaker is fault-current actuated in non-compliance with the guidelines of position 1 of Regulatory Guide 1.75, the intent of this Guide is met through the zone selective interlocking technique; thus, the design meets the recommendations of this and other guides. With respect to protecting Class 1E systems from failure of non-Class 1E systems and components, the staff agrees with the licensee that coordinated breakers with zone selective interlocking meets the intent of position 1 of Regulatory Guide 1.75 and meets the protection requirements of criteria 2 and 4; however, with respect to meeting the sufficient independence requirement of criterion 17, the staff disagrees with the licensees assessment. Non safety computers and transient recorder loads shown on figure 8.3-5 have provisions included in their power supply design for automatically transferring these loads from Class 1E division 1 to 3 and from Class 1E division 2 to 3. In addition, it appears that the power supply may also include provision for automatic transfer of these loads between division 1 and 2. The design does not meet the guidelines of Regulatory Guide 1.6 nor the intent of position 1 of Regulatory Guide 1.75. The proposed design thus may not meet the independence requirements of criterion 17 of Appendix A to 10 CFR Part 50. To resolve this and other issues, additional information is required for the following items and/or staff positions. 1. Reliability, testability, test frequency, functional test, and calibration of the isolation breaker coordination and zone selective interlocking.	A revised single-line diagram is submitted for review by the NRC staff. There are no non-Class 1E loads on the safety buses for the revised single-line. Non-safety related loads which require standby power have all been located on buses which have the combustion turbine generator as an alternate source of power. GE believes that this new single-line addresses all of the NRC staff's concerns regarding voltage distribution. The implementation, however, constitutes a complete rearrangement of the medium-voltage distribution system, and thus affects significant portions of the SSAR text and some RAI/SER responses which pertain to the previous single-line drawing. At present, the Staff is asked to review this proposal independently as submitted in Attachment #1 (see proprietary submittal). Following NRC approval, appropriate adjustments will be made for the other affected areas in the SSAR during the formal engineering review of Chapter 8 (see SER issue 8.3.6.2). Attachment #1 includes the revised single line sketches, a load summary (normal loads on the unit auxiliary transformers are assumed to be 5 MVA per division), a summary of effects of changes, and an operating features summary.

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	2. All non safety circuits connected to the Class 1E system through the isolation breaker with zone selective interlocking shall be treated as associated circuits.	
	3. Interconnection between redundant divisions (whether through safety or non safety buses) shall be maintained with two normally open and interlocked devices that are separate and independent such that single failure or single operator action can not cause the interconnection or or challenge to redundant divisions.	
	4. Administrative interface criteria and/or alarms for maintaining and assuring interconnections open.	
	5. Identification of all safety and non safety loads that can be powered from more than one Class 1E division power supply. Appendix 20B should be modified to clearly indicate loads that can be powered from more than one safety division.	
	6. A description and analysis of the use of fault actuated isolation devices in the Class 1E constant voltage constant frequency power system.	
	7. The use of uninterruptible power supplies as isolation devices (Reference response to question 435.34c).	
	8. Isolation devices used at the interface between Class 1E circuits and non-Class 1E equipment circuits (i.e., annunciators or data loggers) (reference section 8.3.1.4.2.2.4).	
	9. The contradiction between Figure 8.3-3 and response to question 435.49c. Response to question 435.49c states that T/B MCC is non Class 1E and is powered from non Class 1E power sources. Figure 8.3-3 in contradiction shows T/B MCC to be powered from Class 1E power sources.	
	10. The contradiction between response to question 435.18e, question 435.14, and other ABWR SSAR sections (e.g. 8.3.1.1.2.1) as to tripping of non-safety	

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	loads on a LOCA signal. 11. Identification of all non-safety loads and their KW ratings that can be powered from safety related diesel generators and identification of the extra KW capacity available to supply non-safety loads during the various modes of plant operation. 12. The capacity, capacity margin, and other provisions that will be included in the sizing criteria for electric systems and components (i.e. diesel generators, batteries, distribution systems, etc.) which will allow them to perform their safety function reliably while supplying non-safety loads. 13. Inconsistency between response c and d to question 435.18 as to loads that are disconnected for a LOCA occurring after loads have been sequenced following a loss of offsite power. Response c indicates loads not required for LOCA are tripped while response d implies that LOPP loads remain connected.	
17.000	8.3.3.7 Diesel Generator Protective Relaying Section 8.3.1.1.6.4, Protection Requirements, indicates that the following protective relaying will trip the diesel generator and will be retained under accident conditions: 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. This protective relaying (except for bus differential) appears to meet position 7 of Regulatory Guide 1.9 (revision 2) and is acceptable. To resolve the exception (i.e. bus differential relays tripping the diesel generator) and other related concerns, additional information is required for the following items. 1. Bases and justification for bus differential relays tripping the diesel generator.	Item 1: The bus differential relays trip the generator breaker, but do not shut down the diesel. There are two arguments why the bus differential relays should not be bypassed under LOCA conditions: 1) A bus differencial indicates a serious fault condition, in a similar class with the generator differential. Unconditional trips should apply to bus differential signals for the same reasons they apply to generator differential signals. The generator and bus must be protected from such faults because they are capable of inflicting major damage to the generator or bus if left unchecked. Bus differential protection is recommended by IEEE 242-1986 (IEEE Buff Book, Section 12.4) for busses fed by local generators. 2) There are three separate diesel generators, each supplying its own independent safety division. Since a minimum of only one division (i.e., one diesel generator) is required to achieve safe plant shutdown (see response 435.24), each generator can be better protected without compromising plant safety. It is not necessary to risk damage or distruction of one generator,

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	2. Design description for alarming all trips including those that are bypassed during LOCA. 3. Design description of bypass circuitry and its compliance with IEEE 279 requirements. 4. Separation between the two trip sensors and logic for low diesel cooling water pressure and low differential pressure of secondary cooling water. 5. Inconsistencies between section 8.3.1.1.6.4 and 8.3.1.1.8.5 as to bus differential relaying.	even under LOCA conditions, when there are two remaining generator divisions available. For clarification, the first sentence of Subsection 8.3.1.1.6.4 has been changed as follows: "When the diesel-generators are called upon to operate during LOCA conditions, the only protective devices which shut down the diesel are the generator differential relays and the engine overspeed trip." A reference to 8.3.1.1.8.5 was also added at the end of 8.3.1.1.6.4 for consistency. Item 2: The alarm lists in Subsection 8.3.1.1.8.5 have been tabulated, and are provided in a new Table 8.3-11. The alarm list has been expanded to include the bus differential trip, the generator ground overcurrent trip, and the generator loss of field trip. Those signals which are bypassed during LOCA are so indicated in the table. However, the actual alarms required may vary depending on the specific diesel generators selected in the design implementation stage. Item 3: The bypasses used for the diesel generator are designed in accordance with Position 7 of Regulatory Guide 1.9. Only the engine-overspeed and generator-differential trips are not bypassed during an accident signal (see 8.3.1.1.6.4, as modified per Item 1 above). The last of Section 8.3.1.1.6.4 has been clarified as follows: "The relays are automatically isolated from the tripping circuits during LOCA conditions. However, all bypassed parameters are annunciated in the main control room (see 8.3.1.1.8.5). The bypasses are testable, and are manually reset as required by Position 7 of Reg. Guide 1.9." Item 4: The low diesel cooling water pressure trip will be bypassed during LOCA (see "low-low jacket water pressure" on new Table 8.3-11 attached). The need to trip the diesel based on low differential pressure of secondary cooling water is dependent on the specific manufacturer's design. Therefore,

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		both of these trips have been removed from Section 8.3.1.1.6.4. Item 5: The bus differential relay trip has been added to the new Table 8.3-11 (see attached mark-up).
18.000	8.3.3.8 Thermal Overloads In response to question 435.60, the licensee indicated that thermal overload protection for Class 1E MOV's is in effect only when the MOV's are in test and are bypassed at all other times by means of closed contacts in parallel with the thermal overload contacts. A visual indication is provided in the main control room when the MOV is in test. The proposed design for bypass can assure that the thermal overload protection will not be in effect during accident conditions to prevent operation of valves. The design thus meets the intent of Regulatory Guide 1.106 and is acceptable with the possible exception of testability. Sufficient information relating to the capability for periodically testing the contacts that are in parallel with the thermal overload contacts to assure they are closed during normal operation has not been presented. To resolve this concern, additional information is required concerning testing of the thermal overload bypass device.	As indicated in response 435.60, circuit details at the elementary level are beyond the LRB. However, overload protection circuits are available which include manual operation trip buttons to permit testing of operability of the overload-sensing relays. The bypass contacts can therefore be tested in coordination with the operation of the relays via these trip buttons. An interface requirement has been added as section 8.3.4.15 to assure the MOV overload circuits include the testable feature (see attached).
19.000	8.3.3.9 Breaker Coordination In section 8.3.1.1.2.1, the licensee states that tripping of the Class 1E bus feeder breaker is normal for faults which 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 trip of the bus feeder breaker. Clarification of the ABWR design with respect to breaker coordination is required for resolution.	[N/C] The sentence has been clarified as follows: "Tripping of the Class 1E feed breaker is normal for faults which occur on the Class 1E bus it feeds. Coordination is provided between the bus main feed breakers and the load breakers." See attached mark-up.
20.000	8.3.3.10 Protective Relaying Experience with protective relay applications has established that relay trip	[N/C] The details for setpoint methodology specific for the ABWR may be found in the "Instrument Setpoints Design Requirements" document identified in the reference in Section 1.1.3 of the ABWR SSAR. A reference to this document has

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	set point will drift with conventional types of relays. Set point drift at Nuclear power plants has resulted in premature trip of redundant safety related pump motors when they were required to be operative. While the basic need for proper fault protection for feeder /equipment is recognized (and may be a requirement for the design basis event fire), it is the staff position that total non-availability of redundant safety systems due to spurious trips of protective relays is not acceptable. The primary safety function of the electrical distribution system is to provide power, reliably, to safety related equipment. The licensee in response to this position (question 435.58) indicated that loads, such as motors, will be purchased 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. Purchase of motors with sufficient overload margins meets the intent of the above staff position and is acceptable if one assumes the following: 1. The overload margin will accommodate the load's starting current as well as the normal operating currents of loads. 2. Specific design parameters and/or interface requirements clearly define (in the ABWR SSAR) the overload margin requirements with respect to protective device trip set point, 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. 3. The load breaker protective device trip set point is established with sufficient margin (a) between trip point and operating current, (b) between trip point and overload rating of the load, and (c) between trip point and trip point of the main bus feeder breaker. 4. The protective device trip set point is periodically verified and calibrated. 5. The protective device is subjected periodically to a functional test to demonstrate (a) its capability to not trip at its design setting i.e. the	been added to response 435.58 (see attachment).

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	normal operating current of load plus margin and (b) its capability to trip when subjected to a fault current. The staff is concerned that the ABWR design may not meet the above assumptions.	
21.000	8.3.3.11 Fault Interrupting Capacity Design criteria (4) in section 8.3.1.1.5.2 states that 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. Based on this statement, it is not clear that the interrupting capacity of this equipment will be equal to or greater than the maximum available fault current to which it would be exposed. To clarify the criteria for the interrupting capacity of equipment and to resolve other related concerns, additional information is required for the following items. 1. Clarification of the criteria for interrupting capacity, and 2. Compliance of both Class 1E and non-Class 1E switchgear, load center motor control centers, and distribution panels to applicable industry standards.	Item 1: 8.3.1.1.5.2(4) has been modified to say: "Interrupting capacity of switchgear, load centers, motor control centers, and distribution panels is equal to or greater than the maximum available fault current to which it is exposed under all modes of operation." (See attached.) Item 2: Compliance of this equipment to "common" industry standards (i.e., those which are designer oriented and not required for NRC licensing) is beyond the licensing review basis for the ABWR certification. However, an interface item has been added to assure such standards are referenced in the purchase specifications (see Section 8.3.4.17).
22.000	8.3.3.12 Control of Design Parameters Valve problems such as excess friction, packing too tight, etc., 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. Methods, design provisions, alarms, or procedures for assuring the valve motor will not be operated with excessive currents (or will always be operated within their design limits) has not been presented in the ABWR SSAR. To resolve the issue discussed above and related concerns, additional information is required for the following items:	Item 1 [N/C]: Normal settings of the thermal overload trips, in accordance with the manufacturer's requirements, will protect the valve operating motors of all non-Class 1E MOVs at all times. Class 1E MOV's have similar protection during manual testing or maintenance under administrative control (see response 435.60). However, Class 1E MOV thermal overload trips are bypassed at all other times in accordance with Regulatory Guide 1.106. Item 2 [N/C]: All Class 1E components are designed, purchased, tested, and inspected in accordance with IEEE 279, specifically paragraphs 4.3 and 4.4.

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	1. Methods used to assure design parameters for motor operated valves will not be exceeded during valve operation. 2. Method used to assure design parameters for all Class 1E components will not be exceeded during all modes of plant operation.	
23.000	8.3.3.13 Fire Protection of Cable Systems Section 8.3.3.2 indicates that spatial separation is used as a method of preventing the spread of fire between adjacent cable trays of different divisions (e.g. inside primary containment). The objective is always to separate cable trays of different divisions with structural fire barriers such as floors, ceilings, and walls. Where a floor, ceiling, or wall is not possible, divisional trays are separated spatially by 3 ft. horizontally and 5 ft. vertically. Where this 3 ft.-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, the above defined separation meets the guidelines of Regulatory Guide 1.75, will provide reasonable assurance that a fire in one division will not propagate to a redundant division, and is acceptable. For the design basis event fire, spatial separation and fire rated barriers may not be sufficient to prevent the spread of fire between adjacent cable trays or wire bundles. Clarification of the design's compliance with 10 CFR Part 50 Appendix R requirements is required to resolve staff concerns.	[N/C] Spatial separation, where necessary, is justified within the primary containment because it is inerted with nitrogen during reactor operation. An exposure fire cannot be sustained in the nitrogen environment. (See response to SER Section 8.3.2.2.) 10 CFR 50, Appendix R applies to nuclear power facilities operating prior to January 1, 1979; therefore, compliance with Appendix R is not addressed in the ABWR Standard Plant. In accordance with the SRP, the ABWR has committed to meet BTP CMEB 9.5.1, which incorporates the requirements covered by Appendix R. Compliance with BTP CMEB 9.5.1 is discussed in SSAR section 9.5.1 and Appendix 9A.
24.000	8.3.3.14 Electrical Protection Assemblies (EPAs) Two independent electrical protection assemblies (EPAs) were required (by a September 24, 1980 letter to all operating BWRs) on the output of RPS power supplies in order 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. Response to question 435.7 indicates that EPAs will not be used in the ABWR design because of special design features. These special features include	The need for redundant EPAs was based on the fact that RPS power supplies in operation during 1980 were non-Class 1E; therefore, a single random failure had to be taken in addition to the postulated power supply failure. Question 435.7 acknowledged that because a Class 1E RPS power supply is used on the ABWR, redundant EPAs are not required since failure of the Class 1E supply is the first random failure taken. The focus of the question, then, was whether a single seperate and independent EPA is required. GE's position is that even a single separate and independent EPA is not necessary, because (unlike previous plants) the type of protection provided by

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	monitoring of voltage and frequency, automatic transfer of power supply input sources when voltage and/or frequency exceed preestablished limits, control room alarm for abnormal conditions, operator action in response to alarm of abnormality, and design and qualification of equipment to not fail after operation for a period of time under the extremes of voltage and frequency. Based on a review of these special features, it appears that they may 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 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 may thus be compromised. An explicit statement of compliance with the staff position that two EPAs be provided on the output of the RPS power supplies with justification for areas of non compliance should be included in the ABWR SSAR.	such a separate EPA is already included within the protection circuits of the power supplies themselves. The Class 1E power sources supplying power to the solenoids of the scram pilot valves are equipped with Class 1E voltage and frequency regulation circuits, and also with functionally independent Class 1E monitoring and protection devices which monitor for undervoltage, overvoltage, underfrequency and overfrequency conditions and which will automatically trip the power source (i.e., disconnect the loads from the degraded power source) whenever an out-of-specification condition persists. These latter monitoring and protection circuits satisfy the functions of EPAs used in the past for non-1E RPS scram solenoid power sources. Two failures are necessary to cause a condition of degraded power to the scram pilot valve solenoids. The first failure would be the degraded power condition of the Class 1E power source; the second would be the failure to transfer power, to alarm, or to trip. The power distribution system is thus designed such that a single failure cannot result in degraded power being supplied to the "A" or "B" solenoids. Both the technical and redundancy functions performed by an EPA are therefore preserved within the design of the power supply itself, and an external EPA is not necessary or required. With regard to independence, the Class 1E voltage and frequency monitoring and load trip circuits for the Class 1E 12v AC power sources for the ABWR are similar to the "EPA" circuitry that was provided for the Clinton project. In both cases the monitoring and trip circuits are functionally independent of the inverter voltage and frequency regulation circuits, and are mounted on separate logic cards. However, in both cases, the two functionally independent circuit cards are located within the same power supply panel enclosure.
25.000	8.3.4 ELECTRICAL INDEPENDENCE 8.3.4.1 Interconnections	[N/C] This issue is addressed in response 435.67. Figure 8.3-8 was modified as explained in that response.

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	Figure 8.3-8 shows two interconnections between redundant divisions: 1. Division III 480 volt bus designated P/C EN1 is connected to Division I 480 volt bus designated P/C CN1 through circuit breakers and mechanical interlock. Section 8.3.2.1 indicates that this interconnection is used to transfer the 250 VDC Normal battery charger between Division I and III load centers. 2. Division III 480 volt bus designated MCC EN10 is connected to Division I 480 volt bus designated P/C CN1 through battery chargers, breakers, and key interlocked breakers. Section 8.3.2.1 indicates that this interconnection is used for selection of the normal or the standby battery charger. Criterion 17 of Appendix A to 10 CFR Part 50 requires independence between redundant divisions such that failure of one will not challenge or cause failure of the remaining redundant divisions. Sufficient information describing these and other interconnections as to their compliance with the independence requirement of criterion 17 has not been provided in the ABWR SSAR. It is the staff position that two independent open disconnect links, racked open breakers, or other equivalent open devices be maintained between redundant divisions if redundant divisions are to be electrically interconnected. Additional information as to extent of compliance with the above staff position with justification of area of Non Compliance is required in the ABWR SSAR for resolution of this issue.	
26.000	8.3.4.2 Constant Voltage Constant Frequency Power Supplies Section 8.3.1.1.4.2 indicates that each of the four independent trip systems ofthe reactor protection logic and control system are powered by four constant voltage constant frequency control power buses (Divisions I, II, III, and IV). This section also states that each of these buses is supplied independently 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, however, indicate that the AC supply for divisions I and IV originates from a single 480 volt motor control center (C14). A single 480	[W/C] There are four independent and redundant batteries which supply DC power to the CVCF's. The only link between divisions is through the division IV battery charger, which receives its power from the division I AC supply. There is complete independence of the four divisions from the batteries, through the CVCFs, and on to the loads. The statement in 8.3.1.1.4.2.1 has been clarified to explicitly identify the four DC supplies and three AC supplies (see attached mark-up). The purpose of division IV is to provide full two-out-of-four logic for the SSLC, which governs the ECCS and RPS channels. It also facilitates reversion

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	volt motor control center is not independent and redundant as stated in section 8.3.1.1.4.2. To resolve this inconsistency and other concerns, additional information is required for the following issues and/or positions. 1. Description, justification, and analysis to demonstrate that sufficient redundancy and independence has been designed into the protection system and their associated power supplies in accordance with the requirements of criterion 21 of Appendix A to 10 CFR Part 50. 2. AC power supply for Division IV should be powered from a 6.9 KV division bus that is independent, to the extent practical, from Division I, II, and III 6.9 KV and 480 volt distribution systems.	to two-out-of-three logic at the loss of any one of the four channels. A complete justification of this arrangement is assured by the fact that safe shutdown criteria, including single failure considerations, are already accommodated with divisions I, II and III alone. Also, this link between the division IV battery charger and the division I power source is explicitly defined in the PRA study. For additional details, see response 430.315 and subsection 9.5.1.2.11.
27.000	8.3.4.3 Power Supply Circuits for Safety/Relief Valve (SRVs) Section 19E.2.1.2.2.2 indicates that portions of each safety/relief valve (SRV) control circuit utilize non-safety grade power and that this non-safety grade power is taken from the Class 1E DC system through DC/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 implies 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 with the other from a different Class 1E DC bus through the DC/DC converter. The staff is concerned that the proposed design for powering the SRV's may not provide sufficient independence between the redundant DC power sources in accordance with the requirements of GDC 17. To resolve this concern, additional information is required for the following items. 1. Design information and/or criteria for the physical and electrical separation of safety and non-safety control power circuits for each SRV from the power source to and including the SRV control circuit. 2. Physical and electrical separation of the ADS control circuits and their sources of power. (Section 19E.2.1.2.2.2 indicates that four of the eight	Item 1 [N/C]: Section 19E.2.1.2.2.2 has been modified as shown in the attached mark-up (see proprietary submittal). There are six safety relief valves on each of divisions I, II and III. ADS Valves are controlled by divisions I and II. Non-divisional power is not utilized in either the SRV or ADS functions. Division IV is used only for the two-out-of-four initiation logic for the ADS. The electrical power divisions assigned to each valve are shown on Table 19C.3-3. Item 2 [N/C]: The physical and electrical separation for ADS control circuits is preserved. The close proximity of the divisions I and II ADS solenoids requires barriers to maintain separation. These solenoids are isolated by metal junction boxes, rigid conduit, and/or short sections of flexible conduit, as described in 8.3.1.4.2.3.2(4).

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SRV's used two divisions and the remaining four can be supplied by any of three divisions).

28.000 8.3.5 LIGHTING SYSTEMS

Section 9.5.3.1.2 indicates that adequate lighting for any safety related area, such as areas used during emergencies or shutdowns, including those along the appropriate access or exit routes, are provided from 3 different lighting circuits. (a) Normal, (b) Standby, and (c) Emergency DC and/or self-contained battery fixtures.

In order to complete our review of lighting systems, additional information is required for the following items.

1. Criteria for what constitutes an adequate level of lighting for various areas of the plant and for the various modes of plant operation.

2. Clarification of the level of lighting provided by 100 and 50 percent of normal lighting.

3. Identification with justification for specific plant areas and modes of plant operation that do not meet criteria for what constitutes adequate lighting.

4. Source of power for normal lighting.

5. Frequency of inspection for normal lighting.

6. Plant areas where 50% lighting shall be secured with one standby lighting power supply.

7. Method of distinguishing between normal, standby, and Emergency DC circuits to assure that they will be routed separately.

8. Source of power for standby lighting.

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Item 1: The lighting levels are based on the IES recommended intensities, as indicated in 9.5.3.1.1(1).

Figure 9-80 of the IES Lighting Handbook provides currently recommended illumination levels for electrical generating stations. Although a few areas identified in SSAR Table 9.5-1 are not specifically listed in the IES Handbook, there are areas of similar function, or common environmental characteristics such that the adequacy of the illumination level can be justified. The illumination level of some areas in Table 9.5-1 have been modified to be more consistent with the IES handbook. A copy of both tables is provided in Attachment #2. Table 9.5-1 is marked, as needed, for consistency with Figure 9-80; and Figure 9-80 is marked to show the corresponding item in Table 9.5-1.

Item 2 [N/C]: Illumination levels for all areas are given in Table 9.5-1. These are considered 100% levels; therefore, the 50% levels are half those given on the table.

Item 3 [N/C]: All areas meet criteria for adequate lighting.

Item 4 [N/C]: Section 9.5.3.2(1) identifies normal lighting as non-essential. Therefore, the source of power for normal lighting is the non-Class 1E AC power distribution system.

Item 5 [N/C]: Section 9.5.3.3 indicates no periodic testing is required for normal lighting.

Item 6 [N/C]: Section 9.5.3.1.1(4)(r) indicates two power buses shall supply lighting to staircases and passages in main buildings. The additional bus allows these areas to be temporarily placed on 50% lighting (i.e., one power supply) while the other is under inspection or maintenance.

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	9. Separation between the two standby power source circuits. 10. Level of lighting with 100 percent and 50 percent of standby lighting for various areas. 11. Seismic design of standby lighting. 12. Compliance of standby lighting with Class 1E circuit requirements. 13. The redundancy of the emergency DC lighting circuits. 14. The level of illumination of emergency lighting. 15. Periodic inspection and testing of lighting. 16. Justification for not having self contained battery fixtures seismically qualified. 17. The illumination levels with justification of the self contained battery fixtures. 18. Justification for having self contained battery fixture lighting turn off with restoration of power versus restoration of adequate light. 19. Justification for not having any seismically qualified lighting.	Item 7: Wiring/cables are separated and color coded in accordance with criteria delineated in subsections 9.5.3.1.1(7) and (8), respectively; and in 8.3.1.3. A reference to 8.3.1.3 has been added in 9.5.3.1.1(7). Item 8: The standby lighting system is made of two subsystems, safety related and non-safety related. The safety related standby lighting subsystem (SSLS) serves the safety related areas (areas where safety related equipment are mounted), and their associated passageways. The non-safety related standby lighting subsystems (NSLS) serves the non-safety related areas (areas where non-safety related equipment are mounted), and their associated passageways. The back-up power source for the above subsystems are: SSLS - Diesel Generators NSLS - Combustion Turbine Subsection 9.5.3.2.2 has been revised for clarification, as shown in the attached mark-ups. Item 9: Table 9.5-3 and Section 9.5.3.1.1(4)(r) have been revised to clarify the separation between the two power sources. Redundant divisions are not allowed within the same lighting area. Separation between the Class 1E and non-Class 1E lighting circuits is designed in accordance with IEEE 384 and Regulatory Guide 1.75, as delineated in Section 8.3.1.4.1.1(3). Item 10: Illumination levels for all areas are given in Table 9.5-1. These are considered 100% levels; therefore, 50% levels are half those given in the table. Areas specifically designated for standby lighting are identified in Table 9.5-3. Item 11: (See the response to Item 8 above.) Item 12: (See the response fo Item 8 above.)

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		Item 13: The DC emergency lighting is redundant to the AC standby lighting, which is redundant to the normal AC lighting. DC emergency lighting is not multi-divisional within a given area, but is of the same division as the area (i.e., designated fire boundary) it serves, as indicated in Table 9.5-4. Item 14: The minimum illumination levels for DC emergency lighting are given in Table 9.5-4 (modified per attached). Item 15: Inspection and testing requirements are identified in Section 9.5.3.3. The frequency of testing is dependent on the operating and maintenance procedures of the utility applicant. An interface item (9.5.13.13) has been added to address this. Item 16 [N/C]: Self-contained battery fixtures are seismically qualified as stated in the last paragraph of section 9.5.3.2.4. Item 17: The basic function of the emergency lighting system is to prevent total blackout in the areas identified on Table 9.5-4 for periods aft: LOPP (loss of normal lighting), and until the diesel generators energize the standby lighting systems. Therefore, the emergency lighting system is not required to have the same lighting illumination level as the normal/standby lighting systems require. Table 9.5-4 has been revised to specify light levels exceeding the recommendations of the IES lighting handbook. Item 18: The guide lamps chargers and turn-on relays are fed from the AC standby lighting system. Item 19: The standby lighting, the DC emergency lighting, and the self-contained battery fixtures are all seismically supported (see 9.5.3.2.2.1 and 9.5.3.2.3.1 attached).
29.000	8.3.6 DESIGN CONTROL 8.3.6.1 Control of the Design Process	[N/C] The design control for the ABWR is based on NEDO-11209-04a, the "Green Book", Rev. 7. This document has been approved by the NRC, and is referenced in SSAR Section 17.1.3.

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	Recently, there have been a number of problems 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 addresses a number of these problems that have occurred primarily as a result of inadequate control of the design process. These problems have occurred in areas of electrical system design which have historically well established and comprehensive design criteria and guidelines available for the design engineers such as circuit breaker coordination and fault current interruption capability. The staff does not normally undertake a detailed review of these areas. The staff instead relies on the designers proper exercise of the well established design criteria and guidelines. To ensure that the criteria and guidelines are followed control is required. The control being implemented for the ABWR electrical design and the required control for any subsequent modifications thereto should be described in the ABWR SSAR.	
30.000	8.3.6.2 Control of the Design Bases The bases for the design described and presented in the ABWR SSAR is, for the most part, used as the basis by which the NRC issues a plant operating license. Based on a review of the bases presented in Chapter 8 and other related chapters, numerous inconsistencies have been identified. These inconsistencies are identified in other sections of this safety evaluation report. Given these inconsistencies, it appears that the process for controlling the design bases being presented in the ABWR SSAR may be deficient. The process for controlling the design bases should be clarified in the ABWR SSAR.	(N/C) Eight of the fifteen issues identifying inconsistencies in this draft SER were the result of design changes in which areas discussing the same topic were not all updated at the same time. (See responses for draft SER sections 8.3.1, 8.3.2.1, 8.3.2.3, 8.3.2.4, 8.3.? 8.3.6.2, 8.3.7, and 8.3.8.1) These have been corrected in association with these responses, as indicated throughout this submittal. However, a formal engineering review and update will occur following receipt of the SER for Chapter 8. The formal review has been awaiting that time, so that resolution to SER issues can be incorporated along with the general update of the chapter. This is consistent with our scheduling program for the ABWR/SSAR document control. The remaining seven issues were, in fact, erroneous interpretations of the information reviewed. We have also identified those areas within this submittal. (See responses for draft SER sections 8.2, 8.3.2.7, 8.3.3.4, 8.3.3.7, 8.3.4.2, 8.3.8.3, and 8.3.8.5.) The NRC is requested to reconsider this question in the light of the responses and text updates associated with this submittal.

