GE Nuclear Energy

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Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: Submittal Supporting Accelerated ABWR Schedule - **