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31.000	8.3.7 TESTING Section 8.3.1.1.5.3, Testing, indicates that the design of Class 1E equipment provides for periodically testing the chain of system elements from sensing devices through driven equipment to assure that Class 1E equipment is functioning in accordance with design requirements. This section also implies that the requirements of the single failure criterion described in IEEE Standard 379 are met with respect to testing of Class 1E equipment. The staff interprets this section to mean that one complete electrical system division may be deenergized and taken out of service for maintenance and/or repair during any mode of plant operation and still have the remaining electrical systems in compliance with the single failure criterion. The staff concludes that this design provision for testability of electrical systems as interpreted meets the sufficient testability requirement of Criterion 17 and is acceptable. In order to confirm and clarify this interpretation in the ABWR SSAR and address other related issues, additional information is required for the following items. 1. Explicit statement for testability during normal plant operation while meeting single failure requirements with remaining systems for any design basis event. 2. Proposed allowed outage times for one division to be out of service to perform preplanned and unplanned maintenance. 3. Frequency for periodically testing each system element to assure its availability to mitigate design basis events. 4. Basis for establishment of test frequency for each system element. 5. Identification (with justification for their use) of any divisional cross connection which must be used to meet the above design provision for testability.	Item 1: Section 8.3.1.1.5.3 has been modified to specifically state conformance with Regulatory Guide 1.118 and IEEE 338 (see attached). The specific provision for testing with an additional allowance for single failure is addressed in Section 5(4) of IEEE 338. Items 2-4: This information is contained in the Technical Specifications, Chapter 16. Specifically for Item 2, the test frequencies, as identified in the Tech Specs, will account for both preplanned and unplanned maintenance. The basis for both will be established in the PRA. Item 5 [N/C]: There are no divisional cross connections required for testing purposes in the ABWR Standard Plant Design. Item 6 [N/C]: The appropriate versions for all IEEE standards are given in Table 1.8-21. Item 7: Certain components cannot be fully tested during reactor operation without degrading plant operability or safety. Some Class 1E components were specifically identified in response 420.120. In addition, the main generator circuit breaker cannot be operated without taking the unit off the line. However, it can be tested while the reactor is in hot standby. It is possible, (though not advisable for operability or grid stability reasons in some cases), to test all other components in the electrical power distribution system while the reactor is in operation. Item 8 [N/C]: We cannot determine any inconsistencies between these two sections. If the supposed inconsistencies are related to the statements involving applicability, these have been removed in association with Item 3 of

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	6. Clarification of the version of IEEE Standard 379 being referenced in section 8.3.1.1.5.3.	SER issue 8.0. Otherwise, the NRC needs to specifically identify the supposed inconsistency.
	7. Identification with justification for any areas of non-compliance with the above design provision for testability.	Items 9, 10 and 12 [N/C]: This information is contained in the Technical Specifications, Chapter 16.
	8. Inconsistency between section 8.3.1.1.5.3 and 8.3.1.2.2 with respect to meeting the single failure criterion while testing one division of the CVCF power supply system.	Item 11 [N/C]: The testing and calibration of the diesel generator overcurrent relay is based primarily on the relay manufacturer's recommendations; and also on the utility/applicant's surveillance test procedures. This level of detail is beyond the licensing basis for the ABWR Standard Plant.
	9. Periodic testing provisions to assure the capability of the diesel generator to accept loads in any loading order (reference: 435.18).	
	10. Periodic testing to demonstrate the diesel generator's capability of being started in 13 seconds and fully loaded within 30 seconds.	Item 13 [N/C]: The commitments to meet the requirements of Regulatory Guide 1.47 are given in SSAR sections 8.3.1.2.1(2)(d)&(3)(e), and a listing of annunciations associated with this requirement is given in section 8.3.1.1.8.5.
	11. Testing and calibration of the diesel generator over current relay.	
	12. Testing and/or analysis to 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.	
	13. Interface requirements for compliance with Regulatory Guide 1.47, Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems and BTP PSB-2, Criteria for Alarms and Indications Associated with Diesel-Generator Unit Bypassed and Inoperable Status.	Item 14: The ABWR utilizes two-out-of-four logic which can permit any one channel or division to be bypassed while the remaining channels or divisions revert to two-out-of-three logic. This, in conjunction with the self-test features inherent in the Safety System Logic and Control (SSLC), greatly enhances the testability of the protection systems. The testability features of the ABWR I&C are discussed in Sections 7.1.2.1.6, 7A.2(6), 7A.2(14), and RAI responses 420.67, 420.70 and 420.73.
	14. (Added to DSER per 9/16-18/91 meetings) Confirmation that the testability inherent in the design of protection systems is not so burdensome operationally that required testing at intervals of 1, 2, or 3 months cannot be included in the Technical Specifications if deemed necessary. The systems addressed should include but not be limited to the reactor protection system and the engineered safety features actuation system. Identify exceptions.	Surveillance intervals for protection systems are anticipated to be three months or less. Except for certain components which cannot be tested during reactor operation (see Item 7 above), the proposed test intervals could be accommodated if deemed necessary.
	15. (Added to DSER per 9/16-18/91 meetings) Testing to demonstrate the	

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	capability of the diesel generator to automatically revert to the emergency response mode while in the test mode if a design basis accident or loss of offsite power event were to occur.	Item 15: This testing is included in the ITAAC for the Emergency Diesel Generator System.
32.000	8.3.8 CAPACITY AND CAPABILITY 8.3.8.1 Shutdown Capability of Each Load Group Section 8.3.1.2.1 states that the standby power system redundancy is based on the capability of any one of the four divisions (one of three load groups) to provide the minimum safety functions necessary to shut down the unit from the control room in case of an accident and maintain it in the safe shutdown condition. However, in apparent contradiction section 1.2.1.2.5.2 states that the Class 1E power systems are designed with three (3) divisions with any two divisions being adequate to safely place the unit in the hot shut down condition. This apparent contradiction should be clarified in the ABWR SSAR.	[N/C] Section 1.2.1.2.5.2 has been modified to agree with section 8.3.1.2.1, which is correct (see attached mark-up).
33.000	8.3.8.2 Non-Safety DC Power Systems Section 1.2.2.5.1.6 indicates that the ABWR design includes a unit auxiliary dc power system that supplies power to dc loads that are non-safety related. However, section 8.3.2, which is suppose to address dc power systems included in the ABWR, omits description and analysis of the unit auxiliary dc power system. This system and the extent it will be used to supply dc control power to systems that are important to safety (such as offsite power circuits) should be defined in the ABWR SSAR.	Section 1.2.2.5.1.6 has been amended as shown in the attached mark-up. The 125 VDC non-Class 1E system is briefly discussed near the end of section 8.1.2.1; however, a new section 8.3.2.1.4 has been added which further describes this system. The DC-to-DC converters are considered as "power packs" per Section 7.2.2 of IEEE 384, and meet all the requirements of Regulatory Guide 1.75 and IEEE 384 respecting isolation devices.
34.000	8.3.8.3 Class 1E 125 volt DC Battery Capacity Section 8.3.2.1.3.2 indicates that each of the four Class 1E 125 volt batteries have sufficient stored energy to operate connected essential loads continuously for at least two hours without recharging. During loss of ac power, section 5.4.6.1 indicates that the battery capacity should allow over four hours of operation of the RCIC system. Item 3 of section 19E.2.1.2.2.2	Section 5.4.6.1 has been modified, per attached mark-up, to be consistent with the eight-hour coping capacity stated in section 19E.2.1.2.2.2. The two-hour availability time stated in section 8.3.2.1.3.2 is not inconsistent with the eight-hour coping time, in that the former assumes continuous load conditions. The eight-hour time for station blackout conditions is available because RCIC loads are intermittent, and other loads

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	indicates that the dc batteries will be sized to be capable of operating the RCIC system for a minimum of 8 hours assuming load shedding and use of all four Class 1E batteries. Item 2a of section 19E.2.1.2.2.2 indicates that Division 1 battery by itself has sufficient capacity to operate the RCIC system for 8 hours. These inconsistencies should be clarified and the design basis load profile for each battery should be explicitly stated in the ABWR SSAR.	can be shed or shifted to other divisions (i.e., SRV functions). This is explained in responses 435.38(c) and 435.2 (SSAR section 20.3, tab RAI-8); and in section 19E.2.1.2.2.2. This clarification has been added to 8.3.2.1.3.2 per the attached mark-up. An estimated load demand profile for the 125 VDC batteries was provided in Response 435.38 (SSAR page 20.3-253.21). As explained in that response, this information could change as the design is specified for unique applications. A load capacity analysis (based on IEEE 485-1978) was performed for both the two-hour and eight-hour periods, using the data provided in Response 435.38. The results are shown in newly added Tables 8.3-5 through 8.3-10 (attached). The two-hour analyses (Tables 8.3-5, -7, and -9) show extensive additional margins. The Division I additional margin is 149% of the required capacity including the 15% design margin and 25% aging factor suggested by IEEE 485. The eight-hour analyses (Tables 8.3-6, -8, and -10) show that capacities are slightly exceeded when the 15% design margin and 25% aging factor are considered. However, the eight-hour coping is justified for the station blackout scenario for the following reasons: 1. The analyses are highly conservative in that they assume no load shedding. During station blackout, loads would be shed thereby greatly increasing the ampere-hours available. 2. Divisions 2, 3, and 4 are redundant to each other, and as a group redundant to Division I except for the control of the RCIC from the control room. Therefore, the life of the Division I battery could be greatly extended by shedding all of its loads except the RCIC controls. 3. Even with the loads not shed, the capacities are within requirements if the 15% design margin is not applied. 4. The analysis method itself is highly conservative in that loads are

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		considered constant throughout various periods, when, in fact, many are intermittent. 5. The ABWR has three Class 1E diesel generators and a non-Class 1E combustion turbine generator (CTG) on site. This combination of four on-site power sources suggest the probability of a station blackout is very low. In addition, per Regulatory Guide 1.155, the CTG qualifies as an AAC, and precludes the need for a coping analysis (see Sections 3.2.5 and 3.3.5 of Reg. Guide 1.155).
35.000	8.3.8.4 Use of Silicon Diode in the DC System Figure 8.3-7 and response to question 435.51 indicates that a silicon diode (SID) which has a voltage drop of 10 volts has been installed in series with the output of the battery and battery charger. During normal operation (i.e. battery charger output voltage is set at 140 volts for equalize 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 silicone diode) while 140 volts is supplied to the battery for equalize charge. The staff feels that the proposed design has merit; however, sufficient descriptive information and analysis to reach a conclusion on acceptability for all modes of plant operation has not been presented in the ABWR SSAR. To resolve staff concerns, additional information is required for the following items. 1. Reliability of the proposed DC system. The addition of the silicon diode in the DC system circuit adds an additional level of unreliability to the system while at the same time may improve overall DC system reliability. 2. Capacity and capability of the DC system to supply design basis loads during loss of offsite power events. 3. Design provisions to assure the battery will never have to supply its design basis loads with the silicon diode connected in series with the battery and DC bus.	The information requested in Item 2 was provided in response 435.38 (SSAR page 20.3-253.21), and further supported by the load capacity analysis provided in response to SER Issue 34. Items 1, 3, and 4 are resolved because the SIDs and associated shorting switches have been removed from the power supply circuits. The decision to remove the SIDs is based on the fact that DC equipment is specified to operate at 140 vDC, and therefore does not need the voltage drop provided by the SID during the brief equalize charging periods. This design change is reflected per the attached mark-ups of Figure 8.3-7 and RAI Response 435.51.

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	4. Monitoring for the switch installed in parallel with the diode.	
36.000	8.3.8.5 Class 1E AC Standby Power System As a result of our review of the standby power system proposed in the ABWR SSAR, the following areas of concern have been identified. 1. Inconsistency between section 8.3.1.1 8.2 and 8.3.1.1 8.3 as to the design capability of the diesel generator to start and attain rated voltage and frequency. 2. The capability of the diesel generator to supply loads assuming loss of offsite, loads being either supplied by or being sequenced on the diesel generator, and bus voltage drops below 70 percent. 3. Clarification of the diesel generator design details which are to be supplied by others (reference question 435.21(b)) and the criteria the design must meet (i.e. interface requirements). 4. Clarification of the continuous and overload ratings of the diesel generator defined in section 8.3.1.1.8.2.	Item 1 [N/C]: The diesel generator (D/G) capability of reaching full speed and voltage has changed from 13 seconds to 20 seconds because additional margin in the design requirements permits less stress on the diesels. The changes are shown in attached markups for sections 8.3.1.1.8.2(4), 8.3.4.2, and Table 8.3-4. Item 2 [N/C]: As indicated in section 8.3.1.1.8.2(2), the D/G is designed such that its voltage drop will not exceed 25% (75% bus voltage), even under sequence loading conditions. Therefore, while the D/G is supplying power to the bus, the bus voltage will not drop below 70% for a sustained period unless the D/G itself fails or there is a fault condition. Under such conditions, the offending division loads are tripped (assuming no LOCA), and the safety functions will be assumed by the redundant divisions. The three independent D/Gs, and their associated divisions, provide more than adequate redundancy to mitigate the suggested single-failure scenario. Item 3: The diesel generators, their controllers, and their auxiliary support systems will be supplied at the implementation stage of the design. NRC question 435.21b can only be answered when the specific diesel suppier is selected and its corresponding controller circuitry can be obtained. Interface item 8.3.4.2 is written to assure the information is provided, regardless of who acquires it. Response 435.21b has been modified for consistency with the above (see attached page 20.3-253.13). Item 4: This information was provided in response 435.21(a), but in addition, has now been added as subsection 8.3.1.1.8.2(5) [see attached markup].
37.000	8.3.9 STATION BLACKOUT	Item 1: A more severe analysis is already provided. Section 19E.2.1.2.2.1 indicates that if AC power is still unavailable after the 8-hour period, the

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	The ABWR coping analysis for Station Blackout is presented in section 19E.2.1.2.2. Also, table 19E.2-2 presents design basis values for various plant parameters that will not be exceeded at the end of the 8 hour coping duration for a Station Blackout event. Based on a review of this coping analysis and design information presented in other sections of the ABWR SSAR, the staff has identified the following areas of concern. 1. Analysis results demonstrating safe plant shutdown can be accomplished starting with reestablishment of AC power to any one of the three AC divisions from either offsite, diesel generators, or combustion turbine generator at the end of the 8 hours of coping. 2. Justification for the proposed design which provides an alternate AC supply (combustion turbine generator) but dictates that its first priority use be to supply AC power to Non-Class 1E plant investment protection loads versus Class 1E loads needed to assure safe plant shutdown. 3. The capacity and capability of the combustion turbine generator to supply minimum safe shutdown loads and minimum required plant investment protection loads at the same time. 4. Design and qualification of equipment for the environments expected during and following the 8 hour coping time analyzed for station blackout events. 5. Clarification of how Division 2, 3, and 4 are shutdown during a station blackout situation. 6. Clarification of the source of instrument power from DC or constant voltage constant frequency sources during station blackout situations. 7. Extent to which the combustion turbine generator complies with position 3.3.5 of Regulatory Guide 1.155, Station Blackout. 8. The inconsistency between response to question 435.2 and the 6/4/91 draft section of 19E.2.1.2.2 of the SSAR with respect to the number of SRVs powered	core cooling function is assumed to be lost. This scenario is referred to Section 19E.2.2.3, which provides an analysis showing that core cooling can be maintained indefinately if the operator injects using the firewater system. However, no containment cooling system is available until AC power is restored. Table 19E.2-9 shows that much more time is available (24.4 hours) to restore containment cooling than is tolerated for restoration of core cooling. Any one of the three divisions of RHR is sufficient to safely shut down the plant. Therefore, restoration of AC power to any one division at the end of the 8-hour period easily facilitates resumption of the containment cooling function, and subsequently safe shutdown, whether or not the operator restores the ECCS. Further, even if containment cooling cannot be regained, the overpressure protection system rupture disks will relieve pressure and prevent containment failure. The three independent diesel generators are designed with bypass valves for their DC solenoids such that each can be started manually without DC power (i.e., assuming the DC batteries are discharged following 8 hours of coping). Also, the combustion turbine generator is started by a smaller self-contained diesel with its own battery. Therefore, the probability of no AC power for 8 hours is extremely remote. This redundancy and diversity, combined with the more severe analysis provided in 19E.2.2.3, precludes the need for additional analysis. Item 2 [N/C]: The combustion turbine generator (CTG) is included in the ABWR Standard Plant as an alternate and diverse source of on-site AC power. Its function is consistent with the following: 1) The unit is non-Class 1E, and is provided to feed perminant non-safety loads during LOPP events, 2) It is available to back up the Class 1E DGs, should they fail or not be available, and 3) It is capable of coping with a station blackout. The CTG assumes non-safety investment protection loads automatically, but the connection to each Class-1E bus is manual. This is justified because: 1)

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	from division 1.	On-site emergency power is provided by three Class-1E DGs and no credit is taken for safe shutdown utilizing the CTG. 2) Although the CTG can cope with the station blackout, the ABWR can cope with station blackout without the need for the CTG, as described in 19E.2.1.2.2. 3) The CTG interface configuration provides independent standby power for non-safety loads and thus maintains better separation between safety and non-safety systems. This also prevents the investment protection loads from having to be assumed by the DGs. Item 3 [M/C]: The CTG is rated to produce approximately 20% more power than a DG (i.e., 6 MW for the CTG, compared to 6.25 MVA @ 0.8 pf = 5 MW for a DG). However, the CTG is not designed, nor required, to assume all investment protection loads in addition to a DG load. If the need arose for the CTG to assume the Class 1E loads on a DG bus, the investment protection loads would be shed. This is also done as a precaution to assure non-Class 1E loads do not adversly affect the CTG's ability to supply power to the Class 1E loads. Item 4: The environmental effects on most electrical equipment during a station blackout event are expected to be less severe than the accident environments analyzed in Section 3.11. This is because such equipment would be in its deenergized state, and thus would produce no internal heat rise compared with the environment. Exceptions may be the RCIC room and the control room because of energized equipment operating in a loss-of-HVAC environment. However, design constraints for these areas prevent room temperatures from reaching the equipment design temperatures for at least eight hours [see 19E.2.1.2.2, 5) & 6)]. (Remaining items are addressed in the continuation which follows.)
37.500	8.3.9 STATION BLACKOUT (Continuation of previous question to allow room for GE responses.)	Item 5 [M/C]: In a station blackout event, if division I instrumentation is functioning properly, the operator should manually shut down redundant divisions II, III and IV in order to 1) reduce heat dissipation within the control room while HVAC is lost, and 2) conserve battery energy for additional SRV capacity, or other specific purposes as needed, as indicated in 19E.2.1.2.2. Only division I is essential to the RCIC operation and should

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remain functional at all times during this event. This is why the division I battery has significantly more capacity than the other batteries.

An inte 'ace section 8.3.4.16 has been added to assure this operator action is included in the applicant's Emergency Operating Procedures. (See attached mark-up.)

Item 6 [N/C]: As a general rule, all Class 1E instrument power comes directly from the divisional DC buses. The only exceptions are some E/O converters in the process radiation monitoring system. These require AC power provided by the DC via the CVCF power supply units. Non-divisional CVCFs also supply power to the non-Class 1E area radiation detectors.

Item 7: All of the five criteria of Regulatory Guide 1.155, Section 3.3.5, are met or exceeded by the CTG. SSAR Section 9.5.11 describes the CTG, and supports each of the referenced criteria as follows:

Criterion 1: SSAR Section 9.5.11.3 states "The CTG does not supply power to nuclear safety related equipment except on condition of complete failure of the emergency diesel generatorr and all off-site power." Thus, it is not normally "directly connected to the ...unit's onsite emergency ac power system."

Criterion 2: SSAR Section 9.5.11.2 references SLD Figure 8.3-1 which shows that there is "minimum potential for common cause failure with the ...onsite emergency ac power sources" from the electrical perpective. Protection from "single-point vulnerability" due to "weather-related event or single active failure" is also inherent in the physical separation of the CTG (located in the Turbine Building [Figure 9A.4-20]) and the diesel generators (located in the Reactor Building [Figure 9A.4-4]).

Criterion 3: SSAR Section 9.5.11.2 states "Manually controlled breakers also provide the capability of connecting the combustion turbine generator to any one of the emergency buses if all other power sources are lost." Thus, the CTG has "...provisions to be manually connected to one or all of the redundant

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		safety buses as required." Also, the criteria that "The time requ ed for making this equipment available should not be more than 1 hour..." is far exceeded by the CTG capabilities as stated in SSAR Section 9.5.11.1(1): "The CTG unit shall automatically start, accelerate to rated speed, reach nominal voltage, and begin accepting load within two minutes of receipt of its start signal." Criterion 4: SSAR Section 9.5.11.1(3) indicates the CTG's rating at 6 mW. This exceeds that of each diesel generator, which is rated at 5 mW. Therefore, it has more than "...sufficient capacity to operate the systems...". Criterion 5: SSAR Section 9.5.11.4 states that "Site acceptance testing, periodic surveillance testing and preventive maintenance, inspections, etc., shall be performed..." Also, per that same section, the CTG must undergo factory testing similar to the diesel generator (i.e., per IEEE 387) unless its reliability maintains 99% over a five-year period. Item 8: The reference to "5 safety relief valves" has been changed to "6 safety relief valves" consistent with the Section 19E.2.1.2.2.2, as modified per SER Issue 27 (see attached).

(7) Radiation shielding is provided and access control patterns are established to allow a properly trained operating staff to control radiation doses within the limits of applicable regulations in any mode of normal plant operations.

(8) Those portions of the nuclear system that form part of the reactor coolant pressure boundary are designed to retain integrity as a radioactive material containment barrier following abnormal operational transients and accidents.

(9) Nuclear safety systems and engineered safety features function to assure that no damage to the reactor coolant pressure boundary results from internal pressures caused by abnormal operational transients and accidents.

(10) Where positive, precise action is immediately required in response to abnormal operational transients and accidents, such action is automatic and requires no decision or manipulation of controls by plant operations personnel.

(Ref)
1.2.1.1.2 (11) Safety related actions are provided by equipment of sufficient redundance and independence so that no single failure of active components, or of passive components in certain cases in the long term, will prevent the required actions. For Class 1E systems or components (~~to which~~ ie IEEE-279 ~~apply~~ applies) single failures of either active or passive electrical components are considered in recognition of the higher anticipated failure rates of passive electrical components relative to passive mechanical components.

3.0-7

(12) Provisions are made for control of active components of safety related systems from the control room.

(13) Safety related systems are designed to permit demonstration of their functional performance requirements.

(14) The design of safety related systems, components and structures includes allowances for natural environmental disturbances such as earthquakes, floods, and storms at the station site.

(15) Standby electrical power sources have sufficient capacity to power all safety related systems requiring electrical power concurrently.

(16) Standby electrical power sources are provided to allow prompt reactor shutdown and removal of decay heat under circumstances where normal auxiliary power is not available.

(17) A containment is provided that completely encloses the reactor systems, drywell, and suppression chambers. The containment employs the pressure suppression concept.

(18) It is possible to test primary containment integrity and leak tightness at periodic intervals.

(19) A secondary containment is provided that completely encloses the primary containment above the reactor building basemat. This secondary containment provides for a controlled, monitored release of any potential radioactive leakage from the primary containment.

(20) The primary containment and secondary containment in conjunction with other safety related features limit radiological effects of accidents resulting in the release of radioactive material to the containment volumes to less than the prescribed acceptable limits.

(21) Provisions are made for removing energy from the primary containment as necessary to maintain the integrity of the containment system following accidents that release energy to the containment.

(22) Piping that penetrates the primary containment and could serve as a path for the uncontrolled release of radioactive material to the environs is automatically isolated when necessary to limit the

(7) Backup reactor shutdown capability is provided independent of normal reactivity control provisions. This backup system has the capability to shut down the reactor from any operating condition and subsequently to maintain the shutdown condition.

(8) The nuclear system is designed so there is no tendency for divergent oscillation of any operating characteristic, considering the interaction of the nuclear system with other appropriate plant systems.

1.2.1.2.2 Electrical Power Systems Criteria

Sufficient normal auxiliary and standby sources of electrical power are provided to attain prompt shutdown and continued maintenance of the station in a safe condition under all credible circumstances. The power sources are adequate to accomplish all required essential safety actions under all postulated accident conditions.

1.2.1.2.3 Auxiliary Systems Criteria

(1) Fuel handling and storage facilities are designed to prevent inadvertent criticality and to maintain adequate shielding and cooling for spent fuel.

(2) Other auxiliary systems, such as service water, cooling water, fire protection, heating and ventilating, communications, and lighting, are designed to function as needed during normal and/or accident conditions.

(3) Auxiliary systems that are not required to effect safe shutdown of the reactor or maintain it in a safe condition are designed so that a failure of these systems shall not prevent the essential auxiliary systems from performing their design functions.

1.2.1.2.4 Shielding and Access Control Criteria

Radiation shielding is provided and access control patterns are established to allow a properly trained operating staff to control radiation doses within the limits of applicable regulations in any normal mode of plant operation.

1.2.1.2.5 Process Control Systems Criteria

The principal design criteria for the process control systems are as follows:

1.2.1.2.5.1 Nuclear System Process Control Criteria

(1) Control equipment is provided to allow the reactor to respond automatically to load changes within design limits.

(2) It is possible to control the reactor power level manually.

(3) Nuclear systems process displays, controls and alarms are arranged to allow the operator to rapidly asses the condition of the nuclear system and to locate process system malfunctions.

1.2.1.2.5.2 Electrical Power System Process Control Criteria

(three load groups)

(1) The Class 1E power systems are designed with four ~~three~~ (4) divisions with any one ~~two~~ division being adequate to safely maintain ~~place~~ the unit in the safe shut ~~hot shut~~ down condition. 32

(2) Protective relaying is used to detect and isolate faulted equipment from the system with a minimum of disturbance in the event of equipment failure.

(3) Voltage relays are used on the emergency equipment buses to disconnect the normal source in the event of loss of offsite power and to initiate starting of the standby emergency power system diesel generators.

(4) The standby emergency power diesel generators are started and loaded automatically.

(5) Safety related electrically operated breakers are controllable from the control room.

loads which do not require an uninterruptible power source.

1.2.2.5.1.5 Uninterruptible Power System

The uninterruptible power system (UPS) supplies regulated 120-VAC single-phase power to non Class 1E instrument and control loads which require an uninterruptible source of power. The power sources for the UPS are similar to those for the SSLC, but are non-Class 1E.

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1.2.2.5.1.6 Unit Non-Class 1E DC Power System

The non-Class 1E DC power system supplies power to unit DC loads that are nonsafety-related. Non-Class 1E power is taken from each of the four Class 1E batteries. Class 1E isolation is provided by DC-to-DC converters.

1.2.2.5.1.7 Unit Class 1E DC Power System

The unit Class 1E DC power system supplies 125 VDC power to the unit Class 1E loads. Battery chargers are the primary power sources. The system, which includes storage batteries that serve as standby power sources, is divided into four divisions, each with its own independent distribution network, battery, battery charger, and redundant load group.

1.2.2.5.2 Nuclear System Process Control and Instrumentation

1.2.2.5.2.1 Rod Control and Information System

The rod control and information system (RCIS) provides the means by which control rods are positioned from the control room for power control. The system operates the rod drive motors to change control rod position. For operation in the normal gang movement mode, one gang of control rods can be manipulated at a time. The system includes the logic that restricts control rod movement (rod block) under certain conditions as a backup to procedural controls.

1.2.2.5.2.2 Recirculation Flow Control System

During normal power operation, the speed of the reactor internal pumps is adjusted to control flow. Adjusting RIP speed changes the coolant flow rate through the core and thereby changes the core power level. The system can automatically adjust the reactor power output to the load demand. The solid-state adjustable speed drives (ASD) provide variable voltage, variable frequency electrical power to the RIP motors. In response to plant needs, the recirculation flow control system adjusts the ASD power supply output to vary RIP speed, core flow, and core power.

1.2.2.5.2.3 Neutron Monitoring System

The neutron monitoring system (NMS) is a system of in-core neutron detectors and out-of-core electronic monitoring equipment. The system provides indication of neutron flux, which can be correlated to thermal power level for the entire range of flux conditions that can exist in the core. There are fixed in core sensors which provide flux level indications during reactor startup and low-power operation. The startup range neutron monitors (SRNM) and average power range monitors (APRM) allow assessment of local and overall flux conditions during power range operation. The automatic traversing in-core probe (ATIP) system provides a means to calibrate the local power range monitors. The NMS provides inputs to the rod control and information system to initiate rod blocks if preset flux limits or period limits for rod block are exceeded as well as inputs to the RPS if other limits for scram are exceeded.

1.2.2.5.2.4 Refueling Interlocks

A system of interlocks that restricts movement of refueling equipment and control rods when the reactor is in the refueling and startup modes is provided to prevent an inadvertent criticality during refueling operation. The interlocks back up procedural controls that have the same objective. The interlocks affect the refueling platform, refueling platform hoists, fuel grapple, and control rods.

1.2.2.5.2.5 Reactor Vessel Instrumentation

In addition to instrumentation for the nuclear safety systems and engineered safety features, instrumentation is provided to monitor and transmit information that can be used to assess conditions existing inside the reactor depressurization systems perform adequate core cooling to prevent excessive fuel clad temperature during LOCA event. Detailed discussion of RCIC meeting this GDC is described in Subsection 3.1.2.

Compliance with GDC 36. The RCIC system is designed such that in-service inspection of the system and its components is carried out in accordance with the intent of ASME Section XI. The RCIC design specification requires layout and arrangement of the containment penetrations, process piping, valves, and other critical equipment outside the reactor vessel, to the maximum practical extent, permit access by personnel and/or appropriate equipment for testing and inspection of system integrity.

Compliance with GDC 37. The RCIC system is designed such that system and its components can be periodically tested to verify operability. Systems operability is demonstrated by preoperational and periodic testings in accordance with RG 1.68. Preoperational test will ensure proper functioning of controls, instrumentation, pumps and valves. Periodic testings confirm systems availability and operability through out the life of the plant. During normal plant operation, a full flow pump test is being performed periodically to assure systems design flow and head requirements are attained. All RCIC systems components are capable of individual functional testings during plant operation. This includes sensors, instrumentation, control logics, pump, valves, and more. Should the need for RCIC operation occur while the system is being tested, the RCIC system and its components will automatically re-aligned to provide cooling water into the reactor. The above test requirements satisfy GDC 37.

5.4.6.1 Design Basis

The reactor core isolation cooling (RCIC) system is a safety system which consists of a turbine, pump, piping, valves, accessories, and instrumentation designed to assure that sufficient reactor water inventory is maintained in the reactor vessel to permit adequate core cooling to take place. This prevents reactor fuel overheating during the following conditions:

(1) a loss-of-coolant (LOCA) event;

(2) vessel isolated and maintained at hot standby;

(3) vessel isolated and accompanied by loss of coolant flow from the reactor feedwater system;

(4) complete plant shutdown with loss of normal feedwater before the reactor is depressurized to a level where the shutdown cooling system can be placed in operation; or

(5) loss of AC power, ~~for 30 minutes.~~ e

e

Acceptance criteria II.3 of SRP Section 5.4.6 states that the RCIC system must perform its function without the availability of any AC power. Review Procedure III.7 further requires that there be sufficient battery capability for two hours of operation. While RCIC is designed for 30 minutes of operation during loss-of-ac power, the Division I battery capacity is sufficient for ~~should allow over four hours of operation, which would meet this requirement.~~ e eight hours of coping during station blackout (see 19E.2.1.2.2). e

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During loss of AC power, RCIC when started at water level 2 is capable of preventing water level from dropping below the level which ADS mitigates (Level 1). This accounts for decay heat boil-off and primary system leakages.

Following a reactor scram, steam generation will continue at a reduced rate due to the core fission product decay heat. At this time the turbine bypass system will divert the steam to erature. The energy release from the reactor will be controlled by the shutdown cooling system, and there is no need to re ase the reactor energy to the pool.

5.4.7.3.3 Emergency Shutdown Cooling

The design requirements for ABWR emergency shutdown cooling capability are specified in Regulatory Guide 1.139, as follows:

> The reactor shutdown cooling system (SDCS) should be capable of bringing the reactor to a cold shutdown condition within 36 hours following reactor shutdown with only offsite power or onsite power available assuming the most limiting single failure.

The limiting condition is for the case with loss of offsite power which would disable the forced circulation. The most limiting single failure is the loss of one RHR division (designated as N-1 case). Therefore, for the emergency shutdown cooling purpose, one of the bases of RHR heat exchanger sizing is to meet the following requirements:

> The ABWR RHR in shutdown cooling mode should be capable of bringing the reactor to cold shutdown conditions (100°C) within 36 hours following reactor shutdown for N-1 case, with only onsite power available.

The ABWR selected design configuration meets all design requirements and is consistent with the heat exchanger size required for post-LOCA pool temperature control.

3.1/ Insert "A" here

5.4.7.3.4 Normal Shutdown Cooling

After a normal blowdown to the main condenser, the shutdown cooling subsystem is activated. In this mode of operation the RHR shall be capable of removing enough residual heat (decay and sensible) from the reactor vessel water to cool it to 60°C within 24 hours after the control rods are inserted.

Normal shutdown cooling is a nonsafety-related event and is therefore analyzed assuming that all three RHR loops are operational.

The design heat exchanger capacity is sufficient to meet the normal shutdown cooling criteria.

5.4.7.4 Pre-operational Testing

The pre-operational test program and startup tests program discussed in Chapter 14 are used to generate data to verify the operational capabilities of each piece of equipment in the system: each instrument, each set point, each logic element, each pump, each heat exchanger, each valve, and each limit switch. In addition, these programs verify the capabilities of the system to provide the flows, pressures, cooldown rates, and reaction times required to perform all system functions as specified for the system or component in the system data sheets and process data.

Logic elements are tested electrically; valves, pumps, controllers, and relief valves are tested mechanically. Finally, the system is tested for total system performance against the design requirements using both the offsite power and standby emergency power. Preliminary heat exchanger performance can be evaluated by operating in the pool cooling mode, but a vessel shutdown is required for the final check due to the small temperature differences available with pool cooling.

5.4.8 Reactor Water Cleanup System

The reactor water cleanup (CUW) system is classified as a primary power generation system, a part of which forms a portion of the reactor coolant pressure boundary (RCPB). The remaining portion of the system is not part of the RCPB because it can be isolated from the reactor. The CUW system may be operated at any time during normal reactor operations.

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3.1 The RHR heat exchanger sizing is such that cold shutdown can be achieved with only one loop, assuming an extension of time beyond the 36 hours required for the N-1 case. An analysis was performed for this scenario using the nominal decay heat curve. The results showed that the time to reach 100 degrees C with only one RHR loop available varied from 38 to 51.4 hours as the temperature of the ultimate heat sink varied from 29 to 35 degrees C.

SECTION 8.1

CONTENTS

TABLES

FIGURES

8.1 INTRODUCTION

8.1.1 Utility Grid Description

Out of ABWR Standard Plant Scope.

8.1.2 Onsite Electric Power System

8.1.2.1 Description of Electrical Power System

The scope of the onsite electrical power system includes the entire system on the plant side of the low voltage terminals of the main power transformer and the connection at the high voltage bushings of the reserve transformer, as indicated on the single line diagram, Figure 8.3-1. The main power transformer is not in scope. The combustion turbine generator (CTG) is within scope.

The electrical interface requirements are shown on the single line diagram. A generator breaker capable of interrupting the maximum available fault current is provided. This allows the generator to be taken off line and the main grid to be utilized as a power source for the unit auxiliary transformers and their loads, both Class 1E and non-Class 1E. This is also the start-up power train for the unit.

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There are four unit auxiliary transformers, two to feed the non-Class 1E buses and two to feed the Class 1E buses. The "Normal Preferred" power feed is from the unit auxiliary transformers so that there normally are no bus transfers required when the unit is tripped off the line.

One, three-winding 30 MVA unit reserve transformer is supplied to provide power for the emergency buses as an alternate to the "Normal Preferred" power. This is truly a reserve transformer because unit startup is accomplished from the normal preferred power, which is backfed over the main power circuit to the unit auxiliary transformers. The two low voltage windings of the reserve transformer are rated 15 MVA each. One winding provides the second off-site power source for Divisions I and II. The other winding provides the second off-site power source for Division III and non-safety bus B2 which supplies investment protection loads.

There is also a combustion turbine which supplies standby power to ~~two~~ one turbine building bus~~es~~ which feeds the plant investment protection loads. ~~are grouped on the two turbine building buses.~~ Manually controlled breakers provide the capability of connecting the combustion turbine generator to any one of the emergency buses if all other power sources are lost. 435.1 1

The reactor building is supplied with three divisions of class 1E AC power (Figure 8.3-1). Each of the Division I, II, and III Class 1E 6.9 kv buses have two feeders from the offsite sources--normal preferred and alternate preferred power. The Class 1E AC power system is divided into three independent divisions to provide AC power to the three divisions of Class 1E loads. In general, motors larger than 300 KW are supplied from the 6.9-kV bus. Motors 300KW or smaller but larger than 100KW are supplied power from 480V switchgear. 460V motors 100KW or smaller are supplied power from 480V motor control centers. The 6.9KV and 480V switchgear single line diagrams are shown on Figures 8.3-1, 8.3-2 and 8.3-3. 435.1 435.1 435.1

During normal plant operation all of the non-Class 1E buses and two of the Class 1E buses are supplied with power from the turbine generator through the unit auxiliary transformers. The third Class 1E bus is supplied from the reserve transformer. This third division is immediately available, without a bus transfer, if the normal preferred power is lost to the other two divisions. Either of the normal preferred or the alternate preferred AC power sources are capable of providing power to all Division I, II, and III Class 1E loads in addition to some selected non-Class 1E loads. 435.1 435.1

The three standby AC power supplies provide a separate onsite source of power for each class 1E load group when normal and alternate preferred power supplies are not available. The transfer from the normal preferred or alternate preferred power supplies to the diesel generator is automatic. The transfer back to the normal preferred or the alternate preferred power source is a manual transfer. 435.1

The Division I, II, and III standby AC power supplies consist of an independent 6.9-kV Class 1E diesel-generator, one for each division. Each may be connected to its respective 6.9-kV Class 1E switchgear bus through a main circuit breaker located in the switchgear.

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.

The plant 480 VAC auxiliary power system distributes sufficient power for normal auxiliary and Class 1E 480 volt plant loads. All class 1E elements of the auxiliary power distribution system are supplied via the 6.9-kV Class 1E switchgear and, therefore, are capable of being fed by the normal preferred, alternate preferred, standby or combustion turbine generator power supplies.

The 120 VAC non-Class 1E instrumentation power system, Figure 8.3-4, provides power for non-Class 1E control and instrumentation loads.

The Class 1E 120 VAC instrument power system, Figure 8.3-4, provides power for Class 1E plant controls and instrumentation. The system is separated into Divisions I, II, and III with distribution panels fed from their respective divisional sources.

The 125V DC power distribution system provides four independent and redundant onsite sources of power for operation of Class 1E DC loads. The 125VDC non-Class 1E power is taken from the Class 1E batteries. Class 1E isolation is provided by DC-to-DC converters. Separate non-Class 1E 250V batteries are provided to supply uninterruptible power to the plant computers and non-Class 1E DC motors.

The safety system and logic control (SSLC) for RPS and MSIV derives its power from four uninterruptible 120 VAC buses. The SSLC for the ECCS derives its power from the four divisions of 125VDC buses. The four buses provide the redundancy for various instrumentation, logic and trip circuits and solenoid valves. The SSLC power supply is further described in Subsection 8.1.3.1.1.2.

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8.1.2.1.2 ~~8.1.3.1.2~~ **Safety Loads**

The safety loads utilize various Class 1E AC and/or DC sources for instrumentation and motive

~~Record# answer~~
~~Items 1-3: (See the response to Question 435.63.)~~

~~Items 4-7: The following new section has been added to address separation.~~

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8.1.2.1.1 Separation

The locations for the main transformer, unit auxiliary transformers, and reserve auxiliary transformer are shown on Figure 1.2-25. The reserve auxiliary transformer will be separated from the unit auxiliary transformers by 50 feet or shadow fire wall.

Reference is made to Figures 8.3-1, 2 and 3 for the single line diagrams showing the method of feeding the loads. Separation of the normal preferred and alternate preferred power feeds is accomplished by floors and walls over their routes through the turbine, control and reactor buildings except within the switchgear rooms where they must be routed to the same switchgear lineups. The normal preferred feeds are routed within the turbine building from the unit auxiliary transformers to the turbine building switchgear and to the control building. From there, the normal preferred feeds continue across the divisions 1 and 3 sides of the control and reactor buildings to the respective safety-related switchgear rooms in the reactor building.

The alternate preferred feeds from the reserve auxiliary transformer are routed alongside the turbine building. The feed for the non-safety related switchgear peels off and enters the train A switchgear room at grade to pick up the switchgear at that elevation, and then rises on up to the train B switchgear room above. The other alternate preferred feed, which is for the safety-related buses, continues on outside of the turbine building until it enters the clean access corridor (Figure 1.2-24) just below grade between the turbine and control buildings. It crosses the turbine building in the top of the clean access tunnel and then enters the divisions 2 and 4 side of the control building. From there, it crosses the divisions 2 and 4 sides of the control and reactor building to access the switchgear rooms within the reactor building. The normal preferred power feeds are not allowed to be routed in or through the clean access corridor.

The location of the combustion turbine generator (CTG) is shown on Figure 1.2-26. The standby power feed from the CTG is routed directly to the switchgear rooms in the turbine building.

The branch to the reactor building is routed adjacent to the alternate preferred feeds across the control and reactor buildings.

~~Item 8: The second paragraphs of sections 8.1.3.1.1.1 and 8.3.1.1.1 have been revised in accordance with section 8.3.4.9. In addition, sections (1), (3) and (4) of 8.3.1.1.7 have been clarified to allow feed from either offsite source during normal plant operation.~~

~~Item 9: GE questions the validity of this criteria. GDC 17 requires two offsite sources. Yet, any plants (including the ABWR) with more than two divisions could not meet such criteria, because the loss of one of the offsite sources must affect more than one division. Yet less reliable plant designs having only two divisions would meet the criteria. We suggest this item be deleted since it is redundant to SER Issue 8.2.1.~~

or control power or both for all systems required for safety. Combinations of power sources may be involved in performing a single safety function. For example, low voltage DC power in the control logic may provide an actuation signal to control a 6.9kV circuit breaker to drive a large AC-powered pump motor. The systems required for safety are listed below:

(1) Safety System Logic and Control Power Supplies including the Reactor Protection System

(2) Core and Containment Cooling Systems

(a) Residual Heat Removal System (RHR)

(b) High Pressure Core Flooder (HPCF) System

(c) Automatic Depressurization System (ADS)

(d) Leak Detection and Isolation System (LDS)

(e) Reactor Core Isolation Cooling System (RCIC)

(3) ESF Support Systems

(a) Diesel-Generator Sets and Class 1E AC/DC power distribution systems.

(b) HVAC Emergency Cooling Water System (HECW)

(c) Reactor Building Cooling Water (RCW) System

(d) Spent Fuel Pool Cooling System

(e) Standby Gas Treatment System (SGTS)

(f) Reactor Building Emergency HVAC System

(g) Control Building HVAC System

(h) High Pressure Nitrogen Gas Supply System

(4) Safe Shutdown Systems

(a) Standby Liquid Control System (SLCS)

(b) Nuclear Boiler System

(i) Safety/Relief Valves (SRVs)

(ii) Steam Supply Shutoff Portion

(c) Residual Heat Removal (RHR) system decay heat removal

(5) Essential Monitoring Systems

(a) Neutron Monitoring System

(b) Process Radiation Monitoring System

(c) Containment Atmosphere Monitoring System

(d) Suppression Pool Temperature Monitoring System

~~8.1.2.1.2 Division of Safety Loads~~

For detailed listings of Division I, II and III loads, see Tables 8.3-1 and 8.3-2.

8.1.3 Design Bases

8.1.3.1 Safety Design Bases--Onsite Power

8.1.3.1.1 General Functional Requirements

8.1.3.1.1.1 Onsite Power Systems--General

The unit's total safety-related load is divided into three divisions of load groups. Each load group is fed by an independent 6.9-kV Class 1E bus, and each load group has access to two offsite and one onsite power source. An additional onsite power source is provided by the combustion turbine generator (CTG).

Each of the two normally energized power feeders are provided for the Division 1, 2 and 3 Class 1E systems. ~~The normal preferred feeder is used during the plant operation, with the alternate preferred feeder used when the former is lost.~~ Both feeders are used during normal plant operation to prevent simultaneous deenergization of all divisional buses on the loss of only one of the offsite power supplies. The transfer to the alternate preferred feeder is manual. During the interim, power is automatically supplied by the diesel generators.

The redundant Class 1E electrical load groups (Divisions I, II, and III) are provided with separate onsite standby AC power supplies, electric buses, distribution cables, controls, relays and other electrical devices. Redundant parts of the system are physically separated and independent to the extent that in ~~a single credible event,~~

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3.1 ~~including a single electrical failure, cannot cause loss of power to redundant load groups.~~ Independent raceway systems are provided to meet load group cable separation requirements for Divisions I, II, and III.

any design basis event with any resulting loss of equipment and single failure, sufficient remaining safety systems will be available to effect a safe plant shutdown for all allowable modes of plant operation.

Divisions I, II, and III standby AC power supplies have sufficient capacity to provide power to all their respective loads. Loss of the normal preferred power supply, as detected by 6.9-kV Class 1E bus under-voltage relays, will cause the standby power supplies to start and connect automatically, in sufficient time to maintain the reactor in a safe condition, safely shut down the reactor or limit the consequences of a design basis accident (DBA) to acceptable limits. The standby power supplies are capable of being started and stopped manually and are not to be stopped automatically during emergency operation unless required to preserve integrity. Automatic start will also occur on receipt of a level 1 1/2 signal (HPCF initiate).

The Class 1E 6.9-kV Divisions I, II, and III switchgear buses, and associated 6.9-kV diesel generators, 480 VAC distribution systems, 120 VAC and 125 VDC power and control systems conform to Seismic Category I requirements and are housed in Seismic Category I structures. Seismic Qualification is in accordance with IEEE Standard 344.

8.1.3.1.1.2 SSLC (Safety System Logic and Control) Power Supply System Design Bases

In order to provide redundant, reliable power of acceptable quality and availability to support the safety logic and control functions during normal, upset and accident conditions, the following design bases apply:

(1) SSLC power has four separate and independent Class 1E inverter constant voltage constant frequency (CVCF) power supplies each backed by separate Class 1E batteries.

(2) Provision is made for automatic switching to the alternate bypass supply from its division in case of a failure of the inverter power supply. The inverter power supply is synchronized in both frequency and phase with the alternate bypass supply, so that unacceptable voltage spikes will be avoided in case of an automatic transfer from normal to alternate supply. The SSLC uninterruptible power supply complies with IEEE Std. 944.

8.1.3.1.2 Regulatory Requirements

The following list of criteria is addressed in accordance with Table 8.1-1 which is based on Table 8-1 of the Standard Review Plan. In general, the ABWR is designed in accordance with all ~~applicable~~ criteria. Any exceptions or clarifications are so noted.

8.1.3.1.2.1 General Design Criteria

(1) GDC 2 - Design Bases for Protection against Natural Phenomena;

(2) GDC 4 - Environmental and Missile Design Bases;

(3) GDC 5 - Sharing of Structures, Systems and Components;

The ABWR is a single-unit plant design. Therefore, this GDC is not applicable.

(4) GDC 17 - Electric Power Systems;

(5) GDC 18 - Inspection and Testing of Electrical Power Systems;

(6) GDC 50 - Containment Design Bases.

8.1.3.1.2.2 NRC Regulatory Guides

(1) RG 1.6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems;

(2) RG 1.9 - Selection, Design and Qualification of Diesel-Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants;

(3) RG 1.32 - Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants;

(4) RG 1.47 - Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems;

(5) RG 1.63 - Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants;

(6) RG 1.75 - Physical Independence of Electric Systems;

Isolation between Class 1E power supplies and non-Class 1E loads is discussed in Subsection 8.3.1.1.2.1.

(7) RG 1.81 - Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants;

The ABWR is designed as a single-unit plant. Therefore, this Regulatory Guide is not applicable.

(8) RG 1.106 - Thermal Overload Protection for Electric Motors on Motor-Operated Valves;

(9) RG 1.108 - Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants;

(10) RG 1.118 - Periodic Testing of Electric Power and Protection Systems;

(11) RG 1.128 - Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants;

(12) RG 1.129 - Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants;

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8.1.3.1.2.3 Branch Technical Positions

(1) BTP ICSB 4 (PSB) - Requirements on Motor-Operated Valves in the ECCS Accumulator Lines;

This BTP is written for Pressurized Water Reactor (PWR) plants only and is therefore not applicable to the ABWR.

(2) BTP ICSB 8 (PSB) - Use of Diesel-Generator Sets for Peaking;

The diesel-generator sets are not used for peaking in the ABWR design. Therefore, this criteria is satisfied.

(3) BTP ICSB 11 (PSB) - Stability of Offsite Power Systems;

See Subsection 8.1.4.1 for interface requirement.

3.0-4

(4) BTP ICSB 18 (PSB) - Application of the Single Failure Criterion to Manually-Controlled Electrically-Operated Valves;

(5) BTP ICSB 21 - Guidance for Application of Regulatory Guide 1.47;

(6) BTP PSB 1 - Adequacy of Station Electric Distribution System Voltages;
[See Subsection 8.3.1.1.7 (8)]

435.25

(7) BTP PSB 2 - Criteria for Alarms and Indications Associated with Diesel-Generator Unit Bypassed and Inoperable Status;

8.1.3.1.2.4 Other SRP Criteria

(1) NUREG/CR 0660 - Enhancement of Onsite Diesel Generator Reliability;

Operating procedures and the training of personnel are outside the scope of the ABWR Standard Plant. NUREG/CR 0660 is therefore imposed as an interface requirement for the applicant. See Subsection 8.1.4.2 for interface requirement.

(2) TMI Action Item II.E.3.1 - Emergency Power Supply for Pressurizer Heater;

This criteria is applicable only to PWRs and does not apply to the ABWR.

(3) TMI Action Item II.G.1-Emergency Power for Pressurizer Equipment;

This criteria is applicable only to PWRs and does not apply to the ABWR.

8.1.4 Interfaces

8.1.4.1 Stability of Offsite Power Systems

BTP ICSB 11 (PSB) pertaining to the stability of offsite power systems shall be addressed (See Subsection 8.1.3.1.2.3(3).

8.1.4.2 Diesel Generator Reliability

NUREG/CR 0660 pertaining to the enhancement of onsite diesel generator reliability through operating procedures and training of personnel will be addressed by the applicant referencing the ABWR design (see Subsection 8.1.3.1.2.4(1)).

8.1.4.3 Separated power feeds for 6.9 KV Switchgear

1 ~~With reference to Figures 8.1-1 and 8.1-2,~~ Instrumentation and controls associated with the preferred and alternate 6.9 KV buses feeding the non-Class 1E loads shall be powered by separate non-Class 1E DC sources, with power and instrument cables run in separate trays. Separated non-Class 1E DC power sources are available from any two of the four DC-to-DC converters shown on Figure 8.3-7.

See
R.G. 1.32
IEEE 308

TABLE 8.1-1
ON SITE POWER SYSTEM SRP CRITERIA APPLICABLE MATRIX

APPLICABLE CRITERIA	GDC 2	GDC 4	GDC 5**	DGC 17	GDC 18	GDC 50	RG 1.6	RG 1.9	RG 1.32	RG 1.47	RG 1.63	RG 1.75	RG 1.81**	RG 1.106	RG 1.108	RG 1.118	RG 1.128	RG 1.129	BTP ICSB 4*	BTP ICSB 8	BTP ICSB 11	BTP ICSB 18	BTP ICSB 21	BTP PSB 1	BTP PSB 2	NUREG CR0660	II. E. 3.1*	II. G. 1*
REFERENCE IEEE STANDARD								387	308		317	384				338	484	450	279	308								
Onsite Power System (General)	X	X		X	X	X	X	X	X	X	X	X		X	X	X				X		X	X	X	X	X		
Offsite Power System				X	X																X							
Class 1E CVCF Power Supply	X	X		X	X		X		X	X		X				X							X	X	X			
Diesel Generator System	X	X		X	X		X	X	X	X				X	X	X				X			X	X	X	X	X	
DC Power System	X	X		X	X		X		X	X	X	X				X	X	X					X	X				

* PWR only; not applicable to ABWR

** Multi-unit plants only; not applicable to single-unit ABWR

3.0-4

SECTION 8.3

CONTENTS (Continued)

TABLES

Insert B here

ILLUSTRATIONS

Insert B

8.3 ONSITE POWER SYSTEMS

8.3.1 AC Power Systems

8.3.1.1 Description

The auxiliary electric power system includes three independent Class 1E AC electric power systems for nuclear safety-related loads. The principal elements of the auxiliary AC electric power systems are shown on the single line diagrams (SLD) in Figure 8.3-1, 2, 3, 4 and 5.

Each Class 1E division has a dedicated diesel generator, which automatically starts in case of a level trip and/or loss of voltage on the division's 6.9 kV bus. Each 6.9-kV Class 1E bus feeds it's associated 480V unit substation through a 6.9-kV/ 480/277V load center transformer.

435.48 See Subsection 8.3.4.9 for interface requirements.

8.3.1.1.1 Medium Voltage Power Distribution System

AC power is supplied and utilized at 6.9 kV for motor loads larger than 300 KW and transformed to 480 V for smaller loads. The 480V system is further transformed into lower voltages as required for instruments, lighting, and controls. The 6.9-kV system includes normal and alternate preferred power supply feeders.

1.8 + 1.11 Class 1E AC power loads are divided into three divisions (Divisions I, II, and III), each fed from an independent 6.9-kV Class 1E bus. During normal operation (which includes all modes of plant operation; i.e., shutdown, refueling, startup, and run.), two of the three divisions ~~Division I, Division II and Division III loads~~ are fed from an offsite normal preferred power supply. The remaining division shall be fed from the alternate power source (see 8.3.4.9).

Standby AC power for Class 1E buses is supplied by diesel generators at 6.9 kV and distributed by the Class 1E power distribution system. Division I, II and III buses are automatically transferred to the diesel generators when the normal preferred power supply to these buses is lost.

Insert "A"

8.3.1.1.2 Low Voltage Power Distribution System

8.3.1.1.2.1 Power Centers

Power for 480V auxiliaries is supplied from load centers consisting of 6.9-kV/480V transformers and associated metal clad switchgear, Figure 8.3-3. There are three 480 VAC non-Class 1E load centers which are respectively and individually fed from Division I, II and III 6.9KV Class 1E buses. Isolation breakers are provided between the Class 1E and non-Class 1E buses. In addition to normal overcurrent tripping of the isolation breaker, zone selective interlocking is provided between each isolation breaker and its upstream Class 1E feed breaker. If fault current flows in the non-Class 1E bus, it is sensed by the Class 1E current device for the isolation breaker and a trip blocking signal is sent to the upstream Class 1E feed breaker. This blocking lasts for about 75 milliseconds. This allows the isolation breaker to trip in its normal instantaneous tripping time of 35 to 50 milliseconds, if the magnitude of the fault current is high enough. This assures that the fault current has been terminated before the Class 1E upstream breaker is free to trip. For fault currents of lesser magnitude, the blocking delay will time out without either breaker tripping, but the isolation breaker will eventually trip and always before the upstream breaker. This order of tripping is assured by the coordination between the two breakers provided by long-time pickup, long-time delay and instantaneous pickup trip device characteristics. This coordination is carried through to the non-Class 1E load breakers so that for a load fault the load breaker would normally trip without the bus isolation breaker tripping. 435.9

Tripping of the Class 1E feed breaker is normal for faults which occur on the Class 1E bus ~~or its Class 1E loads~~ it feeds. Coordination is provided between the bus main feed breakers and the load breakers. 19 [rew]

Class 1E 480V load centers supplying Class 1E loads are arranged as independent radial systems, with each 480V bus fed by its own power transformer. Each 480V Class 1E bus in a division is physically and electrically independent of the other 480V buses in other divisions.

The 480V unit substation breakers supply motor control centers and 480V motor loads up to

~~Record of Comments~~

~~13 In support of Item 7, the following is added at the end of 8.3.1.1.1:~~

Insert "A"

Each 6.9 kV bus has a safety grounding circuit breaker designed to protect personnel during maintenance operations (see Figure 8.3-1). During periods when the buses are energized, these breakers are racked out (i.e., in the disconnect position). A control room annunciator sounds whenever any of these breakers are racked in for service.

The interlocks for the bus grounding devices are as follows:

1. Undervoltage relays must be actuated.
2. Related breakers must be in the disconnect position.
3. Voltage for bus instrumentation available.

Conversely, the bus feeder breakers are interlocked such that they cannot close unless their associated grounding breakers are in their disconnect positions.

~~The following new interface section is added as shown:~~

~~8.3.4.14 Administrative Controls for Bus Grounding Circuit Breakers~~

~~Figures 8.3-1, 8.3-2, and 8.3-3 show bus grounding circuit breakers, which are intended to provide safety grounds during maintenance operations. Administrative controls shall be provided to keep these circuit breakers racked out (i.e., in the disconnect position) whenever corresponding buses are energized. Furthermore, annunciation shall be provided to alarm in the control room whenever the breakers are racked in for service.~~

8.3.1.1.4.1 120V AC Safety-Related Instrument Power System

Individual transformers supply 120V AC instrument power Figure 8.3-4. Each Class 1E divisional transformer is supplied from a 480V MCC in the same division. There are three divisions, each backed up by its divisional diesel generator as the source when the offsite source is lost. Power is distributed to the individual loads from distribution panels, and to logic level circuits through the control room logic panels.

8.3.1.1.4.2 120V AC Safety Related Uninterruptible Power Supplies (UPS)

8.3.1.1.4.2.1 Constant Voltage, Constant Frequency (CVCF) Power Supply for the Safety System Logic and Control (SSLC) for the Reactor Protection System (RPS)

The power supply for the RPS SSLC is shown in Figure 8.3-6, with each of the four buses supplying power for the independent trip systems of the SSLC system. Four constant voltage, constant frequency (CVCF) control power buses (Divisions I, II, III, and IV) have been established. They are each normally supplied independently from inverters which, in turn, are supplied from four independent and redundant ~~AC and~~ DC supplies, and three independent and redundant AC supplies
26

For Divisions I, II, and III, the AC supply is from a 480 V MCC for each division. The backup DC supply is via a DC/AC inverter from the 125VDC central/distribution board for the division. A static switch also is capable of transferring from the inverter to a direct feed through a voltage regulating transformer from a 480V motor control center for each of the three divisions.

Since there is no 480V AC Division IV power, Division IV is fed from a Division I motor control center. Otherwise, the AC supply for the Division IV CVCF power supply is similar to the other three divisions. The DC supply for Division IV is backed up by a seperate Division IV battery.

The CVCF power supply buses are designed to provide logic and control power to the four-division SSLC system that operates the RPS. [The SSLC for the ECCS derives its power from the 125 VDC power system (Figure 8.3-7)]. The AC buses also supply power to neutron monitoring system and parts of the process radiation monitoring system and MSIV function in the leak detection system. Power distribution is arranged to prevent inadvertent operation of the reactor scram initiation or MSIV isolation upon loss of any single power supply.

Routine maintenance can be conducted on equipment associated with the CVCF power supply. Inverters and solid state switches can be inspected, serviced and tested channel by channel without tripping the RPS logic.

8.3.1.1.4.2.2 Class 1E RPS and MSIV Soleniods Power Supply

Three of the CVCF power supply buses are designed to provide power to the RPS scram and MSIV solenoid valves. The bus for the RPS A solenoids is supplied by the Division II CVCF power supply. The RPS B solenoids bus is supplied from the Division III CVCF power supply. The #3 soleniods for the MSIVs are powered from the Division I CVCF; and the #2 soleniods, from the Division II CVCF power supply.

8.3.1.1.4.2.3 Process Computer Constant Voltage, Constant Frequency (CVCF) Power Supply

Two constant voltage and constant frequency power supplies are provided to power the process computers. Each of the power supplies consists of an AC to DC rectifier, and a DC to AC inverter, a bypass transformer and DC and AC solid state transfer switches (Figure 8.3-5). The normal feed for the power supplies is from a non-Class 1E power center supplied from the Division I diesel generator for one power supply and from a non-Class 1E power center supplied from the Division II diesel generator for the other power supply. The backup for the normal feeds is from the 250VDC battery. Each power supply is provided with a backup AC feed though isolation transformers and a static transfer switch. The backup feed is provided for alternate use during maintenance periods.

8.3.1.1.4.2.4 Non-Class 1E Vital AC Power System

The function of the Non-Class 1E Vital AC Power Supply System is to provide reliable 120V uninterruptible AC power for important non-safety related loads that are required for continuity of power plant operation. The system consists of two 120V AC uninterruptible CVCF power supplies, each including a static inverter, AC and DC static transfer switches, a regulating stepdown transformer (as an alternate AC power supply), and a distribution panel (Figure 8.3-6). The primary source of power comes from the non-Class 1E AC power centers. The secondary source is the non-Class 1E 125 VDC central distribution panels.

If the inverter fails, the AC static switch transfers to the regulating transformer without interruption (not more than 4 msec). If the AC source or rectifier fails, the DC thyrister switch transfers to the DC source without interuption.

8.3.1.1.4.2.5 Components

Each of the four Class 1E CVCF power supplies includes the following components:

(1) a power distribution cabinet, including the CVCF 120 VAC bus and circuit breakers for the SSLC loads;

(2) a solid-state inverter, to convert 125 VDC power to 120 VAC uninterruptible power supply;

(3) a solid-state transfer switch to sense inverter failure and automatically switch to alternate 120 VAC power;

(4) a 480V/120V bypass transformer for the alternate power supply;

(5) a solid-state transfer switch to sense rectifier or AC power failure and automatically switch to alternate 125 VDC power.

(6) a manual transfer switch for maintenance.

8.3.1.1.4.2.6 (Deleted)

8.3.1.1.4.2.7 Operating Configuration

The four 120 VAC essential power supplies operate independently, providing four divisions of CVCF power supplies for the SSLC. The normal lineup for each division is through an essential 480 VAC power supply, the AC/DC rectifier, the inverter and the static transfer switch. Transfer from the inverter, directly to the essential AC source is done automatically in case of inverter failure, or to the DC source in case of rectifier or AC power failure. Annunciation in the control room is provided for any of the alternate operating modes. Three of the four divisions supply independent power to the RPS scram solenoids and the MSIV solenoids for isolation.

8.3.1.1.5 Class 1E Electric Equipment Considerations

The following guidelines are utilized for Class 1E equipment.

8.3.1.1.5.1 Physical Separation and Independence

Equipment of one division is segregated from equipment of other divisions and nondivisional equipment, in accordance with IEEE Std 384, Regulatory Guide 1.75 and General Design Criterion 17. The overall design objective is to locate the divisional equipment and its associated control, instrumentation, electrical supporting systems and interconnecting cabling such that separation is maintained among all divisions. Divisional separation is achieved through the use of Three-hour fire rated barriers, ~~spatial separation,~~ and totally enclosed raceways. (see Section 9.5.1.0)

Redundant divisions of electric equipment and cabling are located in separate rooms or fire areas wherever possible. In some specific instances spatial separation is provided such that no single event may disable more than one of the redundant divisions or prevent safe shutdown of the plant. These are analyzed and justified in Appendix section 9A.5.

Electric equipment and wiring for the Class 1E systems which are segregated into separate divisions are separated and barriered so that no design basis event is capable of disabling more than one division of any ESF total function. 435.11

Class 1E to non-Class 1E separation is designed in accordance with the requirements of IEEE 384. (new) *

10

4.5

The safety-related divisional AC switchgear, load centers, battery rooms and DC distribution panels and MCCs are located to provide separation and electrical isolation among the divisions. Separation is provided among divisional cables being routed between the equipment rooms, the Main Control Room, containment and other processing areas. Equipment in these areas is divided into Divisions I, II, III and IV and separated by barriers formed by walls, floors, and ceilings. The equipment is located to facilitate divisional separation of cable trays and to provide access to electrical penetration assemblies. Exceptions to this separation objective are identified and analyzed as to equivalence and acceptability in the fire hazard analysis. (See Appendix section 9A.5.)

The penetration assemblies are located around the periphery of the containment and at different elevations to facilitate reasonably direct routing to and from the equipment. No penetration carries cables of more than one division.

7.1 ¶ Separation within the main control room is designed in accordance with IEEE 384, and is discussed in 8.3.1.4.2.2.3.

~~Divisional cables to and from the containment and to and from the dedicated divisional equipment in the reactor building are routed in separated cable raceways for each division. Routing is maintained up to the terminal cabinets in the main control room. Separation within the main control room panels is discussed in 8.3.1.4.2.2.3.~~ * (new)

Wiring for all Class 1E equipment indicating lights is an integral part of the Class 1E cables used for control of the same equipment and are considered to be Class 1E circuits.

8.0 Associated cables, if any, are treated as Class 1E circuits and routed in their corresponding divisional raceways. Separation requirements are the same as for Class 1E circuits.

The careful placing of equipment is important to the necessary segregation of circuits by division. Deliberate routing in separate fire areas on different floor levels, and in embedded ducts is employed to achieve physical independence.

8.3.1.1.5.2 Class 1E Electric Equipment Design Bases and Criteria

(1) Motors are sized in accordance with NEMA standards. The manufacturers' ratings are at least large enough to produce the starting, pull-in and driving torque needed for the particular application, with due consideration for capabilities of the power sources. (Insert "A" here) 13.6

(2) Power sources, distribution systems and branch circuits are designed to maintain voltage and frequency within acceptable limits.

(3) The selection of motor insulation such as Class F, H or B is a design consideration based on service requirements and environment. The Class 1E motors are qualified by tests in accordance with IEEE Std 334.

(4) 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.~~ equal to, or greater than the maximum available fault current to which it is exposed under all modes of operation * (new) 21.1 21

Interrupting capacity requirements of the 6.9kV Class 1E switchgear is selected to accommodate the available short-circuit current at the switchgear terminal. Circuit breaker and applications are in accordance with ANSI Standards. (See Subsection 8.3.4.1 for interface requirements) 435.12

Unit substation transformers are sized and impedances chosen to facilitate the selection of low-voltage switchgear, MCCs and distribution panels, which are optimized within the manufacturer's recommended ratings for interrupting capacity and coordination of overcurrent devices. Impedance of connecting upstream cable is factored in for a specific physical layout. * (new) 21.1

8.3.1.1.5.3 Testing

Such on-line testing is greatly enhanced by the design, which utilizes three independent divisions, any one of which can safely shut down the plant

The design provides for periodically testing the chain of system elements from sensing devices through driven equipment to assure that Class 1E equipment is functioning in accordance with design requirements. The requirements of IEEE Std 379, Regulatory Guide 1.118 and IEEE 338 are met. 31

8.3.1.1.6 Circuit Protection

8.3.1.1.6.1 Philosophy of Protection

Simplicity of load grouping facilitates the dit: ANSWER Ins Num

Item 5: The term "hostile area" was intended to mean those areas which could be potentially exposed to the energy of a postulated reactor coolant (steam or water) pressure boundary pipe rupture. This criteria is defined in Appendix 31 and tables 31.3-1 through 31.3-21.

~~Item 6:~~ Plant Design specifications for electrical equipment require such equipment be capable of continuous operation for voltage fluctuations of +/- 10%. In addition, Class 1E motors must be able to withstand voltage drops to 70% rated during starting transients. ~~[These two sentences have been added to SSAR Subsection 8.3.1.1.5.2(1)].~~

13.6

Insert "A"
in 8.3.1.1.5.2(1)

use of conventional, protective relaying practices for isolation of faults. Emphasis has been placed on preserving function and limiting loss of Class 1E equipment function in situations of power loss or equipment failure.

Circuit protection of the Class 1E buses contained within the nuclear island is interfaced with the design of the overall protection system outside the nuclear island.

8.3.1.1.6.2 Grounding Methods

The medium voltage (6900V) system is low resistance grounded except that each diesel generator is high resistance grounded to maximize availability.

8.3.1.1.6.3 Bus Protection

Bus protection is as follows:

(1) 6.9kV bus incoming circuits have inverse time overload, ground fault, bus differential and undervoltage protection.

(2) 6.9kV feeders for load centers have instanttaneous, inverse time overload and ground fault protection.

(3) 6.9kV feeders for heat exchanger building substations have inverse time overload and ground fault protection.

(4) 6.9kV feeders used for motor starters have instantaneous, inverse time overload, ground fault and motor protection.

(5) 480V bus incoming line and feeder circuits have inverse time overload and ground fault protection.

8.3.1.1.6.4 Protection Requirements

When the diesel-generators are called upon to operate during LOCA conditions, the only protective devices which shut down the diesel ~~for the diesel generator~~ are the generator ~~and bus~~ differential relays and the engine overspeed trip. ~~low diesel cooling water pressure (two out of two sensors) and low differential pressure of secondary cooling water (two out of two sensors).~~ These protection devices are retained under accident conditions to protect against possible, significant damage.

(new) 17.1 435.13

Other protective relays, such as loss of excitation, antimotoring (reverse power) low jacket water pressure overcurrent voltage restraint, high jacket water temperature and low lube oil pressure, are used to protect the machine when operating in parallel with the normal power system, during periodic tests. The relays are automatically isolated from the tripping circuits during LOCA conditions. No trips are bypassed during LOPP or testing. However, all bypassed parameters are annunciated in the main control room (see 8.3.1.1.8.5). The bypasses are testable and are manually reset as required by Position 7 of Reg. Guide 1.9. 435.13

(new) 17.2 17.3

8.3.1.1.7 Load Shedding and Sequencing on Class 1E Buses

This subsection addresses Class 1E Divisions I, II, and III. Load shedding, bus transfer and sequencing on a 6.9kV Class 1E bus is initiated on loss of bus voltage. Only LOPP signals are used to trip the loads. However, the presence of a LOCA during LOPP reduces the time delay for initiation of bus transfer from 3 seconds to 0.4 seconds. The load sequencing for the diesels is given on Table 8.3-4. 435.14

Load shedding and buses ready to load signals are generated by the control system for the electrical power distribution system. Individual timers for each major load are reset and started by their electrical power distribution systems signals.

(1) Loss of Preferred Power (LOPP) : The 6.9kV Class 1E buses are normally energized from the normal or alternate preferred power supplies. Should the bus voltage decay to below 70% of its nominal rated value for a predetermined time a bus transfer is initiated and the signal will trip the supply breaker, and start the diesel generator. As the bus voltage decays, large pump motor breakers are tripped. The transfer proceeds to the diesel generator. If the standby diesel generator is ready to accept load (i.e., voltage and frequency are within normal limits and no lockout exists, and the normal and alternate preferred supply breakers are open), then the diesel-generator breaker is signalled to close, accomplishing automatic transfer of the Class 1E bus to the diesel generator. Large motor loads will be sequence started as required and shown on Table 8.3-4. 1.8 435.15

(2) Loss of Coolant Accident (LOCA): When a LOCA occurs, with or without a LOPP, the load sequence timers are started if the 6.9 KV emergency bus voltage is greater than 70% and loads are applied to the bus at the end of preset times.

435.17 Each load has an individual load sequence timer which will start if a LOCA occurs and the 6.9 KV emergency bus voltage is greater than 70%, regardless of whether the bus voltage source is preferred power or the diesel generator. The load sequence timers are part of the low level circuit logic for each LOCA load and do not provide a means of common mode failure that would render both onsite and offsite power unavailable. If a timer failed, the LOCA load could be applied manually provided the bus voltage is greater than 70%.

1.8 (3) LOPP following LOCA: If the bus voltage (normal or alternate preferred power) is lost during post-accident operation, transfer to diesel generator power occurs as described in (1) above.

(4) LOCA following LOPP: If a LOCA occurs following loss of the normal or alternate preferred power supplies, the LOCA signal starts ESF equipment as required. Automatic (LOCA + LOPP) time delayed load sequencing assures that the diesel-generator will not be overloaded.

435.19 (5) LOCA when diesel generator is parallel with preferred power source during test: If a LOCA occurs when the diesel generator is paralled with either the normal preferred power or the alternate preferred power source, the D/G will automatically be disconnected from the 6.9 KV emergency bus regradless of whether the test is being conducted from the local control panel or the main control room.

(6) **LOPP during diesel generator paralleling test**: If the normal preferred power supply is lost during the diesel-generator paralleling test, the diesel-generator circuit breaker is automatically tripped. Transfer to the diesel generator then proceeds as described in (1).

If the alternate preferred source is used for load testing the diesel generator, and the alternate preferred source is lost (and no LOCA signal exists), the diesel-generator breaker will trip on overcurrent, and LOPP condition will exist. Load shedding and bus transfer will proceed as described in (1).

(7) **Restoration of offsite power**: Upon restoration of offsite power, the Class 1E bus(es) can be transferred back to the offsite source by manual operation only.

435.25 (8) **Protection against degraded voltage**: For protection of the Division I, II and III electrical equipment against the effects of a sustained degraded voltage, the 6.9 kV ESF bus voltages are monitored. When the bus voltage degrades to 90% or below of its rated value and after a time delay (to prevent triggering by transients), undervoltage will be annunciated in the control room. Simultaneously a 5-minute timer is started, to allow the operator to take corrective action. After 5 minutes, the respective feeder breaker with the undervoltage is tripped. Should a LOCA occur during the 5-minute time delay, the feeder breaker with the undervoltage will be tripped instantly. Subsequent bus transfer will be as desribed above.

8.3.1.1.8 Standby AC Power System

The diesel generators comprising the Divisions I, II and III standby AC power supplies are designed to quickly restore power to their respective Class 1E distribution system divisions as required to achieve safe shutdown of the plant and/or to mitigate the consequences of a LOCA in the event of a coincident LOPP. Figure 8.3-1 shows the interconnections between the preferred power supplies and the Divisions I, II and III diesel-generator standby power supplies.

8.3.1.1.8.1 Redundant Standby AC Power Supplies

Each standby power system division, including the diesel generator, its auxiliary systems and the distribution of power to various Class 1E loads through the 6.9kV and 480V systems, is segregated and separated from the other divisions. No automatic interconnection is provided between the Class 1E divisions. Each diesel-generator set is operated independently of the other sets and is connected to the utility power system by manual control only during testing or for bus transfer.

8.3.1.1.8.2 Ratings and Capability

The size of each of the diesel-generators serving Divisions I, II and III satisfies the requirements of NRC Regulatory Guide 1.9 and IEEE Std 387 and conforms to the following criteria:

(1) Each diesel generator is capable of starting, accelerating and supplying its loads in the sequence shown in Table 8.3-4.

(2) Each diesel generator is capable of starting, accelerating and supplying its loads in their proper sequence without exceeding a 25% voltage drop at its terminals.

(3) Each diesel generator is capable of starting, accelerating and running its largest motor at any time after the automatic loading sequence is completed, assuming that the motor had failed to start initially.

(4) Each diesel generator is capable of reaching full speed and voltage within ~~13~~ 20 seconds after receiving a signal to start, and capable of being fully loaded within the next 65 ~~30~~ seconds, as shown in Table 8.3-4. 36.1 * (new) 31.10 * (new 36.6

(5) Each diesel generator has a continuous load rating of 6.25MVA @ 0.8 power factor (see Figure 8.3-1). The overload rating is 110% of the rated output for a two-hour period.

See Subsection 8.3.4.2 and 8.3.4.8 for interfece requirements. 435.12 435.46

8.3.1.1.8.3 Starting Circuits and Systems

Diesel generators I, II and III start automatically on loss of bus voltage. Under-voltage relays are used to start each diesel engine in the event of a drop in bus voltage below preset values for a predetermined period of time. Low-water-level switches and drywell high-pressure switches in each division are used to initiate diesel start under accident conditions. Manual start capability (without need of D.C. power) is also provided. The transfer of the Class 1E buses to standby power supply is automatic should this become necessary on loss of all preferred power. After the breakers connecting the buses to the preferred power supplies are open the diesel-generator breaker is closed when required generator voltage and frequency are established.

Diesel generators I, II and III are designed to start and attain rated voltage and frequency within 20 seconds. The generator, and voltage regulator are designed to permit the set to accept the load and to accelerate the motors in the sequence within the time requirements. The voltage drop caused by starting the large motors does not exceed the requirements set forth in Regulatory Guide 1.9, and proper acceleration of these motors is ensured. Control and timing circuits are provided, as appropriate, to ensure that each load is applied automatically at the correct time. Each diesel generator set is provided with two independent starting air systems.

8.3.1.1.8.4 Automatic Shedding, Loading and Isolation

The diesel generator is connected to its Class 1E bus only when the incoming preferred source breakers have been tripped (subsection 8.3.1.1.7). Under this condition, major loads are tripped from the Class 1E bus, except for the Class 1E 480V unit substation feeders, before closing the diesel generator breaker.

The large motor loads are later reapplied sequentially and automatically to the bus after closing of the diesel-generator breaker.

8.3.1.1.8.5 Protection Systems

The diesel generator is shut down and the generator breaker tripped under the following conditions during all modes of operation and testing operation:

(1) engine overspeed trip; and

(2) generator differential relay trip.

The generator breaker is tripped under the following conditions during normal operations and testing:

(1) generator ground overcurrent;

(2) generator voltage restrained overcurrent;

(3) bus underfrequency;

(4) generator reverse power; and

(5) generator loss of field.

17. (new) (6) bus differential relay trip[1]

In addition, during diesel-generator normal operations or testing, the diesel generator is shut down due to:

(1) high jacket water temperature;

(2) generator high bearing temperature;

(3) generator loss of field ~~excitation~~;

(4) reverse power;

(5) low turbo oil pressure;

(6) high bearing vibration;

(7) high lube oil temperature;

(8) low lube oil pressure;

(9) high crankcase pressure; and

(10) low jacket water pressure.

These and other ~~The following~~ protective functions (alarms and trips) ~~(trips)~~ of the engine or the generator breaker and other off-normal conditions are annunciated in the main control room and/or locally as shown in Table 8.3-11. ~~Items marked with asterisk (*) are annunciated directly in the main control room. Otherwise~~, local alarm/annunciation points have auxiliary isolated switch outputs which provide inputs to ~~a single~~ alarm/annunciator refresh units in the main control room which identifies the diesel generator and general anomaly concerned. Those anomalies which cause the respective D/G to become inoperitive are so indicated in accordance with Regulatory Guide 1.47 and BTP PSB-2. 435.22

(1) low level--jacket water;

(2) low pressure--jacket water; *

(3) low-low pressure--jacket water; *

(4) low temperature--jacket water in;

(5) high temperature--jacket water out; *

(6) high-high temperature--jacket water out;

(7) low level--lube oil mark;

(8) low temperature--lube oil in;

(9) high temperature--lube oil out; *

(10) high-high temperature--lube oil;

(11) high differential pressure--lube oil filter;

footnote

1. Trips generator breaker under all modes of operation.

(12) low pressure--turbo oil right/left bank;

(13) low-low pressure--turbo oil;

(14) low pressure--lube oil;

(15) low-low pressure--lube oil;

~~(16) high temperature D/G bearings;~~ *

~~(17) high pressure--crankcase;~~ *

~~(18) excessive D/G bearing vibration;~~ *

~~(19) engine overspeed;~~ *

~~(20) control circuit fuse failure*;~~

~~(21) D/G overvoltage *;~~

~~(22) low pressure--starting air;~~

~~(23) in maintenance mode;~~

~~(24) unit fails to start;~~

bus

~~(25) D/G underfrequency;~~ *

435.22 ~~(26) D/G phase overcurrent*;~~

~~(27) out of service;~~ *

~~(28) diesel engine shutdown;~~

~~(29) lock out relay operated;~~

~~(30) emergency start;~~

~~(31) D/G voltage restraint overcurrent*;~~

~~(32) low-high level--fuel day tank;~~

~~(33) low pressure--fuel oil;~~

~~(34) high differential pressure--fuel filter;~~

~~(35) generator reverse power*;~~

~~(36) in local control only;~~

~~(37) generator differential trip;~~ *

7.5 (38) bus differential trip*

8.3.1.1.8.6 Local and Remote Control

Each diesel generator is capable of being started or stopped manually from the main control room. Start/stop control and bus transfer control may be transferred to a local control station in the diesel generator room by operating key switches at that station.

* Denotes control room annunciator

8.3.1.1.8.7 Engine Mechanical Systems and Accessories

Descriptions of these systems and accessories are given in Section 9.5.

8.3.1.1.8.8 Interlocks and Testability

Each diesel generator, when operating other than in test mode, is totally independent of the preferred power supply. Additional interlocks to the LOCA and LOPP sensing circuits terminate parallel operation test and cause the diesel generator to automatically revert and reset to its standby mode if either signal appears during a test. A lockout or maintenance mode removes the diesel generator from service. The inoperable status is indicated in the control room.

8.3.1.1.8.9 Reliability Qualification Testing

The qualification tests are performed on the diesel generator per IEEE Std. 387 as modified by Regulatory Guide 1.9 requirements.

See Subsection 8.3.4.10 for interface requirements. 435.55

8.3.1.2 Analysis

8.3.1.2.1 General AC Power Systems

The general AC power systems are illustrated in Figures 8.3-1 through 8.3-3. The analysis demonstrates compliance of the Class 1E AC power system to ~~applicable~~ NRC General Design Criteria (GDC), NRC Regulatory Guides and other criteria consistent with the Standard Review Plan (SRP). 3

Table 8.1-1 identifies the onsite power system and the associated codes and standards applied in accordance with Table 8-1 of the SRP. ~~Applicable~~ criteria are listed in order of the listing on the table, and the degree of conformance is discussed for each. Any exceptions or clarifications are so noted. 3

(1) General Design Criteria (GDC):

(a) Criteria: GDCs 2, 4, 17, 18 and 50.

(b) Conformance: The AC power system is in compliance with these GCDs, ~~in part, or as a whole, as applicable.~~ The GDCs are generically addressed in Subsection 3.1.2.

(2) Regulatory Guides (RGs):

(a) RG 1.6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

(b) RG 1.9 - Selection, Design, and Qualification of Diesel-Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants

(c) RG 1.32 - Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants

(d) RG 1.47 - Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems

(e) RG 1.63 - Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants

(f) RG 1.75 - Physical Independence of Electric Systems

(g) RG 1.106 - Thermal Overload Protection for Electric Motors on Motor-Operated Valves

(h) RG 1.108 - Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants

(i) RG 1.118 - Periodic Testing of Electric power and Protection Systems

Regarding Position C-1 of Regulatory Guide 1.75, see Section 8.3.1.1.2.1. Although the AC isolation is fault-current actuated, the intent of Regulatory Guide 1.75 is met through the zone selective interlocking technique. Therefore, the onsite AC power system is designed in accordance with recommendations of this guide, and with the other listed Regulatory Guides.

There are three 6.9 KV electrical divisions which are independent load groups backed by individual diesel-generator sets. The low voltage AC systems consists of four divisions which are backed by independent DC battery, charger and inverter systems. 435.23

The standby power system redundancy is based on the capability of any one of the four divisions (one of three load groups) to provide the minimum safety functions necessary to shut down the unit form the control room in case of an accident and maintain it in the safe shutdown condition. 435.24

There is no sharing of standby power system components between load groups, and there is no sharing of diesel-generator power sources between units, since the ABWR is a single-plant design.

Each standby power supply for each of the three load groups is composed of a single generator driven by a diesel engine having fast-start characteristics and sized in accordance with Regulatory Guide 1.9.

Table 8.3-1 and 8.3-2 show the rating of each of the Division I, II and III diesel generators, respectively, and the maximum coincidental load for each.

(3) Branch Technical Positions (BTPs):

(a) BTP ICSB 8 (PSB) - Use of Diesel-Generator Sets for Peaking

(b) BTP ICSB 18 (PSB) - Application of the Single Failure Criterion to Manually-Controlled Electrically-Operated Valves.

(c) BTP ICSB 21 - Guidance for Application of Regulatory Guide 1.47

(d) BTP PSB 1 - Adequacy of Station Electric Distribution System Voltages

(e) BTP PSB 2 - Criteria for Alarms and Indications Associated with Diesel-Generator Unit Bypassed and Inoperable Status

The onsite AC poer system is designed consistent with these positions.

435.25

(4) Other SRP Criteria:

(a) NUREG/CR 0660 - Enhancement of Onsite Diesel Generator Reliability

As indicated in Subsection 8.1.3.1.2.4, the operating procedures and training of personnel are outside of the Nuclear Island scope of supply. NUREG/CR 0660 is therefore imposed as an interface requirement for the applicant.(See Subsection 8.1.4.2)

8.3.1.2.2 Class 1E Constant Voltage, Constant Frequency (CVCF) Power Supply

3

The CVCF power supply oneline diagram is illustrated in Figure 8.3-6. The following analysis indicates compliance of the Class 1E CVCF power supply to ~~applicable~~ NRC General Design Criteria (GDC), NRC Regulatory Guides and other criteria consistent with the Standard Review Plan (SRP).

3

Table 8.1-1 identifies the Class 1E CVCF power supply and the associated codes and standards applied in accordance with Table 8-1 of the SRP. ~~Applicable~~ criteria are listed in order of the listing on the table, and the degree of conformance is discussed for each. Any exceptions or clarifications are so noted.

(1) General Design Criteria (GDC):

(a) Criteria: GDCs 2, 4, 17, and 18.

435.26

3

(b) Conformance: The Class 1E CVCF power supply is in compliance with these GDCs. ~~in compliance with these GDC's in part or as a whole, as applicable.~~ The GDCs are generically addressed in Subsection 3.1.2

(2) Regulatory Guides (RGs):

(a) RG 1.6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

(b) RG 1.32 - Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants

(c) RG 1.47 - Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems

(d) RG 1.75 - Physical Independence of Electric Systems

(e) RG 1.118 - Periodic Testing of Electric Power and protection Systems

Regarding Position C-1 of Regulatory guide 1.75, see Section 8.1.3.1.2.2 (6). Otherwise, the Class 1E CVCF power system is designed in accordance with recommendations of this guide, and with the other listed Regulatory Guides.

There are four independent electrical divisions, each with its own individual power supply as illustrated on Figure 8.3-6. The normal uninterruptible power (UPS) to each of the four CVCF divisions is provided by its divisional rectifier and inverter powered by its divisional AC bus. The AC/DC rectifier powered by a 480 VAC bus provides the normal DC power with the 125 VDC division as a backup. The Class 1E CVCF power supplies are not shared among multiple reactor units since the ABWR is a single-unit plant design.

The Class 1E CVCF power supply redundancy is based on the capability of any one of the four divisions to provide the minimum safety functions necessary to shut down the unit from the control room in case of an accident and maintain it in the safe shutdown condition. 435.27

The Class 1E CVCF power supply system is designed to permit inspection and testing of all important equipment and features, and all automatic and manual switching functions.

(3) Branch Technical Positions (BTPs):

(a) BTP ICSB 21 - Guidance for Application of Regulatory Guide 1.47

(b) BTP PSB 1 - Adequacy of Station Electric Distribution System Voltages

With regrad to BTP PSB1, protection against degraded voltage is discussed in Subsection 8.3.1.1.7(8). The CVCF power supply is designed consistent with these BTPs.

8.3.1.2.3 Quality Assurance Requirements

A planned quality assurance program is provided in Chapter 17. This program includes a comprehensive system to ensure that the purchased material, manufacture, fabrication, testing and quality control of the equipment in the emergency electric power system conforms to the evaluation of the emergency electric power system equipment vendor quality assurance programs and preparation of procurement specifications incorporating quality assurance requirements. The administrative responsibility and control provided are also described in Chapter 17.

These quality assurance requirements include an appropriate vendor quality assurance program and organization, purchaser surveillance as required, vendor preparation and maintenance of appropriate test and inspection records, certificates and other quality assurance documentation, and vendor submittal of quality control records considered necessary for purchaser retention to verify quality of completed work.

A necessary condition for receipt, installation and placing of equipment in service has been the sighting and auditing of QA/QC verification data and the placing of this data in permanent onsite storage files.

8.3.1.2.4 Environmental Considerations

13.1 In addition to the effects of operation in normal service environment, all Class 1E equipment ~~which is essential to limiting the consequences of a LOCA~~ is designed to operate during and after any design basis event in the ~~post-~~accident environment expected in the area in which it is located. All Class 1E ~~Electric~~ equipment is qualified to IEEE ~~344~~ 323 (see Section 3.11).

All cables specified for Class 1E systems ~~and associated~~ circuits are moisture and radiation resistant, are highly flame resistant and evidence little corrosive effect when subjected to heat or flame, or both. Certified proof tests are performed on cable samples to:

(1) certify 60 year life by thermal aging;

(2) prove the radiation resistance by exposure of aged specimens to integrated dosage;

(3) prove mechanical/electrical tests of cable for environmental conditions specified;

(4) prove flame resistance by the vertical tray, 70,000 Btu/hr flame test for 8 minutes (minimum); and

(5) show acceptable levels of gas evolution by an acid gas generation test.

The directives which also govern the qualification are:

IEEE Std 317 -	Electric Penetration Assemblies
IEEE Std 323 -	Class 1E Equipment Qualification
IEEE Std 334 -	Continuous Duty Class 1E Motors
IEEE Std 382 -	Class 1E Electric Valve Operators
IEEE Std 383 -	Class 1E Cables, Splices and Connectors
IEEE Std 387 -	Diesel-Generator Standby Power Supplies

See Subsection 8.3.4.3 for interface reqmts. 435.28

8.3.1.3 Physical Identification of Safety-Related Equipment

8.3.1.3.1 Power Systems

Equipment of each division of the Class 1E electric system and various CVCF power supply divisions are identified as follows:

(1) The background of the nameplate for the equipment of a division has the same color as the cable jacket markers and the raceway markers associated with that division.

(2) Power system distribution equipment (e.g., motor control centers, switchgear, trans-

formers, distribution panels, batteries, chargers) is tagged with an equipment number the same as indicated on the single-line diagrams.

(3) The nameplates are laminated black and white plastic, arranged to show black engraving on a white background for non-Class 1E equipment. For Class 1E equipment, the nameplates have color coded background with black engraving.

6

All cables for Class 1E systems and ~~associated~~ e circuits (except those routed in conduits) are tagged every 5 ft prior to (or during) installation. All cables are tagged at their terminations with a unique identifying number (cable number), in addition to the marking characteristics shown below.

* (new) 9.1 Insert "B"

All conduit is similarly tagged with a unique conduit number, in addition to the marking characteristics shown below, at 15 ft intervals, at discontinuities, at pull boxes, at points of entrance and exit of rooms and at origin and destination of equipment. Conduits containing cables operating at above 600V (i.e., 6.9kV) are also tagged to indicate the operating voltage. These markings are applied prior to the installation of the cables.

* (new) 9.1

All Class 1E cable trays are marked with the division color, and with their proper raceway identification at 15 ft intervals on straight sections, at turning points and at points of entry and exit from enclosed areas. Cable trays are marked prior to installation of their cables.

To help distinguish the neutron-monitoring and scram solenoid cables from other type cables, the following unique voltage class designations are used in the cable routing program:

Type of Special Cables	Unique Voltage Class
Neutron-monitoring	VN
Scram solenoid cables	VS

Neutron-monitoring cables are run in their own divisional conduits and cable trays, separately from all other power, instrumentation and control cables. Scram solenoid cables are run in a separate conduit for each rod scram group.

In addition, the cables of the rod control and information system in the hydraulic control unit (HCU) are also placed in separate conduits and cable trays.

The redundant Class 1E, equipment and circuits, assigned to redundant Class 1E divisions and non-class 1E system equipment and circuits are readily distinguishable from each other without the necessity for consulting reference materials. This is accomplished by color coding of equipment, nameplates, cables and raceways, as described above.

8.3.1.3.2 Instrumentation and Control Systems

Major electrical and control equipment, assemblies, devices, and cables grouped into separate divisions ~~per Table 8.3-1~~ shall be identified so that their electrical divisional assignment is apparent and so that an observer can visually differentiate between Class 1E ~~(or 1E associated)~~ e equipment and wiring of different divisions, and between Class 1E and non-Class 1E ~~(or between 1E associated and non-Class 1E)~~ e equipment and wires. The identification method shall be placed on color coding. All markers within a division shall have the same color. See Note 1 For associated cables (if any) treated as Class 1E, there shall be an "A" appended to the divisional designation (e.g., A1). The latter "A" stands for associated and ND for nondivisional. Associated cables are uniquely identified by a longitudinal stripe or other color coded marker and/or the data on the label. The color of the cable marker for associated cables shall be the same as the related Class 1E cable. Divisional separation requirements of individual pieces of hardware are shown in the system elementary diagrams. Identification of raceways, cables, etc., shall be compatible with the identification of the Class 1E equipment with which it interfaces. Location of identification shall be such that points of change of circuit classification (at isolation devices, etc.) are readily identifiable.

8

* (new) 9.2

8.3.1.3.2.1 Identification

(1) Panels and racks

Note 1 (Insert attached Note 1) 8

Record# comments
11 In support of Items 1 and 3, the following was added to 8.3.1.3.1:

9.1 Cables shall be marked in a manner of sufficient durability to be legible throughout the life of the plant, and to facilitate initial verification that the installation is in conformance with the separation criteria.

Such markings shall be color'd to uniquely identify the division (or non-division) of the cable. Generally, individual conductors exposed by stripping the jacket are also color coded or color tagged (at intervals not to exceed 1 foot) such that their division is still discernable. Exceptions are permitted for individual conductors within cabinets or panels where all wiring is unique to a single division (or is non-divisional).

Insert "B"

~~Record# comments~~

~~9 The following interface criteria is inserted as indicated:~~

~~8.3.4.13 Identification and Justification of Associated Circuits~~

~~Prior to the final design, there were no "associated circuits" (as defined by IEEE 384) known to exist in the ABWR Standard Plant design. In the final design, provide 1) assurance that this is still a true statement, or, 2) specifically identify and justify each such circuit in the ABWR SSAR, and show it meets the requirements of Regulatory Guide 1.75, position C.4.~~

~~The following "Note 1" has also been added as a reference pertaining to associated circuits in 8.3.1.3.2:~~

Note 1: Associated circuits added beyond the certified design must be specifically identified and justified per 8.3.4.13. Associated circuits are defined in Section 5.5.1 of IEEE 384-1981, with the clarification for Items (3) and (4) that non-Class 1E circuits being in an enclosed raceway without the required physical separation or barriers between the enclosed raceway and the Class 1E or associated cables makes the circuits (related to the non-Class 1E cable in the enclosed raceway) associated circuits.

8

8.3.1.3.2.1 cont.

color of engraving fill. The marker plates shall include identification of the proper division of the equipment included.

(2) Junction or pull boxes

Junction and/or pull boxes enclosing wiring for the nuclear safety-related systems shall have identification similar to and compatible with the panels and racks.

(3) Cables — Insert "A" here

~~Cables external to cabinets and/or panels for the safety-related systems shall be marked, as indicated in Subsection 8.3.1.3.1, to distinguish them from other cables and identify their separate division as applicable. This identification requirement does not apply to individual conductors.~~

435.29 (new) 7.3

(4) Raceways

Those trays or conduits which carry nuclear safety-related system wiring shall be identified as indicated in Subsection 8.3.1.3.1, at room entrance points through which they pass (and exit points unless the room is small enough to facilitate convenient following of cable) with a permanent marker identifying their assigned division.

435.29

(5) Sensory equipment grouping and designation letters

Redundant sensory logic/control and actuation equipment for safety-related systems shall be identified by suffix letters.

8.3.1.4 Independence of Redundant Systems

8.3.1.4.1 Power Systems

The Class 1E onsite electric power systems and major components of the separate power divisions is shown on Figure 8.3-1.

Independence of the electric equipment and raceway systems between the different divisions is maintained primarily by firewall-type separation ~~where feasible and by spatial separation, in accordance with criteria given in Subsection 8.3.1.4.2, where firewalls are not feasible.~~ as described in Subsection 8.3.1.4.2. Any exceptions are justified in Appendix 9A, Subsection 9A.5.5.5.

6

~~Where spatial separation cannot be maintained in hazardous areas (e.g., potential missile areas), physical isolation between electrical equipment of different divisions is achieved by use of a 6-inch minimum thickness reinforced concrete barrier.~~

3.1

The physical independence of electric power systems complies with the requirements of IEEE Standards 279, 308, 379, 384, General Design Criteria 17, 18 and 21 and NRC Regulatory Guides 1.6 and 1.75.

8.3.1.4.1.1 Class 1E Electric Equipment Arrangement

(1) 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, removal of decay heat from the core, or isolation of the containment in the event of an accident. Separation requirements are applied to control power and motive power for all systems involved.

(2) Equipment arrangement and/or protective barriers are provided such that no locally generated force or missile can destroy any redundant RPS, NSSS, ECCS, or ESF functions. In addition, arrangement and/or separation barriers are provided to ensure that such disturbances do not affect both HPCF and RCIC systems.

(3) Routing of wiring/cabling is arranged such as to eliminate, insofar as practical, all potential for fire damage to cables and to separate the redundant divisions so that fire in one division will not propagate to another division. Class 1E and non-Class 1E cables are separated in accordance with IEEE 384 and RG 1.75. (See Figures 9A.4-1 through 9A.4-16) 10.9 (new)

(4) An independent raceway system is provided for each division of the Class 1E electric system. The raceways are arranged, physically, top to bottom, as follows (based on the function and the voltage class of the cables):

(a) V4 = Medium voltage power, 6.9kV (8kv insulation class).

Record# ~~comments~~

~~See answer for comments. The main issue is Item 2.~~

~~For Item 3, the following replaces 8.3.1.3.2.1(3):~~

9.3 Cables shall be marked in a manner of sufficient durability to be legible throughout the life of the plant, and at intervals not to exceed 5 feet, to facilitate initial verification that the installation is in conformance with the separation criteria.

9.3 Such markings shall be colored, as delineated in 8.3.1.3.1, to uniquely identify the division (or non-division) of the cable. Generally, individual conductors exposed by stripping the jacket are also color coded or color tagged (at intervals not to exceed 1 foot) such that their division is still discernable. Exceptions are permitted for individual conductors within cabinets or panels where all wiring is unique to a single division (or is non-divisional).

Insert "A"

(b) V3 = Low voltage power including 480 VAC, 120 VAC, 125 VDC power and all instrumentation and control power supply feeders (600V insulation class).

(c) V2 = High level signal and control, including 125 VDC and 120 VAC controls which carry less than 20A current and 250 VDC or AC for relay contactor control. fiber-optic cables; and metallic cables with

10.1 (d) V1 = Low level signal and control, including ~~an~~ analog signals up to 55 VDC and digital signals up to 12 VDC.

8.3.1.4.1.2 Electric Cable Installation

(1) Cable Derating and cable tray fill--Base ampacity rating of cables is established as described in Subsection 8.3.3.1. Electric cables of a discrete Class 1E electric system division are installed in a cable tray system provided for the same division. Cables are installed in trays in accordance with their voltage ratings and as described in Subsection 8.3.1.4.1. Tray fill is as established in Subsection 8.3.3.2.

(2) Cable routing in potentially hostile areas--Circuits of different safety divisions are not routed through the same potentially hostile area, with the exception of main steam line instrumentation and control circuits and main steam line isolation valves circuits which are exposed to possible steam line break and turbine missiles, respectively. ~~The drywell is not considered a hostile area because of the application of pipe whip and other restraints.~~ Cable routing in the drywell is discussed in association with the equipment it serves in the "special cases" section 9A.5.

13.4

(3) Sharing of cable trays--All divisions of Class 1E AC and DC systems are provided with independent raceway systems.

(4) Cable fire protection and detection--For details of cable fire protection and detection, refer to Subsections 8.3.3 and 9.5.1.

(5) Cable and raceway markings--All cables (except lighting and nonvital communications) are tagged at their terminations with a unique identifying number. Colors used for identification of cables and raceways are covered in Subsection 8.3.1.3.

(6) Spacing of wiring and components in control boards, panels and relay racks--Separation is accomplished by mounting the redundant devices or other components on physically separated control boards if, from a plant operational point of view, this is feasible. When operational design dictates that redundant equipment be in close proximity, separation is achieved by a barrier or enclosure to retard internal-fire or by a maintained air space in accordance with criteria given in Subsection 8.3.1.4.2.

In this case, redundant circuits which serve the same safety-related function enter the control panel through separated apertures and terminate on separate and separated terminal blocks. Where redundant circuits unavoidably terminate on the same device, barriers are provided between the device terminations to ensure circuit separation approved isolators (generally optical) are used.

(7) Electric penetration assembly--Electric penetration assemblies of different Class 1E divisions are separated by 3-hour rated fire barriers ~~distance~~, separate rooms ~~or barriers~~ and/or locations on separate floor levels (i.e., Separation by distance (without barriers) is allowed only within the inerted containment. (See Section 20.3, RAI 8, Response 435.31)). Grouping of circuits in penetration assemblies follows the same raceway voltage groupings as described in Subsection 8.3.1.4.1.

Separation between divisional and non-divisional penetrations shall be in accordance with IEEE 384.

5 (new)

Replace w/ insert C.

~~Power circuits going through electric penetration assemblies are protected against overcurrent by redundant overcurrent interrupting devices to~~ This is to avoid penetration damage in the event of failure of any single overcurrent device to clear a fault within the penetration or beyond it. (See Subsection 8.3.4.4 for interface requirements). 10.1

435.31(c&d)

8.3.1.4.1.3 Control of Compliance with Separation Criteria During Design and Installation

Compliance with the criteria which insures independence of redundant systems is a supervisory responsibility during both the design and installation phases. The responsibility is

Insert "C"

~~Record of comments~~

~~11 The following replaces the first half of the second paragraph of 8.3.1.4.1.2(7)~~

Redundant overcurrent interrupting devices are provided for all electrical circuits (including all instrumentation and control circuits, as well as power circuits) going through containment penetrations, if the maximum available fault current (including failure of upstream devices) is greater than the continuous current rating of the penetration.

discharged by:

(1) identifying applicable criteria;

(2) issuing working procedure to implement these criteria;

(3) modifying procedures to keep them current and workable;

(4) checking the manufacturer's drawings and specifications to ensure compliance with procedures; and

(5) controlling installation and procurement to assure compliance with approved and issued drawings and specifications.

The equipment nomenclature used on the ABWR standard design is one of the primary mechanism for ensuring proper separation. Each equipment and/or assembly of equipment carries a single number, (e.g., the item numbers for motor drivers are the same as the machinery drivers). Based on these identification numbers, each item can be identified as essential or nonessential, and each essential item can further be identified to its safety separation division. This is carried through and dictates appropriate treatment at the design level during preparation of the manufacturer's drawings.

Non-Class 1E equipment is separated where desired to enhance power generation reliability, although such separation is not a safety consideration.

Once the safety-related equipment has been identified with a Class 1E safety division, the divisional assignment dictates a characteristic color (Subsection 8.3.1.3) for positive visual identification. Likewise, the divisional identification of all ancillary equipment, cable and ~~conduit and~~ raceways match the divisional assignment of the system it supports.

The standby and emergency lighting fixtures are ~~There are certain~~ exceptions to the above where non-Class 1E equipment is connected to Class 1E power sources for functional design reasons. ~~(viz., the standby AC lighting).~~ This is immediately apparent by the absence of essential classification identification of the connected equipment. The equipment is then designated "associated" per Regulatory Guide 1.75. Cables used to connect such equipment are safety grade and qualified and routed as "associated circuits" and marked as described in Subsection 8.3.1.3.

8

8.3.1.4.2 Independence of Redundant Safety-Related Instrumentation and Control Systems

This subsection defines independence criteria applied to safety-related electrical systems and instrumentation and control equipment. Safety-related systems to which the criteria apply are those necessary to mitigate the effects of anticipated and abnormal operational transients or design basis accidents. This includes all those systems and functions enumerated in Subsections 7.1.1.3, 7.1.1.4, 7.1.1.5, and 7.1.1.6. The term "systems" includes the overall complex of actuated equipment, actuation devices (actuators), logic, instrument channels, controls, and interconnecting cables which are required to perform system safety functions. The criteria outlines the separation requirements necessary to achieve independence of safety-related functions compatible with the redundant and/or diverse equipment provided and postulated events.

8.3.1.4.2.1 General

Separation of the equipment for the systems referred to in Subsection 7.1.1.3, 7.1.1.4, 7.1.1.5, and 7.1.1.6 is accomplished so that they are in compliance with ~~the substance and intent of~~ IEEE 279, 10CFR50 Appendix A, General Design Criteria 3, 17, 21 and 22, and NRC Regulatory Guides 1.75 (IEEE 384) and 1.53 (IEEE 379). 435.32 3

three-hour fire-rated barriers

Independence of mutually redundant and/or diverse Class 1E equipment, devices, and cables is achieved by ~~physical separation~~ and/or electrical isolation. ~~Physical separation and/or electrical isolation~~ This protection is provided to maintain the independence of nuclear safety-related circuits and equipment so that the protective function required during and following a design basis event including a single fire anywhere in the plant or a single failure in any circuit or equipment can be accomplished. The exceptional cases where it is not possible to install such barriers have been analyzed and justified in Appendix Section 9A.5.

8.3.1.4.2.2 Separation Techniques

The methods used to protect redundant safety systems from results of single failures or events are utilization of safety class structures, ~~spatial separation and/or~~ protective barriers, and isolation devices. (three-hour fire rated)

8.3.1.4.2.2.1 Safety Class Structure (i.e. separate fire zones)

The basic design consideration of plant layout is such that redundant circuits and equipment are located in separate safety class areas insofar as possible. The separation of Class 1E circuits and equipment is such that the required independence will not be compromised by the failure of mechanical systems served by the Class 1E electrical system. For example, Class 1E circuits are routed or protected so that failure of related mechanical equipment of one system cannot disable Class 1E circuits or equipment essential to the operation of a redundant system. This separation of Class 1E circuits and equipments make effective use of features inherent in the plant design such as using different rooms or floors. ~~opposite side of rooms or areas (distances).~~

8.3.1.4.2.2.2 Three-hour fire rated ~~Spatial Separation and/or~~ Protective Barriers

(Three-hour fire rated) ~~Spatial (distance) separation and/or~~ protective barriers shall be such that no locally generated (fire) ~~force~~ or missile resulting from a design basis event (DBE) or from random failure of Seismic Category I equipment can disable a safety-related function. ~~In the absence of confirming analysis to support less stringent requirements, the following rules apply.~~ The exceptional cases where it is not possible to install such barriers have been analyzed and justified in 9A.5.

~~(1) In rooms or compartments having heavy rotating machinery (such as the turbine-generator or the reactor feedwater system pumps) or in rooms containing high-pressure feedwater piping or high pressure steam lines such as those between the reactor and the turbine, minimum separation of 20 feet or a 6-inch thick reinforced concrete wall is required between trays containing cables of different divisions. An exception is made in the steam tunnel where all four divisions of conduit are separated by about three or four feet for the steam line leakage detection instrumentation.~~

~~(2) Redundant switchgear or motor control equipment associated with redundant safety-related systems is not located in a potential mechanical damage zone, such as discussed in (1).~~

~~(3) In any compartment containing an operating crane (such as the region above the reactor pressure vessel), there must be a minimum horizontal separation of 20 feet or a 6-inch thick reinforced concrete wall between trays containing cables from different divisions.~~

~~(4) Spatial separation in general plant areas shall equal or exceed the minimum allowed by IEEE-384. (See Subsection 8.3.4.5 for interface requirements)~~ 435.33

(2) ~~(5) Spatial~~ Separation in all safety equipment or cable areas ~~cable spreading areas~~ shall equal or exceed the requirements of ~~minimum allowed by~~ IEEE 384. (See Subsection 8.3.4.5 for interface requirements) 435.33

8.3.1.4.2.2.3 Main Control Room and Relay Room Panels

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.

Control, relay, and instrument panels/racks will be designed in accordance with the following general criteria to preclude failure of non-safety circuits from causing failure of any safety circuit, and to preclude failure of one safety circuit from causing failure of any other redundant safety circuit. ~~the possibility of fire propagating between redundant circuits and preventing safe shutdown of the plant.~~ Single panels or instrument racks will not contain circuits or devices of the redundant protection system or ESF systems except:

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

(2) Class 1E circuits and devices will also be separated from the non-Class 1E circuits and

from each other horizontally and vertically by a minimum distance of 6 inches or by steel barriers or enclosures.

(3) Where electrical interfaces between Class 1E and non-Class 1E circuits or between Class 1E circuits of different divisions cannot be avoided, Class 1E isolation devices are used (Subsection 8.3.1.4.2.2.4).

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

(5) Penetration of separation barriers within a subdivided panel is 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.

(6) Local instrument racks on which flow transmitters for main steam or recirculation water are located are permitted to have redundant instruments on adjacent bays of a single rack in order to avoid superfluous instrument piping from flow elements within the drywell. In these cases a spatially diverse set of redundant transmitters shall be provided on a separate local instrument rack.

8.3.1.4.2.2.4 Isolation Devices

Where electrical interfaces between Class 1E ~~or 1E associated~~ and non-Class 1E circuits or between Class 1E ~~(or 1E associated)~~ circuits of different divisions cannot be avoided, Class 1E isolation devices will be used. DC isolation is provided by DC-to-DC converters. AC isolation is provided by interlocked circuit breaker coordination as described in Subsection 8.3.1.1.2.1.

435.35

Wiring from Class 1E ~~(or 1E associated)~~ equipment or circuits which interface with non-Class 1E equipment circuits (i.e., annunciators or data loggers) is treated as Class 1E ~~(or 1E associated)~~ and retain its divisional identification up to and including its isolation device. The output circuits from this isolation device are classified as nondivisional and shall be physically separated from the divisional ~~(or 1E associated)~~ wiring.

8.3.1.4.2.3 System Separation Requirements

Specific divisional assignment of safety-related systems and equipment is given in Table 8.3-1. Other separation requirements pertaining to the RPS and other ESF systems are given in the following subsections.

8.3.1.4.2.3.1 Reactor Protection (Trip) System (RPS)

The following separation requirements apply to the RPS wiring:

(1) RPS sensors, sensor input circuit wiring, trip channels and trip logic equipment will be arranged in four functionally independent and divisionally seperate groups designated Divisions I, II, III and IV. The trip channel wiring associated with the sensor input signals for each of the four divisions provides inputs to divisional logic cabinets which are in the same divisional group as the sensors and trip channels and which are functionally independent and physically seperated from the logic cabinets of the redundant divisions.

(2) Where trip channel data originating from sensors of one division are required for coincident trip logic circuits in other divisions, Class 1E isolation devices will be used as interface elements for signals sent from one division to another such as to

maintain electrical isolation between divisions.

(3) Sensor wiring for several trip variables associated with the trip channels of one division may be run together in the same conduits or in the same raceways of that same and only division. Sensor wiring associated with one division will not be routed with, or in close proximity to, any wiring or cabling associated with a redundant division.

(4) The scram solenoid circuits, from the actuation devices to the solenoids of the scram pilot valves of the CRD hydraulic control units, will be run in grounded steel conduits, with no other wiring contained within the conduits, so that each scram group is protected against a hot short to any other wiring by a grounded enclosure. Short sections (less than one meter) of flexible metallic conduit will be permitted for making connections within panels and the connections to the solenoids.

(5) Separate grounded steel conduits will be provided for the scram solenoid wiring for each of four scram groups. Separate 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.

Insert "A"

(6) ~~The scram group conduits will have unique identification and will be treated essentially as if they are separate enclosed raceways. The conduits containing the scram solenoid group circuit wiring will be physically separated by a minimum separation distance of one inch from either metal enclosed raceways or non-enclosed raceways which contain either divisional or "non-divisional" (non-safety-related) circuits.~~

(7) Any scram group conduit may be routed alongside of any cable or raceway containing either safety-related circuits (of any division), or any cable or raceway containing non-safety-related circuits, as long as the conduit itself is not within the boundary of any raceway which contains either the divisional or the non-safety-related circuits and is physically separated from said cables and raceway boundaries as stated in (6) above. ~~by a minimum separation distance of one inch.~~ Any one scram group conduit may also be routed along with scram group conduits of the same scram group or with conduits of any of the three other scram groups as long as the minimum separation distance of one inch (2.5 cm) is maintained.

(8) The standby liquid control system redundant Class 1E controls will be run as Division I and Division II so that no failure of standby liquid control (SLC) function will result from a single electrical failure in a RPS circuit.

(9) The startup range monitoring (SRNM) subsystem cabling of the NMS and the rod control and information system (RC&IS) cabling under the vessel is treated as divisional. The SRNM cables will be assigned to Division I, II, III and IV, and the RC&IS cables to Division I and II. Under the vessel, cables will be enclosed and separated as defined in [illegible] ~~not be placed in any enclosure which will unduly restrict capability of removing probe connectors for maintenance purposes.~~

3.1.4.2.3.2 Other Safety-Related Systems

(1) Separation of redundant systems or portions of a system shall be such that no single failure can prevent initiation and completion of an engineered safeguard function.

(2) The inboard and outboard isolation valves are redundant to each other so they are made independent of and protected from each other to the extent that no single failure can prevent the operation of at least one of an inboard/outboard pair. The MSL fail-safe solenoid circuits follow the cable separation requirements described in Subsection 8.3.1.4.2.3.1 for RPS rod scram groups.

(3) Isolation valve circuits require special attention because of their function in limiting the consequences of a pipe break outside the primary containment. Isolation valve control and power circuits are requir-

40 8a/1

Record# comments
5 The following paragraph replaces all of 8.3.1.4.2.3.1(6):

4.1.2

Scram group conduits will have unique identification and will be separately routed as Division II and III conduits for the A and B solenoids of the scram pilot valves, respectively. This corresponds to the divisional assignment of their power sources. The conduits containing the scram solenoid group wiring of any one scram group will also be physically separated by a minimum separation distance of 1 inch from the conduit of any other scram group, and from metal enclosed raceways which contain either divisional or non-safety-related (non-divisional) circuits. The scram group conduits may not be routed within the confines of any other tray or raceway system. The RPS conduits containing the scram group wiring for the A and B solenoids of the scram pilot valves (associated with Divisions II and III, respectively), shall be separated from non-enclosed raceways associated with any of the four electrical divisions or non-divisional cables in accordance with the normal division-to-division separation requirements of the plant. (See 8.3.1.1.5.1)

* (new)

Insert "A"

ECCS function. This is accomplished by limiting consequences of a single failure to equipment listed in any one division of Table 8.3-1. The wiring to the ADS solenoid valves within the drywell shall run in one or more rigid conduits. ADS conduits for solenoid A shall be divisionally separated from solenoid B conduits. Short pieces (less than 2 feet) of flexible conduit may be used in the vicinity of the valve solenoids.

(5) Electrical equipment and raceways for systems listed in Table 8.3-1 shall not be located in close proximity to primary steam piping (steam leakage zone), or be designed for short term exposure to the high temperature and humidity associated with a steam leak.

(6) ~~Any electrical equipment and/or raceways for RPS or ESF located in the suppression pool level swell zone will be designed to satisfactorily complete their function before~~

Replace with Insert "B"

Page 8.3-18.1

~~being rendered inoperable due to exposure to the environment created by the level swell phenomena. This zone includes that space above the suppression pool normal level which sees the surge of water that could result from a high drywell-to-containment differential pressure.~~

(7) Containment penetrations will be so arranged that no design basis event can disable cabling in more than one division. Penetrations will not contain cables of more than one divisional assignment.

(8) Annunciator and computer inputs from Class 1E equipment or circuits are treated as Class 1E and retain their divisional identification up to Class 1E isolation device. The output circuit from this isolation device is classified as nondivisional.

Annunciator and computer inputs from non-Class 1E equipment or circuits do not require isolation devices.

8.3.2 DC Power Systems

8.3.2.1 Description

A 125 VDC power system, Figure 8.3-7, is provided for switchgear control, control power, instrumentation, critical motors and emergency lighting in control rooms, switchgear rooms and fuel handling areas.

The 125 VDC systems provide a reliable control and switching power source for the Class 1E systems.

All batteries are sized so that required loads will not exceed 80% of nameplate rating, or warranted capacity at end-of-installed-life with 100% design demand. Each 125 VDC battery is provided with a charger, and a standby charger (shared by two divisions), each of which is capable of recharging its battery from a discharged state to a fully charged state while handling the normal, steady-state DC load.

Batteries are sized for the DC load in accordance with IEEE Standard 485.

A non-class 1E 250VDC power supply, Figure 8.3-8, is provided for the computers and the turbine turning gear motor. The power supply consists of one 250VDC battery and two chargers. The normal charger is fed by 480VAC from either the Division I or Division III load centers. Selection of the desired AC supply is by a mechanically interlocked transfer switch. The standby charger is fed from a control building motor control center. Selection of the normal or the standby charger is controlled by key interlocked breakers. A 250VDC central distribution board is provided for connection of the loads, all of which are non-class 1E.

See Subsection 8.3.4.6 for interface requirements

~~Record# Comments~~

~~15 The following replaces item (6) of 3.3.1.4.2.3.2.~~

Class 1E electrical equipment located in the suppression pool level swell zone is limited to suppression pool temperature monitors, which have their terminations sealed such that operation would not be impaired by submersion due to pool swell or LOCA. Consistent with their Class 1E status, these devices are also qualified to the requirements of IEEE 323 for the environment in which they are locatec ← Insert B

Each of the 125 VDC systems has a 125 VDC battery, a battery charger and a distribution panel. One standby battery charger ~~is shared by~~ can be connected to either of two divisions and another standby battery charger ~~is shared by~~ can be connected to either of two other divisions. The main DC distribution buses include distribution panels, drawout-type breakers and molded case circuit breakers.

Local distribution panels and motor control centers are fed from the DC distribution switchgear.

The 125 VDC systems supply DC power to Divisions I, II, III and IV, respectively, and are designed as Class 1E equipment in accordance with IEEE Std 308. They are designed so that no single failure in any 125 VDC system will result in conditions that prevent safe shutdown of the plant. The plant design and circuit layout from these DC systems provide physical separation of the equipment, cabling and instrumentation essential to plant safety.

Each 125 VDC battery is separately housed in a ventilated room apart from its charger and distribution panel. Each division of the system is located in an area separated physically from other divisions. All the components of Class 1E 125 VDC systems are housed in Seismic Category I structures. An emergency eye wash is supplied in each room. All chargers are sized to supply the continuous load demand to their ~~associated~~ bus while restoring batteries to a fully charged state. (See Subsection 8.3.4.7 for interface requirements) 8 435.42

8.3.2.1.3.1 125 VDC Systems Configuration

Figure 8.3-7 shows the overall 125 VDC system provided for Class 1E Divisions I, II, III and IV. One divisional battery charger is used to supply each divisional DC distribution panel bus and its associated battery. The divisional battery charger is normally fed from its divisional 480V MCC bus.

8.3.2.1.3.2 Battery Capacity Considerations

As a general requirement, ~~These~~ these batteries have sufficient stored energy to operate connected essential loads continuously for at least two hours without recharging. Each distribution circuit is capable of transmitting sufficient energy to start and operate all required loads in that circuit. 34

The division I battery, which controls the RCIC system, is sufficient for eight hours of coping during station blackout. During this event scenario, the load reductions on Divisions II, III, and IV also extend the times these batteries are available (see 19E.2.1.2.2).

Insert "C" here 34 (new)

An initial composite test of onsite AC and DC power systems is called for as a prerequisite to initial fuel loading. This test will verify that each battery capacity is sufficient to satisfy a safety load demand profile under the conditions of a LOCA and loss of preferred power.

Thereafter, periodic capacity tests may be conducted in accordance with IEEE Std 450. These tests will ensure that the battery has the capacity to continue to meet safety load demands.

See Subsection 8.3.4.6 for interface requirements. 435.38(b)

8.3.2.1.3.3 Ventilation

Battery rooms are ventilated to remove the minor amounts of gas produced during the charging of batteries.

8.3.2.1.3.4 Station Blackout 435.2

Station blackout performance is discussed in Subsection 19E.2.1.2.2.

8.3.2.1.4 Insert "A" here 33

8.3.2.2 Analysis

8.3.2.2.1 General DC Power Systems

The 480 VAC power supplies for the divisional battery chargers are from the individual class 1E MCC to which the particular 125 VDC system belongs (Figure 8.3-7). In this way, separation between the independent systems is maintained and the AC power provided to the chargers can be from either preferred or standby AC power sources. The DC system is so arranged that the probability of an internal system failure resulting in loss of that DC power system is extremely low. Important system components are either self-alarming on failure or capable of clearing faults or being tested during service to detect faults. Each battery set is located on its own ventilated battery room. All abnormal conditions of important system parameters such as charger failure or low bus voltage are annunciated in the main control room and/or locally.

AC and DC switchgear power circuit breakers in each division receive control power from the batteries in the respective load groups ensuring the following:

2.0 (1) The unlikely loss of one 125 VDC system does not jeopardize the Class 1E feed supply ~~of preferred and standby AC power~~ to the Class 1E buses

Insert "C"

A load capacity analysis has been performed, based on IEEE 485-1978, for estimated DC battery loads as of September, 1989. The results for both two hours and eight hours are provided as Tables 8.3-5 through 8.3-10.

~~Record# comments~~
~~35 The following replaces the entire subsection 1.2.2.5.1.6:~~

~~1.2.2.5.1.6 Unit Non-Class 1E DC Power System~~

~~The non-Class 1E DC power system supplies power to unit DC loads that are nonsafety-related. Non-Class 1E power is taken from each of the four Class 1E batteries. Class 1E isolation is provided by DC-to-DC converters.~~

~~The following new subsection is added per this response:~~

e

8.3.2.1.4 Non-Class 1E Loads

The 125 VDC non-Class 1E power is used for operation of non-safety equipment such as 6.9 KV switchgear (see 8.1.4.3), valves, converters, transducers, controllers, etc. It also supplies power to non-Class 1E distribution panels and local racks housing non-safety instrumentation.

The 125 VDC non-Class 1E power distribution is shown on Figure 8.3-7. There are four groups of non-Class 1E distribution panels which receive their power through DC-to-DC converters from the four Class-1E electrical divisions.

The DC-to-DC converters (or "power packs") act as electrical isolators such that any anomalies in the non-Class 1E system will not affect the Class 1E system. Also, grounds on the output side (non-Class 1E) of the DC-to-DC converters do not appear on the input side (Class 1E).

33 (new*

These power packs fully comply with all the requirements of Regulatory Guide 1.75 and Section 7.2.2 of IEEE 384, and are therefore acceptable isolation devices. The non-Class 1E loads and their relationship to the power packs and Class 1E power supply buses are the same configuration as those illustrated in the #2 load circle of Figure 1 of IEEE 384.

The Class 1E 125 VDC systems are adequately sized to handle the non-Class 1E loads. Should a loss of all AC power occur, the non-Class 1E loads can be shed, as needed, to assure extended battery life for the safe shutdown functions of the plant. (For battery capacity considerations, see Section 8.3.2.1.3.2.)

Insert "A"

of the other load groups.

(2) The differential relays in one division and all the interlocks associated with these relays are from one 125 VDC system only, thereby eliminating any cross connections between the redundant DC systems.

8.3.2.2.2 Regulatory Requirements

The following analyses demonstrate compliance of the Class 1E Divisions I, II, III and IV DC power systems to ~~applicable~~ NRC General Design Criteria, NRC Regulatory Guides and other criteria consistent with the standard review plan. The analyses establish the ability of the system to sustain credible single failure and retain their capacity to function.

The following list of criteria is addressed in accordance with Table 8.1-1 which is based on Table 8-1 of the Standard Review Plan (SRP). In general, the ABWR is designed in accordance with all ~~applicable~~ criteria. Any exceptions or clarifications are so noted.

(1) General Design Criteria (GDC):

(a) Criteria: GDCs 2, 4, 17, and 18.

(b) Conformance: The DC power system is in compliance with these GDCs~~, in part, or as a whole, as applicable~~. The GDCs are generically addressed in Subsection 3.1.2.

(2) Regulatory Guides (RGs):

(a) RG 1.6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

(b) RG 1.32 - Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants

(c) RG 1.47 - Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems

(d) RG 1.63 - Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants

(e) RG 1.75 - Physical Independence of Electric Systems

(f) RG 1.118 - Periodic Testing of Electric Power and Protection Systems

(g) RG 1.128 - Installation Designs and Installation of Large Lead Storage Batteries for Nuclear Power Plants

(h) RG 1.129 - Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants

The Class 1E DC power system is designed in accordance with the listed Regulatory Guides. It is designed with sufficient capacity, independence and redundancy to assure that the required power support for core cooling, containment integrity and other vital functions are maintained in the event of a postulated accident, assuming a single failure.

The batteries consist of industrial-type storage cells, designed for the type of service in which they are used. Ample capacity is available to serve the loads connected to the system for the duration of the time that alternating current is not available to the battery charger. Each division of Class 1E equipment is provided with a separate and independent 125 VDC system.

The DC power system is designed to permit inspection and testing of all important areas and features, especially those which have a standby function and whose operation is not normally demonstrated.

(3) Branch Technical Positions (BTPs):

(a) BTP ICSB 21 - Guidance for Application of Regulatory Guide 1.47.

The DC power system is designed consistent with this criteria.

(4) Other SRP Criteria:

According to Table 8-1 of the SRP, there are no other criteria applicable to DC power systems.

8.3.3 Fire Protection of Cable Systems

The basic concept of fire protection for the cable system in the ABWR design is that it is incorporated into the design and installation rather than added onto the systems. By use of fire resistant and nonpropagating cables, conservative application in regard to ampacity ratings and raceway fill, and by separation, fire protection is built into the system. Fire suppression systems (e.g., automatic sprinkler systems) are provided for cable trays in areas of high combustible loads or possible transit fire loading.

8.3.3.1 Resistance of Cables to Combustion

The electrical cable insulation is designed to resist the onset of combustion by limiting cable ampacity to levels which prevent overheating and insulation failures (and resultant possibility of fire) and by choice of insulation and jacket materials which have flame-resistive and
435.45 self-extinguishing characteristics. Polyvinyl chloride or neoprene cable insulation is not used in the ABWR. All cable trays are fabricated from noncombustible material. Base ampacity rating of the cables was established as published in IPCEA-46-426/IEEES-135andIPCEA-54-440/NEMA WC-51. Each coaxial cable, each single conductor cable and each conductor in multi- conductor cable is specified to pass the vertical flame test in accordance with UL-44.

In addition, each power, control and instrumentation cable is specified to pass the vertical tray flame test in accordance with IEEE 383.

Power and control cables are specified to continue to operate at conductor temperature not exceeding 90°C and to withstand an emergency overload temperature of up to 130°C in accordance with IPCEA S-66-524/NEMA WC-7 Appendix D. Each power cable has stranded conductor and flame-resistive and radiation-resistant covering. Conductors are specified to continue to operate at 100% relative humidity with a
435.45 service life expectancy of 60 years. Also, Class 1E Cables are designed to survive the LOCA ambient condition at the end of the 60-yr life span. The cable installation (i.e., redundant divisions separated by fire barriers) is such that direct impingement of fire suppressant will not prevent safe reactor shutdown. (See the fourth requirement/compliance in Subsection 9.5.1.0.) 15

8.3.3.2 Localization of Fires

In the event of a fire, the installation design will localize the physical effects of the fire by preventing its spread to adjacent areas or to adjacent raceways of different divisions. Localization of the effect of fires on the electric system is accomplished by separation of redundant cable systems and equipment as described in Subsection 8.3.1.4. Floors and walls are effectively used to provide vertical and horizontal fire-resistive separations between redundant cable divisions.

In special cases spatial separation is used as a method of preventing the spread of fire between adjacent cable trays of different divisions (e.g., inside primary containment). In special cases where minimum separation cannot be maintained between divisional cables in panels or at equipment, barriers are provided between the cable systems or ~~justification is provided between the cable systems of~~ justification is provided (Appendix 9A.5) ~~(Subsection 9.5.1)~~. The objective is always to separate cable trays of different divisions with structural fire barriers such as floors, ceilings and walls. Where this is not possible divisional trays are separated 3 ft horizontally and 5 ft vertically, which meets minimum separations allowed by IEEE-384 and associated Regulatory Guide 1.75. These are specifically analyzed and justified in 9A.5. Fire rated barriers are used to separate divisional cable trays when they are separated by less than 3 ft horizontally and 5 ft vertically. Tray fill is limited to 40% cross-sectional area for all cables.

Maximum separation of equipment is provided through location of equipment in separate fire rated rooms. The safety-related divisional AC unit substations, motor control centers, and DC distribution panels are located to provide separation and electrical isolation between the divisions. Clear access to and from the main switchgear rooms is also provided. Separation is provided between the divisional cables and between divisional cables and nondivisional cables being routed throughout the plant via separate fire rated compartments or embedments. Local instrument panels and racks are located to facilitate adequate separation of cabling.

8.3.3.3 Fire Detection and Protection Systems

All areas except the diesel-generator room are protected by product of combustion detectors. The diesel-generator rooms are protected by carbon dioxide suppression, which is actuated by compensated rate of heat rise and ultraviolet flame detectors.

Automatic wet standpipe, sprinklers, hose reels, and manual pull boxes for the operator's initiation of fire signals are provided in areas as described in subsection 9.5.1, which includes areas where cables and cable trays are routed.

8.3.4 Interfaces

8.3.4.1 Interrupting Capacity of Electrical Distribution Equipment

435.12 The interrupting capacity of the switchgear and circuit interrupting devices must be shown to be compatible with the magnitude of the available fault current based on final selection of the transformer impedence, etc. (See Subsection 8.3.1.1.5.2(4)).

8.3.4.2 Diesel Generator Design Details

36.1 435.21(b) Subsection 8.3.1.1.8.2 (4) requires the diesel generators be capable of reaching full speed and voltage within ~~13~~ 20 seconds after the signal to start. Demonstrate the reliability of the diesel generator start-up circuitry designed to accomplish this.

8.3.4.3 Certified Proof Tests on Cable Samples

435.28 Subsection 8.3.1.2.4 requires certified proof tests on cables to demonstrate 60-year life, and resistance to radiation, flame and the environment. Demonstrate the testing methodology to assure such attributes are acceptable for the 60-year life.

8.3.4.4 Electrical Penetration Assemblies

435.31(c) Subsection 8.3.1.4.1.2. (7) specifies design requirements for electrical penetration assemblies. Provide 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 (to maintain mechanical integrity). Also, provide a simplified one-line diagram showing the location of the protective devices in the penetration circuit. and indicate the maximum available fault current of the circuit. 10.2

Provide specific identification and locations of power supplies used to provide external control power for tripping primary and backup electrical penetration breakers (if utilized). 435.31(d) (new) 11.2

← Insert "D" here 10.2

8.3.4.5 Analysis Testing for Spatial Separation per IEEE 384

~~Item (4) specifies~~ Subsection 8.3.1.4.2.2.2 states that all safety equipment or cable ~~spatial separation in general plant~~ areas shall ~~and in cable spreading areas~~ equal or exceed the requirements of ~~maximum allowed by~~ IEEE 384. Identify any specific instances where this requirement is met by testing and analysis (as opposed to actual ~~distance~~ separation barriers). 435.33

8.3.4.6 DC Voltage Analysis

Provide a DC voltage analysis showing battery terminal voltage and worst case DC load terminal voltage at each step of the Class 1E battery loading profile. (See Subsection 8.3.2.1) 435.37

Provide the manufactor's ampere-hour rating of the batteries at the two hour rate and at the eight hour rate, and provide the one minute ampere rating of the batteries (see Subsection 8.3.2.1.3.2). 435.38(b)

8.3.4.7 Seismic Qualification of Eyewash Equipment

Subsection 8.3.2.1.3 specifies that an emergency eyewash shall be located in each battery room. Provide assurance that the eyewash and associated piping are seismically qualified, and that the eyewash is located such that water cannot splash on the battery. 435.42

8.3.4.8 Diesel Generator Load Table Changes

Tables 8.3-1 and 8.3-3 are generic. However, changes may be needed for specific 435.46

Record# comments

13 See answer for comments concerning NRC SER issues.

....

For Item 1, the following replaces the first half of the second paragraph of 8.3.1.4.1.2(7):

Redundant overcurrent interrupting devices are provided for all electrical circuits (including all instrumentation and control circuits, as well as power circuits) going through containment penetrations, if the maximum available fault current (including failure of upstream devices) is greater than the continuous current rating of the penetration.

....

For Item 2, the following is added, beginning at the end of the last sentence in Section 8.3.4.4:

Provide an analysis demonstrating the thermal capability of all electrical conductors within penetrations is preserved and protected by one of the following:

1. Show that maximum available fault current (including failure of upstream devices) is less than the maximum continuous current capacity of the conductor within the penetration; or

2. Show that redundant circuit protection devices are provided, and are adequately designed and set to interrupt current, in spite of single failure, at a value below the maximum continuous current capacity of the conductor within the penetration. Such devices must be located in separate panels or be separated by barriers; and must be independent such that failure of one will not adversly affect the other. Furthermore, they must not be dependent on the same power supply. 11.2 (new)

Insert "D"

plant applications. Such changes, if any, shall be identified and addressed. (See Subsection 8.3.1.1.8.2)

8.3.4.9 Offsite Power Supply Arrangement

435.48 Operating procedures shall require one of the three divisional buses of Figure 8.3-1 be fed by the alternate power source during normal operation; in order to prevent simultaneous deenergization of all divisional b[illegible]ses on the loss of only one of the offsite p[illegible] supplies.

8.3.4.10 Diesel Generator Quali[illegible] Tests

435.55 The schedule for qualification [illegible] diesel generators, and the subse[illegible] those tests, must be provided. T[illegible] be in accordance with IEEE 387 and R[illegible] Guide 1.9. (See Susbsection 8.3.1.1.8.9)

8.3.4.11 Defective Refurbished Circuit Breakers

435.56(c) NRC Bulliten No. 88-10 and NRC Information Notice No. 88-46 identify problems with defective refurbished circuit breakers. To ensure that refurbished circuit breakers shall not be used in safety related or non-safety related circuitry of the ABWR design, it is an interface requirement that new breakers be specified in the purchase specifications.

8.3.4.12 Minimum Starting Voltages for Class 1E Motors

435.62 Provide the minimum required starting voltages for Class 1E motors. Compare these minimum required voltages to the voltages that will be supplied at the motor terminals during the starting transient when operating on offsite power and when operating on the ediesel generators.

8.3.4.13 Identification and Justification of Associated Circuits

8 Prior to the implementation stage of the design, the only "associated circuits" (as defined by IEEE 384) known to exist in the ABWR Standard Plant design are in the safety related ~~standby~~ lighting subsystems (see 9.5.3.2.2.1 and 9.5.3.1.3.1). In the implementation design, provide 1) assurance that this is still a true statement, or, 2) specifically identify and justify ~~each~~ any other such circuits in the ABWR SSAR; and show ~~it~~ that they ~~meets~~ meet the requirements of Regulatory Guide 1.75, position C.4.

8.3.4.14 Administrative Controls for Bus Grounding Circuit Breakers

Figures 8.3-1, 8.3-2, and 8.3-3 show bus grounding circuit breakers, which are intended to provide safety grounds during maintenance operations. Administrative controls shall be provided to keep these circuit breakers racked out (i.e., in the disconnect position) whenever corresponding buses are energized. Furthermore, annunciation shall be provided to alarm in the control room whenever the breakers are racked in for service. 12

8.3.4.15 Testing of Thermal Overload Bypass Contacts for MOVs

As indicated in the response to 435.60, thermal overload protection for Class 1E MOVs is bypassed at all times except when the MOV is being tested. A means for testing the bypass ~~contacts~~ function shall be implemented, in accordance with the requirements of Regulatory Guide 1.106. 18

8.3.4.16 Emergency Operating Procedures for Station Blackout

Applicants referencing the ABWR Standard Plant should provide instructions in their plant Emergency Operating Procedures for operator actions during a postulated station blackout event. Specifically, if division I instrumentation is functioning properly, the redundant divisions II, III and IV should be shut down in order to 1) reduce heat dissipation in the control room while HVAC is lost, and 2) conserve battery energy for additional SRV capacity, or other specific functions, as needed, throughout the event. 37

8.3.4.17 Common Industrial Standards Referenced in Purchase Specifications.

In addition to the regulatory codes and standards required for licensing, purchase specifications shall contain a list of common industrial standards, as appropriate, for the assurance of quality manufacturing of both safety and non-safety related equipment. Such standards would include ANSI, ASTM, IEEE, NEMA, UL, etc.

TABLE 8.3-1

D/G LOAD TABLE -LOCA + LOPP

16.11

	SYS. NO.	LOAD DESCRIPTION	RATING (kW)	DIESEL ENGINE OUTPUT (kW) A	B	C	NOTE*
	--	MOTOR ope VALVES	120x3	X	X	X	(2)
435.46 435.59	C12	FMCRD	70x3	X	X	X	(4)
	C41	SLC HEATER	40;10x1	X	X	--	(3)
		SLC PUMP	45x2	47.4	47.4	--	
	E11	RHR PUMP	450x3	526.3	526.3	526.3	
435.46 435.59	E12	HPCF PUMP	1450	--	1606.7	1606.7	
	G31	CUW PUMP	120x2	X	X	--	(6)
	G41	FPC PUMP	75x2	78.9	78.9	--	
	P13	MUWC PUMP	55x3	X	X	X	
	P21	RCW PUMP	250x4	584.8	584.8	--	
435.36 435.59			350x2	--	--	818.8	
	P25	HECW PUMP	22x4	46.3	46.3	--	
		HECW REFRIGERATOR	190x4	400	400	--	
	P41	RSW PUMP**	200x4	467.8	467.8	--	
435.46 435.59			250x2	--	--	584.8	
	P52	IA COMPRESSOR	110x2	X	X	--	(3)
	R23	P/C TRANSF. LOSS	40x6	84.2	84.2	84.2	
	R42	DC 125V CHGR div. I	70x1	98.2	--	--	
435.46 435.59		div. II, III, IV	34x3	47.7	47.7	47.7	(11)
		non-div.	34x2	47.7	47.7		
		DC 250V CHGR	126x2	176.8	--	176.8	

* *See Table 8.3-3 for Notes*
** *Part of Turbine Island*

TABLE 8.3-1

D/G LOAD TABLE - LOCA +LOPP (Continued)

16.11

	SYS. NO.	LOAD DESCRIPTION	RATING (kW)	DIESEL ENGINE OUTPUT (kW) A	B	C	NOTE*
435.46 435.59	R46	VITAL CVCF(non 1E)	20x2	18.9	18.9	--	
		SSLC CVCF	20x4	37.8	18.9	18.9	
		COMP CVCF	150x2	189.5	--	189.5	
	R47	TRANSF. C/R INST	30kVAx3	19.3	19.3	19.3	
		NOR INST	50kVAx2	32.2	32.2	--	
	R52	LIGHTING	100x3	117	117	117	
435.46 435.59	T22	SGTS FAN	16.5x2	17.4	17.4	--	
		SGTS HEATER	25x2	29.2	29.2	--	
	T41	DRYWELL COOLER	18.5x4	X	X	X	(3)
435.46 435.59	T49	FCS HEATER	110x2	128.6	128.6	--	
		FCS BLOWER	11x2	11.6	11.6	--	
	U41	R/B ELEC. ROOM FAN	57.2x6	60.2	60.2	60.2	
		MCR FAN	127.2x2	~~133.9~~	133.9	133.9	
		C/B ELEC. ROOM FAN	38.5x6	40.5	40.5	40.5	
		HX/A FAN	77x3	81.1	81.1	81.1	
		DG FAN	30x6	63.2	63.2	63.2	
		OTHER LOADS		360	120	210	(9)
435.46 435.59		TOTAL		~~3940.3~~ 3812.6	4829.8	~~4645.0~~ 4778.9	

16.11

* *See Table 8.3-3 for Notes*

TABLE 8.3-2

D/G LOAD TABLE - LOPP (w/o LOCA)

16.11

SYS. NO.	LOAD DESCRIPTION	RATING (kW)	DIESEL ENGINE OUTPUT (kW) A	B	C	NOTE*
--	MOTOR ope VALVES	120x3	X	X	X	(2)
C12	FM CRD	70x3	X	X	X	(4)
C41	SLC HEATER	40;10x1	11.7	46.8	--	(3)
	SLC PUMP	45x2	X ~~47.4~~ e	X ~~47.4~~ e	--	(6)
E11	RHR PUMP	450x3	526.3	526.3	526.3	
E12	HPCF PUMP	1450	--	1606.7	1606.7	
G31	CUW PUMP	120x2	126.4 ~~X~~ e	126.4 ~~X~~ e	--	(6)
G41	FPC PUMP	75x2	78.9	78.9	--	
P13	MUWC PUMP	55x3	57.9	57.9	57.9	
P21	RCW PUMP	250x4	584.8	584.8	--	
		350x2	--	--	818.8	
P25	HECW PUMP	22x4	46.3	46.3	--	
	HECW REFRIGERATOR	190x4	400	400	--	
P41	RSW PUMP**	200x4	467.8	467.8	--	
		250x2	--	--	584.8	
P52	IA COMPRESSOR	110x2	115.8	115.8	--	(3)
R23	P/C TRANSF. LOSS	40x6	84.2	84.2	84.2	
R42	DC 125V CHGR div. I	70x1	98.2	--	--	
	div. II, III, IV	34x3	47.7	47.7	47.7	(11)
	non-div.	34x2	47.7	--	47.7	
	DC 250V CHGR	126x2	176.8	--	176.8	

435.46 435.59

435.36 435.59

16.11

16.11

* *See Table 8.3-3 for Notes*
** *Part of Turbine Island*

TABLE 8.3-2

D/G LOAD TABLE -LOPP (W/O LOCA) (Continued)

SYS. NO.	LOAD DESCRIPTION	RATING (kW)	DIESEL ENGINE OUTPUT (kW) A	B	C	NOTE*	
R46	VITAL CVCF(non-1E)	20x2	18.9	18.9	--		
	SSLC CVCF	20x4	37.8	18.9	18.9		
	COMP CVCF	150x2	189.5	--	189.5		
R47	TRANSF. C/R INST	30 kVAx3	19.3	19.3	19.3		
	NOR INST	50 kVAx3	32.2	32.2	--		
R52	LIGHTING	100x3	117	117	117		
T22	SGTS FAN	16.5x2	17.4	17.4	--		
	SGTS HEATER	25x2	29.2	29.2	--		
T41	DRYWELL COOLER	18.5x4	19.5	19.5	39.0	(3)	16.10
T49	FCS HEATER	110x2	X	X	--	(8)	
	FCS BLOWER	11x2	X	X	--	(8)	
U41	R/B ELEC. ROOM FAN	57.2x6	60.2	60.2	60.2		16.11
	MCR FAN	127.2x2	~~133.9~~	133.9	133.9		
	C/B ELEC. ROOM FAN	38.5x6	40.5	40.5	40.5		
	HX/A FAN	77x3	81.1	81.1	81.1		
	DG FAN	30x6	63.2	63.2	63.2		
	OTHER LOADS		360	120	210	(9)	
	TOTAL		~~4011.2~~ 3956.3	~~4881.9~~ 4960.9	~~4789.6~~ 4913.5		16.11

435.46 & 435.59

* *See Table 8.3-3 for Notes*

TABLE 8.3-3

NOTES FOR TABLES 8.3-1 AND 8.3-2

(1) --: shows that the load is not connected to the switchgear of this division.
X: shows that the load is not counted for D/G continuous output claculation by the reasons shown on other notes.

(2) "Motor operated valves" are operated only 30-60 seconds. Therefore they are not counted for the DG continuous output calculation.

(3) LOADS are shed with ~~LOCA~~ LOPP signal, but resequenced on to D/G if LOCA is not present. 16.10

(4) FMCRD operating time (about 2 minutes) is not counted for the DG continuous output calculation.

435.46 435.59 (5) Deleted

(6) CUW pump will not operate under LOCA condition. CUW pump may operate under LOPP condition, but will not operate with SLC pump. On this calculation, the CUW pump is considered and the SLC pump is not since the CUW motor is the larger of the two.

435.46 435.59 (7) Deleted

(8) FCS will not operate under LOPP condition.

435.46 435.59 (9) Deleted

(10) Deleted

(11) Div. IV battery charger is fed from Div. i motor control center.

(12) Load description acronyms are interpeted as follws:

435.46 435.59

C/B	- Control Building	HX	- Heat Exchanger
COMP	- Computer	IA	- Instrument Air
CRD	- Control Rod Drive	MCR	- Main Control Room
CUW	- Clean Up Water	MUWC	- Make Up Water System (condensed)
CVCF	- Constant Voltage Constant Frequency	NPSS	- Nuclear Protection Safety System
DG	- Diesel Generator	R/B	- Reactor Building
FCS	- Flammability Control System	RCW	- Reactor Cooling Water (building)
FPC	- Fuel Pool Cooling	RHR	- Residual Heat Removal
FMCRD	- Fine Motion Cotrol Rod Drive	RSW	- Reactor Sea Water
HECW	- Emergency Cooling Water	SBGT	- Standby Gas Treatment
HPCF	- High Pressure Core Flooder	SLC	- Standby Liquid Control

36.1

Table 8.3-4

D/G LOAD SEQUENCE DIAGRAM
MAJOR LOADS
(Response to Questions 435.14 & 435.15)

Mode	Block Time Div.	BLOCK 1 (SEC) 20	BLOCK 2 (SEC) 30	BLOCK 3 (SEC) 35	BLOCK 4 (SEC) 40	BLOCK 5 (SEC) 45	BLOCK 6 (SEC) 50	BLOCK 7 (SEC) 55	BLOCK 8 (SEC) 60	BLOCK 9 AFTER SEC Manual 65	
LOPP	I	MOV Inst. Tr Lighting	D/W Cooling Fan DG HVAC	RCW Pump HECW Pump	RCW Pump MCR HVAC	RSW Pump R/B Emer. HVAC C/B Emer. HVAC	RSW Pump Hx/A Emer. HVAC	FMCRD MUWC Pump SGTS	Chargers CVCFs	SLC Pump HECW Refrig IA Compres. SLC Heater	RHR Pump CUW Pump FPC Pump SPCU Pump
LOPP	II	MOV ~~HPCF Pump*~~ Inst. Tr Lighting	D/W Cooling Fan DG HVAC	RCW Pump HECW Pump	RCW Pump MCR HVAC	RSW Pump R/B Emer. HVAC C/B Emer. HVAC	RSW Pump Hx/A Emer. HVAC	FMCRD MUWC Pump SGTS	Chargers CVCFs	SLC Pump HECW Refrig IA Compres. SLC Heater	RHR Pump CUW Pump FPC Pump
LOPP	III	MOV ~~HPCF Pump*~~ Inst. Tr Lighting	D/W Cooling Fan DG HVAC	RCW Pump	RCW Pump	RSW Pump R/B Emer. HVAC C/B Emer. HVAC	RSW Pump Hx/A Emer. HVAC	FMCRD SGTS	Chargers CVCFs		RHR Pump
LOCA & LOPP	I	MOV Inst. Tr Lighting	RHR Pump DG HVAC	RCW Pump HECW Pump	RCW Pump MCR HVAC	RSW Pump R/B Emer. HVAC C/B Emer. HVAC	RSW Pump Hx/A Emer. HVAC	FMCRD MUWC Pump SGTS	Chargers CVCFs	SLC Pump HECW refrig	FCS FPC Pump SPCU Pump
LOCA & LOPP	II	MOV HPCF Pump* Inst. Tr Lighting	RHR Pump DG HVAC	RCW Pump HECW Pump	RCW Pump MCR HVAC	RSW Pump R/B Emer. HVAC C/B Emer. HVAC	RSW Pump Hx/A Emer. HVAC	FMCRD MUWC Pump SGTS	Chargers CVCFs	SLC Pump HECW Refrig	FCS FPC Pump
LOCA & LOPP	III	MOV HPCF Pump* Inst. Tr Lighting	RHR Pump DG HVAC	RCW Pump	RCW Pump	RSW Pump R/B Emer. HVAC C/B Emer. HVAC	RSW Pump Hx/A Emer. HVAC	FMCRD SGTS	Chargers CVCFs		

Note* In case of the failure of RCIC pump startup.

TABLE 8.3-5

ABWR Battery Division I Two-Hour Load Capacity Analysis
(Assumes no load shedding - based on IEEE 485-1978)

34 * (new)

T(low): 70 MinCellV: 1.75

Period	Load	LoadChng	PerTime	SecTime	K Factor	SecSize
1: A1=	1000	1000	1	120	3.1	3100
2: A2=	573	-427	1	119	3.1	-1323.7
3: A3=	339	-234	3	118	3.1	-725.4
4: A4=	405	66	1	115	3.05	201.3
5: A5=	338	-67	4	114	3.04	-203.68
6: A6=	405	67	1	110	3	201
7: A7=	339	-66	4	109	2.9	-191.4
8: A8=	405	66	1	105	2.7	178.2
9: A9=	339	-66	4	104	2.6	-171.6
10: A10=	405	66	1	100	2.4	158.4
11: A11=	339	-66	39	99	2.3	-151.8
12: A12=	340	1	60	60	2	2
Total:						1073.32

(Only the highest of 12 calculated sections is selected.)

Summary of All Data

Maximum Section Size:	1073
+ Random Section Size:	0
* Temperature Correction (1.04):	1116
* Design Margin (1.15):	1284
* Aging Factor (1.25):	1605
TOTAL AMPERE HOURS REQUIRED (2 HOURS):	1605
BATTERY RATING FOR DIVISION I:	4000
ADDITIONAL MARGIN (AMPERE-HOURS):	2395
% ADDITIONAL MARGIN:	149

Legend

T(low): Lowest expected electrolyte temperature.
MinCellV: Minimum allowable cell voltage / # cells (105/60).
Period: Time interval in which current is assumed constant.
Load: Current load during Period (in Amperes).
LoadChng: Change in load from previous Period (in Amperes).
PerTime: Duration of Period (in minutes).
SecTime: Time to end of Section (in minutes).
K Factor: Battery capacity at SecTime minute rate.
SecSize: Required Section size (in Ampere-Hours).

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34
*
(*PW)

TABLE 8.3-6

ABWR Battery Division I Eight-Hour Load Capacity Analysis
(Assumes no load shedding - based on IEEE 485-1978)

T(low): 70 MinCellV: 1.75

Period	Load	Loadchng	PerTime	SecTime	K Factor	SecSize
1: A1=	1000	1000	1	480	8.21	8210
2: A2=	573	-427	1	479	8.21	-3505.67
3: A3=	339	-234	3	478	8.2	-1918.8
4: A4=	405	66	1	475	8.19	540.54
5: A5=	338	-67	4	474	8.19	-548.73
6: A6=	405	67	1	470	8.17	547.39
7: A7=	339	-66	4	469	8.16	-538.56
8: A8=	405	66	1	465	8.15	537.9
9: A9=	339	-66	4	464	8.14	-537.24
10: A10=	405	66	1	460	8.13	536.58
11: A11=	339	-66	39	459	8.12	-535.92
12: A12=	340	1	420	420	7.95	7.95
Total:						2795.44

(Only the highest of 12 calculated sections is selected.)

Summary of All Data

Maximum Section Size:	2795
+ Random Section Size:	0
* Temperature Correction (1.04):	2907
* Design Margin (1.15):	3343
* Aging Factor (1.25):	4179
TOTAL AMPERE HOURS REQUIRED (8 HOURS):	4179
BATTERY RATING FOR DIVISION I:	4000
ADDITIONAL MARGIN (AMPERE-HOURS):	-179
% ADDITIONAL MARGIN:	-4

Legend

T(low): Lowest expected electrolyte temperature.
MinCellV: Minimum allowable cell voltage / # cells (105/60).
Period: Time interval in which current is assumed constant.
Load: Current load during Period (in Amperes).
LoadChng: Change in load from previous Period (in Amperes).
PerTime: Duration of Period (in minutes).
SecTime: Time to end of Section (in minutes).
K Factor: Battery capacity at SecTime minute rate.
SecSize: Required Section size (in Ampere-Hours).

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34
(new)

TABLE 8.3-7

ABWR Battery Divisions II & III Two-Hour Capacity Analysis
(Assumes no load shedding - based on IEEE 485-1978)

T(low): 70 MinCellV: 1.75

Period	Load	Loadchng	PerTime	SecTime	K Factor	SecSize
1: A1=	448	448	1	120	3.1	1388.8
2: A2=	248	-200	1	119	3.1	-620
3: A3=	252	4	3	118	3.1	12.4
4: A4=	301	49	1	115	3.05	149.45
5: A5=	252	-49	4	114	3.04	-148.96
6: A6=	301	49	1	110	3	147
7: A7=	252	-49	4	109	2.9	-142.1
8: A8=	301	49	1	105	2.7	132.3
9: A9=	252	-49	4	104	2.6	-127.4
10: A10=	301	49	1	100	2.4	117.6
11: A11=	252	-49	39	99	2.3	-112.7
12: A12=	253	1	60	60	2	2
Total:						798.39

(Only the highest of 12 calculated sections is selected.)

Summary of All Data

Maximum Section Size:	798
+ Random Section Size:	0
* Temperature Correction (1.04):	830
* Design Margin (1.15):	955
* Aging Factor (1.25):	1194
TOTAL AMPERE HOURS REQUIRED (2 HOURS):	1194
BATTERY RATING FOR DIVISIONS II & III:	3000
ADDITIONAL MARGIN (AMPERE-HOURS):	1806
% ADDITIONAL MARGIN:	151

Legend

T(low): Lowest expected electrolyte temperature.
MinCellV: Minimum allowable cell voltage / # cells (105/60).
Period: Time interval in which current is assumed constant.
Load: Current load during Period (in Amperes).
LoadChng: Change in load from previous Period (in Amperes).
PerTime: Duration of Period (in minutes).
SecTime: Time to end of Section (in minutes).
K Factor: Battery capacity at SecTime minute rate.
SecSize: Required Section size (in Ampere-Hours).

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34
(new)

TABLE 8.3-8

ABWR Battery Divisions II & III Eight-Hour Capacity Analysis
(Assumes no load shedding - based on IEEE 485-1978)

T(low): 70 MinCellV: 1.75

Period	Load	Loadchng	PerTime	SecTime	K Factor	SecSize
1: A1=	448	448	1	480	8.21	3678.08
2: A2=	248	-200	1	479	8.21	-1642
3: A3=	252	4	3	478	8.2	32.8
4: A4=	301	49	1	475	8.19	401.31
5: A5=	252	-49	4	474	8.19	-401.31
6: A6=	301	49	1	470	8.17	400.33
7: A7=	252	-49	4	469	8.16	-399.84
8: A8=	301	49	1	465	8.15	399.35
9: A9=	252	-49	4	464	8.14	-398.86
10: A10=	301	49	1	460	8.13	398.37
11: A11=	252	-49	39	459	8.12	-397.88
12: A12=	253	1	420	420	7.95	7.95
Total:						2078.3

(Only the highest of 12 calculated sections is selected.)

Summary of All Data

Maximum Section Size:	2078
+ Random Section Size:	0
* Temperature Correction (1.04):	2161
* Design Margin (1.15):	2486
* Aging Factor (1.25):	3107
TOTAL AMPERE HOURS REQUIRED (8 HOURS):	3107
BATTERY RATING FOR DIVISIONS II & III:	3000
ADDITIONAL MARGIN (AMPERE-HOURS):	-107
% ADDITIONAL MARGIN:	-3

Legend

T(low): Lowest expected electrolyte temperature.
MinCellV: Minimum allowable cell voltage / # cells (105/60).
Period: Time interval in which current is assumed constant.
Load: Current load during Period (in Amperes).
LoadChng: Change in load from previous Period (in Amperes).
PerTime: Duration of Period (in minutes).
SecTime: Time to end of Section (in minutes).
K Factor: Battery capacity at SecTime minute rate.
SecSize: Required Section size (in Ampere-Hours).

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TABLE 8.3-9

34 (new)

ABWR Battery Division IV Two-Hour Load Capacity Analysis
(Assumes no load shedding - based on IEEE 485-1978)

T(low): 70 MinCellV: 1.75

Period	Load	Loadchng	PerTime	SecTime	K Factor	SecSize
1: A1=	224	224	1	120	3.1	694.4
2: A2=	124	-100	1	119	3.1	-310
3: A3=	127	3	3	118	3.1	9.3
4: A4=	150	23	1	115	3.05	70.15
5: A5=	126	-24	4	114	3.04	-72.96
6: A6=	151	25	1	110	3	75
7: A7=	126	-25	4	109	2.9	-72.5
8: A8=	151	25	1	105	2.7	67.5
9: A9=	126	-25	4	104	2.6	-65
10: A10=	151	25	1	100	2.4	60
11: A11=	126	-25	39	99	2.3	-57.5
12: A12=	127	1	60	60	2	2
Total:						400.39

(Only the highest of 12 calculated sections is selected.)

Summary of All Data

Maximum Section Size:	400
+ Random Section Size:	0
* Temperature Correction (1.04):	416
* Design Margin (1.15):	479
* Aging Factor (1.25):	599
TOTAL AMPERE HOURS REQUIRED (2 HOURS):	599
BATTERY RATING FOR DIVISION IV:	1400
ADDITIONAL MARGIN (AMPERE-HOURS):	801
% ADDITIONAL MARGIN:	134

Legend

T(low): Lowest expected electrolyte temperature.
MinCellV: Minimum allowable cell voltage / # cells (105/60).
Period: Time interval in which current is assumed constant.
Load: Current load during Period (in Amperes).
LoadChng: Change in load from previous Period (in Amperes).
PerTime: Duration of Period (in minutes).
SecTime: Time to end of Section (in minutes).
K Factor: Battery capacity at SecTime minute rate.
SecSize: Required Section size (in Ampere-Hours).

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TABLE 8.3-10

ABWR Battery Division IV Eight-Hour Load Capacity Analysis
(Assumes no load shedding - based on IEEE 485-1978)

34
*
(new)

T(low): 70 MinCellV: 1.75

Period	Load	Loadchng	PerTime	SecTime	K Factor	SecSize
1: A1=	224	224	1	480	8.21	1839.04
2: A2=	124	-100	1	479	8.21	-821
3: A3=	127	3	3	478	8.2	24.6
4: A4=	150	23	1	475	8.19	188.37
5: A5=	126	-24	4	474	8.19	-196.56
6: A6=	151	25	1	470	8.17	204.25
7: A7=	126	-25	4	469	8.16	-204
8: A8=	151	25	1	465	8.15	203.75
9: A9=	126	-25	4	464	8.14	-203.5
10: A10=	151	25	1	460	8.13	203.25
11: A11=	126	-25	39	459	8.12	-203
12: A12=	127	1	420	420	7.95	7.95
Total:						1043.15

(Only the highest of 12 calculated sections is selected.)

Summary of All Data

Maximum Section Size:	1043
+ Random Section Size:	0
* Temperature Correction (1.04):	1085
* Design Margin (1.15):	1248
* Aging Factor (1.25):	1560
TOTAL AMPERE HOURS REQUIRED (8 HOURS):	1560
BATTERY RATING FOR DIVISION IV:	1400
ADDITIONAL MARGIN (AMPERE-HOURS):	-160
% ADDITIONAL MARGIN:	-10

Legend

T(low): Lowest expected electrolyte temperature.
MinCellV: Minimum allowable cell voltage / # cells (105/60).
Period: Time interval in which current is assumed constant.
Load: Current load during Period (in Amperes).
LoadChng: Change in load from previous Period (in Amperes).
PerTime: Duration of Period (in minutes).
SecTime: Time to end of Section (in minutes).
K Factor: Battery capacity at SecTime minute rate.
SecSize: Required Section size (in Ampere-Hours).

~~c:\calc5d/battcap4.8pr~~

~~Record# resolution~~ R

~~36~~ Notes relating to Tables 8.3-5 through 8.3-10 34 (new)

An estimated load demand profile for the 125 VDC batteries was provided in Response 435.38 (SSAR page 20.3-253.21). As explained in that response, this information could change as the design is specified for unique applications.

A load capacity analysis (based on IEEE 485-1978) was performed for both the two-hour and eight-hour periods, using the data provided in Response 435.38. The results are shown in Tables 8.3-5 through 8.3-10.

The two-hour analyses (Tables 8.3-5, -7, and -9) show extensive additional margins. The Division I additional margin is 149% of the required capacity including the 15% design margin and 25% aging factor suggested by IEEE 485.

The eight-hour analyses (Tables 8.3-6, -8, and -10) show that capacities are slightly exceeded when the 15% design margin and 25% aging factor are considered. However, the eight-hour coping is justified for the station blackout scenario for the following reasons:

1. The analyses are highly conservative in that they assume no load shedding. During station blackout, loads would be shed thereby greatly increasing the ampere-hours available.

2. Divisions 2, 3, and 4 are redundant to each other, and as a group redundant to Division I except for the control of the RCIC from the control room. Therefore, the life of the Division I battery could be greatly extended by shedding all of its loads except the RCIC controls.

3. Even with the loads not shed, the capacities are within requirements if the 15% design margin is not applied.

4. The analysis method itself is highly conservative in that loads are considered constant throughout various periods, when, in fact, many are intermittent.

5. The ABWR has three Class 1E diesel generators and a non-Class 1E combustion turbine generator (CTG) on site. This combination of four on-site power sources suggest the probability of a station blackout is very low. In addition, per Regulatory Guide 1.155, the CTG qualifies as an AAC, and precludes the need for a coping analysis (see Sections 3.2.5 and 3.3.5 of Reg. Guide 1.155).

TABLE 8.3-11
DIESEL GENERATOR ALARMS *

ANNUNCIATION	DOS	DTS	DTT	GDT	GCB	GTT	LBP
ENGINE OVERSPEED TRIP	X	X	X		X		
GENERATOR DIFFERENTIAL RELAY TRIP		X		X	X	X	
GENERATOR GROUND OVERCURRENT					X	X	X
GENERATOR VOLTAGE RESTRAINT OVERCURRENT					X	X	X
GENERATOR BUS UNDERFREQUENCY					X	X	X
GENERATOR REVERSE POWER		X			X	X	X
GENERATOR LOSS OF FIELD		X			X	X	X
GENERATOR BUS DIFFERENTIAL RELAY TRIP					X		
HIGH-HIGH JACKET WATER TEMPERATURE		X	X		X		X
D/G BEARINGS HIGH TEMPERATURE		X			X	X	X
LOW-LOW TURBO OIL PRESSURE		X	X		X		X
D/G BEARINGS HIGH VIBRATION		X	X		X		X
HIGH-HIGH LUBE OIL TEMPERATURE		X	X		X		X
LOW-LOW LUBE OIL PRESSURE		X	X		X		X
HIGH CRANK[illegible] PRESSURE		X	X		X		X
LOW-L[illegible]ET WATER PRESSURE		X	X		X		X
LOW [illegible]--JACKET WATER			X				
LOW P[illegible]ESSURE--JACKET WATER			X				
LOW TEMPERATURE--JACKET WATER IN			X				
HIGH TEMPERATURE--JACKET WATER OUT			X				
LOW LEVEL--LUBE OIL MARK			X				
LOW TEMPERATURE--LUBE OIL IN			X				
HIGH TEMPERATURE--LUBE OIL OUT			X				
HIGH DIFF. PRESSURE--LUBE OIL FILTER			X				
LOW PRESSURE--TURBO OIL RIGHT/LEFT BANK			X				
LOW PRESSURE--LUBE OIL			X				
CONTROL CIRCUIT FUSE FAILURE			X				

} See legend below

ANNUNCIATION	DOS	DTS	DTT	GDT	GCB	GTT	LBP
DIESEL GENERATOR OVERVOLTAGE						X	
LOW PRESSURE--STARTING AIR			X				
IN MAINTENANCE MODE			X			X	
D/G UNIT FAILS TO START			X				
D/G PHASE OVERCURRENT						X	
OUT OF SERVICE		X			X		
LOCKOUT RELAY OPERATED		X			X	X	
LOW-HIGH LEVEL--FUEL DAY TANK			X				
LOW LEVEL--FUEL STORAGE TANK			X				
LOW PRESSURE--FUEL OIL			X				
HIGH DIFF. PRESSURE--FUEL FILTER			X				
IN LOCAL CONTROL ONLY			X				

LEGEND:
DOS - Diesel OverSpeed
DTS - Diesel Trip or Service inoperative
DTT - Diesel Trouble or in Test
GDT - Generator Differential Trip
GCB - Generator Circuit Breaker trip
GTT - Generator Trouble or in Test
LBP - LOCA ByPass (i.e., trip bypassed during LOCA) (Not an annunciator window)

* This list may vary depending on unique characteristics of specific diesel generator selected.

REFER TO PROPRIETARY SUBMITTAL

FOR FIGURE 8.3-2

REFER TO PROPRIETARY SUBMITTAL

FOR FIGURE 8.3-4

REFER TO PROPRIETARY SUBMITTAL

FOR FIGURE 8.3-7

REFER TO PROPRIETARY SUBMITTAL

FOR SECTION 9.5.3

AND ASSOCIATED SUBSECTIONS

(4) Ultimate heat sink

430.315 The applicant's fire protection program shall comply with the SRP Section 9.5.1, with ability to bring the plant to safe shutdown condition following a complete fire burnout without a need for recovery.

9.5.13.10 HVAC Pressure Calculations

430.20 The applicant referencing the ABWR design shall provide pressure calculations and confirm capability during pre-operational testing of the smoke control mode of the HVAC systems as described in Subsection 9.5.1.0.6.

9.5.13.11 Plant Security Systems Criteria

The design of the security system shall include an evaluation of its impact on plant operation, testing, and maintenance. This evaluation shall assure that the security restrictions for access to equipment and plant regions is compatible with required operator actions during all operating and emergency modes of operation (i.e., loss of offsite power, access for fire protection, health physics, maintenance, testing and local operator). In addition, this evaluation shall assure that:

910.10 (a) There are no areas within the Nuclear Island where communication with central and secondary alarm stations is not possible;

(b) Portable security radios will not interfere with plant monitoring equipment;

(c) Minimum isolation zone and protected area illumination capabilities cannot be defeated by sabotage actions outside of the protected area; and,

(d) Electromagnetic interference from plant equipment startups or power transfers will not create nuisance alarms or trip security access control systems.

9.5.13.12 Fire Hazard Analysis

A compliance review of the as built design against the assumptions and requirements stated in the fire hazard analysis (Appendix 9A) shall be conducted. Any non compliance shall be documented as being required and acceptable on the basis of the Fire Hazard Analysis, Appendix 9A, and the Fire Hazard Probabilistic Risk Assessment, Appendix 19M.

insert "E" below

9.5.14 References

1. Stello, Victor, Jr., *Design Requirements Related To The Evolutionary Advanced Light Water Reactors (ALWRS)*, Policy Issue, SECY-89-013, The Commissioners, United States Nuclear Regulatory Commission, January 19, 1989.

2. Cote, Authur E., *NFPA Fire Protection Handbook*, National Fire Protection Association, Sixteenth Edition.

3. *Design of Smoke Control Systems for Buildings*, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., September 1983.

4. *Recommended Practice for Smoke Control Systems*, NFPA 92A, National Fire Protection Association, 1988.

28.15 (new)

Insert "E"

9.5.13.13 The utility applicant shall provide a detailed periodic inspection, testing, and maintenance procedure for the standby and emergency lighting systems electrical power for operation. Each division also has its own cooling water supply, diesel generator and room cooling system. For the shutdown cooling function each division has its own suction line from and return line to the RPV. Thus each of the three RHR divisions is completely independent of the other divisions in its shutdown cooling function. The RHR system reduces the primary system temperature to 51.7°C within 24 hours of plant shutdown.

Normally, in evaluating component failure considerations associated with RHR system shutdown cooling mode operation, active pumps, valves or instrumentation would be assumed to fail. If the single active failure criterion is applied to the RHR system, one of the three RHR divisions would be inoperable. However, the two operable RHR divisions could achieve cold shutdown to 100°C within 36 hours after reactor shutdown.

Failure of offsite power is another case which could affect the shutdown cooling function. The plant will have two independent offsite power supplies. If both offsite power supplies are lost, each RHR division has its own diesel generator which will permit operating that division at its rated capacity. Application of the single active failure criterion would still leave two RHR divisions operational.

3.1 The RHR system description and performance evaluation in Subsection 5.4.7 describes the models, assumptions and results for shutdown cooling with ~~two~~ RHR ~~divisions operational.~~ various operating conditions.

15.2.10 References

1. F. G. Brutshscy, et al., *Behavior of Iodine in Reactor Water During Plant Shutdown and Startup*, August 1972 (NEDO-10585).

2. H. Creway, V. Nguyen, and P. Stancavage, *Radiological Accident-The CONAC03 CODE*, December 1981 (NEDO-21143-1).

Refer to proprietary submittal

for Section 19E.2.1.2.2.2

RESPONSE 435.2

The ABWR plant design has the capability to maintain core cooling during the station blackout.

Upon loss of AC off-site and on-site power, the RCIC system will be initiated and provides water to the reactor vessel from the condensate storage tank. The condensate storage tank has sufficient water capacity to provide core cooling to the reactor vessel. The suppression pool is another water source which can be used during the station blackout if the condensate storage tank becomes low.

37.8 The RCIC system and 8 (6) safety relief valves (SRVs) derive their power from the Division I DC bus, which is capable of delivering 4000 ampere hours. These will support RCIC equipment for a minimum of eight hours.

An alternate AC (AAC) power source is available from an on-site combustion turbine generator (CTG), should all other power sources fail. However, the plant is capable of coping with a station blackout without the need for the CTG. The design bases and description of the CTG is provided in Subsection 9.5.11.

Station blackout performance is discussed in detail in Subsection 19E.2.1.2.2.

QUESTION 435.3

Section 8.1.2.1 of the ABWR SSAR states that the transfer of the Class 1E buses to the alternate preferred power source is a manual transfer. This seems to contradict sections 3.1.2.2.9.2.1 and 3.1.2.2.9.2.2 which indicate that the transfer is automatic. Please clarity, and if the transfer is automatic provide details on the type of transfer (slow, fast, make-before-break, etc.), the signals used to initiate transfer, and how the transfer is accomplished.

RESPONSE 435.3

Subsection 3.1.2.2.9.2 has been revised in Amendment 7 to reference Chapter 8. The transfer from the normal preferred to the alternate preferred power source is manual.

QUESTION 435.4

(a) In section 8.2.3 of the ABWR SSAR one of the Nuclear Island interfaces identified is four 6.9 kV feeders to four transformers powering ten RIP pumps. However figure 8.3-1 and figure 8.3-2 show motor generator sets between two of the 6.9 kV feeders and the RIP pumps. Please clarify whether the motor generator sets will be used in the ABWR design and if so, describe their function.

(b) Also, with regard to the same subject, section 15.3.1.1.1 states that since four buses are used to supply power to the RIPS, the worst single failure can only cause three RIPs to trip, and the frequency of occurrence of this event is estimated to be less than 0.001 per [illegible]. Further down in this same section a statement is made that the probability of additional RIP trips is low (less than 10^{-6} per year). Justify these figures in light of the fact that historically, a total loss of offsite power occurs about once per 10 site-years (NUREG/CR-3992). Also, has the effect of a fault on the common feeder upstream of the 6.9 kV feeders been considered with respect to the coastdown capability of the RIPS and motor generator sets (braking effect)?

RESPONSE 435.4

(a) Motor generator sets are used in the ABWR design. Their primary function is to provide additional mechanical inertia to extend the coastdown time of the connected RIPs during a bus failure transient. With the adoption of motor-generator set design, the probability of having an all RIPs trip is virtually eliminated.

Replace with Insert "A"

(b) A RIP reliability analysis is included in. This analysis estimates the probability that exactly 1, 2, ... 10 out of ten RIPs will trip. The results are shown in the following:

# OF PUMPS TRIPPED	PROBABILITY
1	5.57E-3
2	1.07E-4
3	1.64E-3
4	6.44E-6
5	4.36E-5
6	6.37E-7
7	1.41E-7
8	<< 1.00E-6
9	<< 1.00E-6
10	<< 1.00E-6

This analysis includes the effect of a fault on the common feeder upstream of the 6.9 kV feeders. However, the effect of a total loss of offsite power is not included. This is because the reactor system response to a total loss of offsite power is more than a trip of RIPs. For example, a load rejection followed by a reactor scram will be initiated after a loss of offsite power. The complete discussion of the loss of offsite power event is contained in Subsection 15.2.6.

2.1 (new)

QUESTION 435.5

(a) Section 8.2.3 identifies the nominal voltage and number of feeders interfacing between the Nuclear Island and remainder of plant power systems; but they do not specify any interface requirements such as voltage and frequency tolerances, available fault current, loading, availability, etc., that are necessary to completely define the required interfaces. Please provide the information.

(b) You also need to provide additional information on the power sources (Unit Transformer, Startup Transformer, etc.) and the way they are configured to provide power to the RIP pumps in order to support the availabilities claimed for these power sources in section 15.3.1. We suggest a one-line diagram similar to that which you provided in your presentation to the staff on September 14, 1988, be included in the ABWR SSAR to better define this interface.

RESPONSE 435.5

(a) Subsection 8.2.3 has been revised to provide the updated interface definition.

(b) The electrical system single line (Figure 8.3-1) has been revised (per attached) to provide additional information on the power sources (Main Transformer, Auxiliary Transformers, etc.) and the way they are configured to provide power to the RIP pumps in order to support the abilities claimed for these power sources in Section 15.3.1.

QUESTION 435.6

Section 8.3.1.1.4.1 and Figure 8.3-4 briefly describe the 120 VAC Safety-Related Instrument Power System. This is interruptible power backed up by the divisional diesel generators. Please identify the major loads and type of instrument loads fed by this system.

Record# Answer

3 ~~The reference statement in Section 15.3.1.1.1 of the SSAR, specifying that no single failure shall cause an inadvertent trip of more than three RIPs, is a design requirement on the on-site RIP power supply equipment. Faults in the off-site circuit which result in a loss of AC power to plant equipment are analyzed in Section 15.2.6 of the SSAR. The Section 15.2.6 evaluations do address a loss of power to the on-site RIP power supply equipment.~~

An analysis is provided in Appendix 15C to the SSAR which demonstrates that the combined probability of events resulting in a trip of more than three RIPs is less than 1E-6. This analysis includes main generator trips, faults on the common feeder upstream of the 6.9 kV feeders (braking effect), and loss of off-site power, thereby bounding any postulated faults in the off-site circuit. The analysis results, as provided in Amendment 15, are listed below.

No. of Pumps Tripped	Probability
1	0.113/yr
2	0.028/yr
3a (w/o coastdown)	0.36/yr
3b (w/ coastdown)	Negligible*
4	Negligible*
5	Negligible*
6	Negligible*
7	Negligible*
8	Negligible*
9	Negligible*
10	Negligible*

2.1 (new)

* < 1.0E-6/yr

As explained in Section 15C.4, the failure of power to the Motor/Generator (M/G) sets does not generally constitute a trip of the RIPs powered by the M/G sets.

Insert "A"

RESPONSE 435.18

(a) If a LOCA occurs just after a LOPP but prior to load sequencing of the LOPP loads, the following events occur:

(1) Following a LOPP the 6.9 KV emergency bus loads are shed and the diesel generator output is connected to the diesel bus. This function is not dependent upon a LOCA.

(2) When a LOCA occurs (just after the LOPP) and when the 6.9 KV emergency bus voltage is greater than 70%, the load sequence timers start and apply the appropriate 6.9 KV emergency bus LOPP and LOCA loads at preset times.

(b) If a LOCA occurs in the middle of a LOPP loading sequence, sequencing of loads that are applied to the 6.9 KV emergency bus after a LOPP will continue without interruption. The drywell cooling fans will be tripped off the bus if they have been started. All other auto-loaded LOPP loads are required for LOCA and will remain on the buses. The diesel generators are capable of accepting the load blocks in any loading order.

(c) If a LOCA occurs following completion of the LOPP sequence, loads which are only applied to the 6.9 KV emergency bus in the event of a LOCA will be sequenced onto the bus. Loads not required for a LOCA are tripped off.

(d) In the event of a LOCA following completion of a LOPP sequence, LOPP loads required for LOCA remain on the bus, but others are tripped off. Additional loads required for a LOCA are sequenced onto the bus. 16.13

(e) Non-Class 1E loads are tripped by a LOCA signal and not by a LOPP. 16.10

(f) The diesel generator circuit breaker is not tripped to accomplish the LOCA loading following a LOPP response.

QUESTION 435.19

Section 8.3.1.1.7(4) states that if a LOCA occurs when the diesel generator is paralleled with the preferred power source during test 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. Because the diesel generator is not available to automatically respond to the LOCA in this circumstance it is considered to be bypassed and automatic indication of the bypass should be provided in the control room in accordance with RG 1.47. Please verify that this is the case.

RESPONSE 435.19

Section 8.3.1.1.7(5) has been changed to read:

"If a LOCA occurs when the diesel generator is paralled with either the normal preferred power or the alternate preferred power source, the D/G 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."

QUESTION 435.20

In section 8.3.1.1.7(5) the description of what occurs following a LOPP during a diesel generator paralleling test with the normal preferred power source is different from that described for a paralleling test with the alternate preferred power source. In the first case it is stated that the diesel generator circuit breaker is

The 13 second starting period has been changed to 20 seconds for conservatism.

(b) The details of the diesel generator design are beyond the scope of the Licensing Review Bases (LRB) document, ~~It is therefore an interface requirement that this response be provided by the applicant.~~ and cannot be provided until the specific diesal supplier is selected. An interface requirement has been added to address this question after that selection (see 8.3.4.2). 36.3

QUESTION 435.22

Section 8.3.1.1.8.5 lists the diesel engine and its generator breaker protective trips and other off-normal conditions that are annunciated in the main control room and/or locally. Please identify which of these conditions are annunciated in the main control room and which are annunciated locally.

With regard to the diesel generator alarms in the control room. A review of malfunction reports of diesel generators at operating nuclear plants has uncovered that in some cases the information available to the control room operator to indicate the operational status of the diesel generator may be imprecise and could lead to misinterpretation. This can be caused by the sharing of a single annunciator station to alarm conditions that render a diesel generator unable to respond to an automatic emergency start signal and to also alarm abnormal, but not disabling, conditions. Another cause can be the use of wording of an annunciator window that does not specifically say that a diesel generator is inoperable (i.e., unable at the time to respond to an automatic emergency start signal.) when in fact it is inoperable for that purpose.

Review and evaluate the alarm and control circuitry for the diesel generators in the ABWR design to determine how each condition that renders a diesel generator unable to respond to an automatic emergency start signal is alarmed in the control room. These conditions include not only the trips that lock out the diesel generator start and require manual reset, but also control switch or mode switch positions that block automatic start, loss of control voltage, insufficient starting air pressure or battery voltage, etc. This review should consider all aspects of possible diesel generator operational conditions, for example test conditions and operation from local control stations. One area of particular concern is the unreset condition following a manual stop at the local station which terminates a diesel generator test and prior to resetting the diesel generator controls for enabling subsequent automatic operation.

Provide the details of your evaluation, the results and conclusions, and a tabulation of the following information:

(a) all conditions that render the diesel generator incapable of responding to an automatic emergency start signal for each operating mode as discussed above;

(b) the wording on the annunciator window in the control room that is alarmed for each of the conditions identified in (a);

(c) any other alarm signals not included in (a) above that also cause the same annunciator to alarm;

(d) any condition that renders the diesel generator incapable of responding to an automatic emergency start signal which is not alarmed in the control room; and

(e) any proposed modifications resulting from this evaluation. For additional information and the staff position on this item see Branch Technical Position (BTP) PSB-2 in the Standard Review Plan (NUREG-0800). Describe how the ABWR design meets each position of BTP PSB-2.

RESPONSE 435.22

The list in Subsection 8.3.1.1.8.5 has been ~~revised to distinguish between the local and control room annunciations~~ tabulated, along with the requested information, and is provided as Table 8.3-11. 17 * (new)

The diesel generator, auxiliary systems and circuitry are unique depending on the supplier. Likewise, conditions which could render the diesel generator unable to respond to automatic emergency start signals could vary, depending on the unique design of the units. Such a detailed analysis is hardware specific, and therefore

RESPONSE 435.25

The design meets the requirements of PSB-1. Subsections 8.1.3.1.2.3(6) and 8.3.1.2.1(3) have been revised accordingly. A new Subsection 8.3.1.1.7(8) has been added to describe the degraded voltage protection provided for the safety related buses.

QUESTION 435.26

Clarify statement (1)(b) of section 8.3.1.2.2 regarding conformance of the SSLC power supply to GDC 2, 4, 17, and 18. If the SSLC power supply is not in conformance with any part of the GDCs, so state and justify.

RESPONSE 435.26 Replace with Insert "A" attached

~~A line was missing in the first submittal and has been added so that it is consistent with similar statements in other sections.~~

3 ~~The statement is intended to mean that the SSLC power supply complies with all portions of the listed GDCs which are applicable to this type of power supply. There are no non-compliances, but some portions of the GDCs are not applicable at this level (for example, the statement in GDC 17 about two physically independent circuits from the transmission network).~~

QUESTION 435.27

Section 8.3.1.2.2 states that the SSLC redundancy is based on the capability of any two of the four divisions to provide the minimum safety functions necessary to shut down the unit in case of an accident and maintain it in the safe shutdown condition. Why can't the unit be shut down in case of an accident with only one of the four divisions available? Identify the systems or loads needed that require that two of the four divisions be available.

RESPONSE 435.27

Subsection 8.3.1.2.2 was incorrect and has been revised accordingly. The reactor can be safely shut down from the control room with any one of the three load groups available.

QUESTION 435.28

In section 8.3.1.2.4, item (1) states that certified proof tests are performed on cable samples to certify 60 year life by thermal aging. Subsequent items, (2) thru (5), identify various cable attributes such as radiation resistance, mechanical/electrical endurance, flame resistance, and level of gas evolution that are also demonstrated by certified proof tests performed on cable samples. Do the tests identified in items (2) thru (5) demonstrate that the cables have an acceptable level of the particular attributes at the end of their 60 year life? How is this demonstrated?

RESPONSE 435.28

The thermal aging test is the inclusive test that proves a reasonable expectancy of a 60-year life for the cable. The other tests, items (2) through (5), prove that individual parameters such as flame resistance, radiation resistance, etc. have a reasonable expectance of remaining within acceptable limits of change for each parameter over the 60-year life of the plant. (See Subsection 8.3.4.3)

Record# answer
3 ~~Response 436.26 has been modified as follows:~~

Insert "A"

3

All conformance statements in the analysis sections of Chapter 8 have been modified to state full compliance without the applicability caveat (see attached).

There are no non-conformances with the GDCs. The 'as applicable' statements were intended only to differentiate between those portions of the GDCs we interpreted to be applicable to the plant as a whole, rather than to individual systems or components. However, it is better to delete such statements if they are construed to mean any degree of non-conformance.

~~With regard to the CVCF power supplies, they are ultimately fed from their respective 6.9KV divisional buses (see Figures 8.3-1, 8.3-3 and 8.3-6). Each 6.9KV divisional bus is connectable to two offsite sources (prefered and alternate perfered) and two onsite sources (EDG and CTG).~~

(c) Provide the fault current clearing-time curves of the electrical penetrations' primary and secondary current interrupting devices plotted against the thermal capability (I*I*t) curve of the penetration (to maintain mechanical integrity). Provide a simplified one-line diagram on this drawing showing the location of the protective devices in the penetration circuit, and indicate the maximum available fault current of the circuit.

(d) Where external control power is needed for tripping electrical penetration breakers, signals for tripping the primary and backup breakers should be independent, physically separated and powered from separate sources. Verify that your design complies and identify the power supplies to the redundant circuit breakers.

RESPONSE 435.31

5 (a) ~~The physical separation between redundant penetrations meets the requirements for cables and raceways given in Section 6.1.5 of IEEE 384-1981.~~ Insert B here 5

(b) It is a design requirement that redundant overcurrent interrupting devices be provided for electrical circuits going through containment penetrations, if the maximum available fault current (including failure of upstream devices) is greater than the continuous current rating of the penetration.

(c) The detail design for the current interrupting devices for the electrical penetrations has not been performed and is beyond the scope of the Licensing Review Bases (LRB) document. It is an interface requirement for the applicant to supply this information.(See Subsection 8.3.4.4)

(d) In general, breakers and starters will be backed up by properly selected current limiting fuses. Smaller circuits will employ redundant fuses. Specific identification of power supplies for redundant breakers, if utilized, is an interface requirement to be supplied by the applicant.(See Subsection 8.3.4.4)

QUESTION 435.32

Section 8.3.1.4.2.1 identifies the standards that are used for the separation of equipment for the systems referred to in subsection 7.1.1.3, 7.1.1.4, and 7.1.1.6 (safety-related control and instrumentation systems). IEEE 384-1974 however is not listed. The separation of equipment in these systems should comply with the requirements of this standard. Please verify that this is the case.

In addition, the listed standards and requirements are not identified as being applicable to subsection 7.1.1.5 (safety-related display instrumentation). Please verify that they are indeed applicable to this subsection.

RESPONSE 435.32

IEEE 384 is addressed in Tables 7.1-2 and 8.1-1, as endorsed by Regulatory Guide 1.75. Since the requirements of this guide envelope and endorse IEEE 384, it is not necessary to address IEEE 384 separately. However, we assumed the augmentations of the guide apply equally to IEEE 384-1981, because that version is the certification standard (see Table 1.8-21).
4 To be consistent with the Standard Review Plan format (SRP Tables 7-1, 7-2 and 8-1), and to avoid unnecessary redundancy in the text, we have not addressed the IEEE standards separate from the Regulatory Guides which endorse them. However, since IEEE 379 was inadvertently mentioned in addition to RG 1.53, we have modified and clarified the paragraph per the attached mark-up.

Also, the separation requirements do apply to the Safety Related Display. Therefore, a reference to Subsection 7.1.1.5 has been added.

QUESTION 435.33

Items (4) and (5) in section 8.3.1.4.2.2.2 state that spatial separation in general plant areas and in cable spreading areas shall equal or exceed the minimum allowed by IEEE 384. IEEE384-1974 however provides two means for establishing minimum physical separation distances. The first, which is specified in section 5.1.1.2 of

Record# comments

6 The following insert replaces 435.31(a).

Insert "B"

5 * (new)

(a) The separation of elect[illegible] penetration assemblies exceeds the requirements for cables and raceways given [illegible]ion 6.1.5 of IEEE 384-1981.

Separation by distance (without barriers) is allowed only within the inerted containment. Here the minimum allowable distances of 3 feet horizontal and 5 feet vertical between penetrations apply, as delineated in Section 6.1.5 of IEEE 384-1981.

For the other ends of the penetrations, which are outside the containment in the non-inerted areas, separation by distance alone is not allowed. These will be separated by separate rooms, or barriers, or different floor levels. Such walls, barriers or floors are 3-hour fire-rated.

Such separation criteria applies to the following:

1. Between redundant penetrations,
2. Between penetrations containing non-Class 1E and penetrations containing Class 1E or associated Class 1E circuits.
3. Between penetrations containing Class 1E circuits and other divisional or non-divisional cables.

The lesser distances allowed by IEEE 384 for enclosed raceways does not apply to the containment penetrations.

the standard allows the minimum separation distance to be established by analysis based on tests of the proposed cable installation. The second, which is specified in sections 5.1.3 and 5.1.4 of the standard, specifies specific minimum physical separation distances that must be maintained.

Please clarify whether you intend to meet the specific distances specified in the standard or whether you intend to establish your own separation distances through analysis based on tests. The prefereble option is to meet the specific distances specified in IEEE 384-1974.

RESPONSE 435.33

which is either equivalent or more stringent than IEEE 384-1974 in all areas.

5.1c In accordance with the Licensing Review Bases (LRB) document, the certification is based on IEEE 384-1981. The specific separation distances listed in IEEE 384-1981 will be met wherever possible and practical. In addition, the ABWR will provide separation by fire barriers sufficient to meet the requirements of letter SECY-89-013. As the detail design proceeds, specific instances which can best be resolved by analysis may arise. Identification of such cases is an interface requirement for the applicant.(See Subsection 8.3.4.5)

QUESTION 435.34

(a) Section 8.3.1.4.2.2.4 discusses the use of isolation devices in power circuits. It states that non-Class 1E instrument and control circuits will not be energized from a Class 1E power supply unless potential for degradation of the Class 1E power source can be demonstrated to be negligible by effective current or voltage limiting (i.e., functional isolation) under all design basis conditions. Please explain what this means. Does it imply that no isolation device will be used if no credible failure modes can be identified that will result in fault currents? Qualified isolation devices should be used in all cases where a non-Class 1E circuit is connected to a Class 1E power supply.

(b) It also states in section 8.3.1.4.2.2.4 that Class 1E power supplies which interface non-Class 1E circuits are required to be disconnected or otherwise decoupled from the non-Class 1E circuits such that conditions of the non-Class 1E portion of the system cannot jeopardize the Class 1E portions (e.g., by a current limiting element). Verify that, if overcurrent interrupting devices such as fuses or circuit breakers are used as isolation devices, redundant qualified interrupting devices will be used at the Class 1E/non-Class 1E interfaces. List all the locations where there is an interface between a Class 1E power supply and non-Class 1E circuit. Identify the isolation device that is used at the interface.

(c) Where redundant Class 1E power circuits interface with a common non_Class 1E system such as a computer, the isolation devices used should ensure that a worst case abnormal occurence (fault, overvoltage, voltage surge or spike, etc.) on one of the Class 1E power circuits cannot migrate through the non-Class 1E system and affect the redundant Class 1E circuit. This is in addition to the normal criteria for isolation devices that require that any worst case occurences (maximum credible faults, etc.) in the non-Class 1E system not affect the Class 1E system.

RESPONSE 435.34

(a) The discussion under Subsection 8.3.1.4.2.2.4 means that qualified isolation devices will be used in all cases where a non-Class 1E circuit is connected to a Class 1E power supply. Subsection 8.3.1.4.2.2.4 has been rewritten (per attached) to better define the use of isolation devices.

(b) See revised Subsection 8.3.1.1.2.1 for locations and type of isolation devices used between Class 1E power supplies and non-Class 1E circuits. A single Class 1E isolation breaker is used, but in addition to the normal coordinated trip devices, zone selective interlocking is used. This insures that unless there is a failure of the Class 1E isolation breaker, the Class 1E bus feed breaker or the Class 1E current sensing and tripping devices, the isolation breaker and not the Class 1E bus feed breaker will always trip if there is a fault at any location in the non-Class 1E system. Load circuit faults on the non-Class 1E system will normally trip their load breaker without tripping the bus isolation breaker. The large difference in the total size of the Class 1E loads versus the total size of the non-Class 1E loads, roughly 2 to 1, provides a wide margin between the time current curves of the Class 1E feed breaker and the non-Class 1E isolation breaker.

(c) Precautions are taken to ensure that a worst case abnormal occurrence on one of the Class 1E circuits cannot migrate through a non-Class 1E system into another Class 1E division. For example, power for the computer is supplied by non-Class 1E uninterruptable power supplies that are powered by non-Class 1E bus extensions of the Divisions I and III Class 1E buses. The non-Class 1E buses are isolated from the Class 1E buses as described in the revised Subsection 8.3.1.1.2.1. The uninterruptable power supplies will prevent disturbance on one Class 1E bus from passing to the other Class 1E bus, via the computer. Signal isolation for computer input circuits is by fiber optic cables.

QUESTION 435.35

Item (4) of section 8.3.1.4.2.3.1 states that the scram solenoid conduits will have unique identification but no specific separation requirements, and the scram group conduits may run in the same raceway with other divisional circuits. If the scram group conduits are run in the same raceway with other divisional circuits or if they have less than the minimum separation from Class 1E circuits, they must be treated as associated circuits and must meet the requirements specified in section 4.5 of IEEE 384-1974. Please verify that this is the case, and identify the specific separation requirements that will be applied to the scram group conduits when they become associated circuits.

RESPONSE 435.35

The statement in item (4) related to "no specific separation requirements" was not correct. There are specific separation requirements for the conduits containing the RPS wiring associated with each of the four scram groups, i.e., the conduits required from the scram actuating devices to the scram solenoid fuse panels, and from the fuse panels to the two solenoids of each of the individual scram pilot valves. Subsection 8.3.1.4.2.3.1 has been completely revised as per attached pages.

Individual grounded steel conduits will be provided to contain the scram solenoid wiring of each of the four scram groups to protect this wiring from hot shorts to any other wiring. Individual conduits will also be provided for the A solenoid wiring and for the B solenoid wiring in the same scram group.

The routing and identification of the scram group conduits is discussed in 8.3.1.4.2.3.1(6)

~~The scram group conduits will have unique identification and will be treated essentially as if they are separate enclosed raceways, i.e., the conduits containing the scram solenoid group circuit wiring will be physically separated from raceways which contain either divisional or "non-divisional" (non-safety-related) circuits. Any scram group conduit may be routed alongside of any raceway containing either safety-related circuits (of any division), or any raceway containing non-safety-related circuits, as long as the conduit itself is not within the boundary of the raceway which contains either the divisional or non-safety-related circuits. Each scram conduit will be physically separated by at least one (1) inch from either metal enclosed raceways or non-enclosed raceways.~~

QUESTION 435.36

Item (6) of section 8.3.1.4.2.3.2 states that any electrical equipment and/or raceways for RPS or ESF located in the suppression pool level swell zone will be designed to satisfactorily complete their function before being rendered inoperable due to exposure to the environment created by the level swell phenomena. This information is not sufficient for us to evaluate the effects on flooding of electrical equipment. Please identify all electrical equipment, both safety and non-safety, that may become submerged as a result of the suppression pool level swell phenomena or as a result of a LOCA. For all such equipment that is not qualified for service in such an environment provide an analysis to determine the following:

(a) The safety significance of the failure of this equipment (e.g., spurious actuation or loss of actuation function) as a result of flooding.

(b) The effects on Class 1E electrical power sources serving this equipment as a result of such submergence, and

(c) Any proposed design changes resulting from this analysis.

RESPONSE 435.36

14 Class 1E ~~E~~lectrical equipment that may be submerged as a result of suppression pool level swell phenomena, or as the result of a LOCA, is ~~as follows:~~ required to meet the environmental requirements of IEEE 323 (see section 3.11). Such equipment is identified as follows:

(1) Suppression pool temperature monitors (48 each): Temperature monitors are required for safety. Electrical wiring for each sensor is to be terminated, for sensor replacement or maintenance, in the wetwell. The design specifications require that terminations be sealed such that operation would not be impaired by submersion due to pool swell or LOCA.

(2) Suppression pool level monitors (6 each) and suppression chamber pressure monitors (2 each): This equipment is required for safety. The level and pressure transmitters are located outside of the wetwell. Therefore, their operation will not be impaired by pool swell or LOCA.

(3) Suppression chamber free volume temperature monitors (4 each): Temperature monitors are required for safety. The design specifications require that terminations be sealed such that operation would not be impaired by submersion due to pool swell or LOCA.

QUESTION 435.37

In the description of the DC power system in section 8.3.2.1 it is stated that the operating voltage range of Class 1E DC loads is 105 to 140 V. It is also stated that the maximum equalizing charge voltage for Class 1E batteries is 140 VDC, and the DC system minimum discharge voltage at the end of the discharge period is 1.75 VDC per cell.

For a 125 VDC lead acid battery with 60 cells, 1.75 VDC per cell equates to a final discharge voltage of 105 VDC at the battery terminals. This is the same as the stated minimum operating voltage of the Class 1E DC loads. There is therefore no allowance for voltage drop from the battery terminals to the terminals of the Class 1E loads at the final voltage value of 1.75 VDC per cell. Please address this discrepancy.

Also, provide the results of your DC voltage analysis showing battery terminal voltage and worst case DC load terminal voltage at each step of the Class 1E battery loading profile. See the following question with regard to the battery loading profile.

RESPONSE 435.37

The required operating range for DC loads is 100 to 140 VDC. This leaves 5 volts for the voltage drop from the battery terminals to the terminals of the Class 1E loads. Subsection 8.3.2.1 has been corrected accordingly.

A worst case DC voltage analysis is beyond the scope of the SSAR, as defined by the Licensing Review Bases (LRB) document. However, it is an interface requirement for this to be performed as part of the detail design of the plant.(See Subsection 8.3.4.6)

QUESTION 435.38

Section 8.3.2.1 addresses the DC power systems in general and section 8.3.2.1.3.2 specifically addresses battery capacity. With regard to battery capacity, section 8.3.2.1.3.2 states that battery capacity is sufficient to satisfy a safety load demand profile under the conditions of a LOCA and loss of preferred power, and the batteries have sufficient stored energy to operate connected essential loads continuously for at least two hours without recharging.

(a) Provide the stated load demand profiles and a breakdown of the loading during this demand.

(b) Provide the manufacturer's ampere-hour rating of the batteries at the two hour rate and at the eight hour rate, and provide the one minute ampere rating of the batteries.

(c) Address station blackout with regard to battery capacity. If a station blackout coping analysis is being prepared for the ABWR, provide a battery load demand profile for the coping duration. Provide a breakdown of the loading during this demand.

RESPONSE 435.38

(a) Based on information available as of September, 1989, the load demand profile for the 125V batteries under LOCA conditions with loss of preferred power is estimated as follows:

Min.	Div I Amps	Div II Amps	Div III Amps	Div IV Amps	Total
0 - 1	1000	448	448	224	2121
1 - 2	573	248	248	124	1193
2 - 5	339	252	252	127	968
5 - 6	405	301	301	150	1157
6 - 10	338	252	252	126	968
10 - 11	405	301	301	151	1158
11 - 15	339	252	252	126	969
15 - 16	405	301	301	151	1158
16 - 20	339	252	252	126	969
20 - 21	405	301	301	151	1158
21 - 60	339	252	252	126	969
60 - 120	339	252	252	126	969

Rated AH	4000	3000	3000	1400
AH / 2 hrs	702.3	514.5	514.5	257.2

(b) The manufacturer's ampere-hour rating of the batteries at the two hour rate, the four hour rate and the one minute ampere rating is beyond the License Review Bases (LRB) document definition. (See Subsection 8.3.4.1) c 6

34 (c) During a station blackout, Divisions II, III and IV will be powered down to an output of essentially zero. The load demand on Division I will be intermittant as the RCIC cycles on and off and will be equal to, or less than, the value shown above for Division I during any two hour period. For additional information related to dealing with a station blackout refer to the response to Question 435.002.

(c) If the T/B MCCs are non-Class 1E identify the isolation devices used and the interface requirements.

RESPONSE 435.49

(a) The feeds for 480V switchgear P/C 6A-1, P/C 6A-2, P/C 6B-1, and P/C 6B-2 are shown on revised Figure 8.3-1. These are the non-class 1E 480V switchgear for the plant. They feed all of the 480V non-safety loads except those few non-Class 1E loads which are fed from Class 1E buses as indicated in revised Figure 8.3-3.

(b) P/C 6SB-1 (P/C SB-1) provides power to motor control centers which are primarily used for maintenance outages. The cross ties to the safety-related buses were for maintenance outages also. The cross ties have been removed.

(c) The motor control centers are spotted in the listed buildings to be accessible during maintenance outages. The motor control centers are non-Class 1E and are fed from non-Class 1E power centers.

QUESTION 435.50

The non-safety related instrument power system shown in Figure 8.3-4 has two redundant Class 1E power feeds to it. Identify the isolation devices used between the Class 1E and non-Class 1E systems. A Class 1E circuit breaker tripped on a LOCA signal or two redundant Class 1E circuit breakers coordinated with the upstream MCC feeder breaker are acceptable isolation devices.

RESPONSE 435.50

The non-safety related instrument power supplies are fed from the non-Class 1E extensions of the Class 1E 480 V buses. See the revised Subsection 8.3.1.1.2.1 (see response to Question 435.9) for a description of the isolation between the Class 1E buses and the non-Class 1E extension buses.

QUESTION 435.51

On figures 8.3-5, 8.3-6, 8.3-7, and 8.3-8 describe the function and operation of the various devices that are identified by device numbers. Also, on figures 8.3-7 and 8.3-8 define the acronym SID located next to the diode device. Describe the function and operation of this device.

RESPONSE 435.51

Figures 8.3-5, -6, -7 and -8 have been revised. However, the meaning to the numeric codes on the new figures are as follows:

27 - AC undervoltage relay.
Operates when AC voltage drops below predefined minimum value.

64 - Ground overcurrent relay. Uses voltage to detect grounded circuit.

76 - DC overcurrent relay.

80 - DC undervoltage relay.

84 - Voltage relay. Operates at a specified voltage for DC or AC circuits.

"SID" is the acronym for silicone diode. However, this diode and associated switch have been removed ~~When the batteries are on float charge the battery terminal voltage is about 129 VDC and the diode shorting switch is closed. When the battery is placed on equalizing charge, the terminal voltage is increased to about 140 VDC and the shunting switch for the diode is opened so that the diode is in series with the battery. The diode has an almost constant voltage drop of approximately 10 volts over the forward current range of 10% to 100% of its current rating. This functions to maintain~~

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*
(new)

~~constant voltage at the distribution panel as load current varies during the time that the battery is on equalizing charge.~~ 35

QUESTION 435.52

On figure 8.3-7 "125 VDC Power System" describe the function and operation of the various key interlocks shown on the figure.

RESPONSE 435.52

The key interlocks on the output of the standby chargers insure that a standby charger is only connected to one load at a time. The key interlocks on the inputs of the standby chargers insure that the standby charger is connected to only one input feed at a time.

The key interlocks on the output of the normal chargers prevent the normal charger and the standby charger from being simultaneously connected to the load.

QUESTION 435.53

On figure 8.3-8 "250 VDC Power System" describe the type of isolation provided between the Class 1E divisional power feeds and the non-Class 1E DC Power System. Also describe the type of isolation and separation provided between the power feed from P/C 6E-1 (Division III) and the power feed the P/C 6C-1 (Division I).

RESPONSE 435.53

Figure 8.3-8 has been revised and subject power feeds are now identified as P/C CN1 and P/C DN1. These power feeds come from non-Class 1E extensions of buses P/C C1 and P/C D1 and are therefore non-Class 1E. See revised Figure 8.3-3 and the responses to Questions 435.9 and 435.40 for a description of the method used to achieve electrical isolation.

QUESTION 435.54

With regard to the classification of structures, components, and systems in Table 3.2-1; item R1 "DC Power Supply - Nuclear Island" and item R2 "Auxiliary AC Power System" are very general in their present form. We have therefore determined that Table 3.2-1, items R1 and R2, should be expanded to include the following list of items. Please incorporate these items into Table 3.2-1 adding any additional items necessary to make it a complete list.

<u>R1 DC Power Supply - Nuclear Island</u>

125 volt batteries, battery racks, battery chargers, and distribution equipment
Control and power cables (including underground cable system, cable splices, connectors and terminal blocks)
Conduit and cable trays and their supports
Protective relays and control panels
Containment electrical penetration assemblies
Motors

Valve operations have been evaluated in the design. If inadvertent open operation has unacceptable safety consequences, two valves are placed in series on the pipe with logic segregation such that no single electrical failure can open both valves. Likewise, if inadvertent close operation has unacceptable safety consequences, two valves are placed in parallel on the pipe with logic segregation such that no single electric failure can close both valves. The power disconnect option is therefore unnecessary and is not used.

QUESTION 435.58

Experience with nuclear power plant Class 1E electrical system equipment protective relay applications has established that relay trip setpoint drifts with conventional type relays have resulted in premature trips of redundant safety related system pump motors when the safety system was required to be operative. While the basic need for proper protection for feeders/equipment agains perminent faults is recognized, it is the staff's position that total non-availability of redundant safety systems due to spurious trips in protective relays is not acceptable.

Provide a description of your circuit protection criteria for safety systems/equipment to avoid incorrect initial setpoint selection and the above cited protective relay trip setpoint drift problems.

RESPONSE 435.58

The ABWR design is such that there are no single failures of electrical protective devices which could cause loss of function of redundent systems. This will minimize the probability of simultaneous trips.

User devices such as motors will be purchased with sufficient overload margins for set points of protective devices to be set sufficiently above the operating point to allow for setpoint drift. Setpoint methodology is detailed in the "Instrument Setpoints Design Requirements" document referenced in Section 1.1.3. 20

QUESTION 435.59

Explicitly identify all non-Class 1E electrical loads which are or may be powered from the Class 1E AC and DC systems. For each load identified provide the horsepower or kilowatt rating for that load and identify the corresponding bus number and division from which the load is powered.

Also identify the type of isolation device used between the non-Class 1E load and Class 1E power supply.

RESPONSE 435.59

In Appendix 20B under "POWER SOURCE", the following 480V buses are powered by Class 1E AC systems and are used to power Non-Class 1E AC loads: 480V P/C CN1, DN1 and EN1. (See Figure 8.3-3.) These buses power instrument air compressors, 250 chargers, CVCFs for the computer power supplies and motor control centers (MCCs) for smaller loads. Loads on the MCCs are also shown in Appendix 20B. The electrical division from which each load is powered is identified in Appendix 20B. All of the loads on these diesel-fed, non-safety power center buses and associated MCCs are included in the D/G load summary tables, Tables 8.3-1 through 8.3-3. Their estimated power requirements are also shown on the tables. The actual KW rating for each load cannot be identified until vendor data is received during the bid/purchasing phase.

Isolation between non-Class 1E buses P/C CN1, DN1 and EN1, and Class 1E buses P/C C1, D1 and E1 is described in revised Subsection 8.3.1.1.2.1 (See response to Question 435.9).

Non-Class 1E DC loads powered by Class 1E DC systems are powered from non-Class 1E buses DCN A10, DCN B10, DCN C10 and DCN D10. Load and electrical division information for these buses is shown in Appendix 20B.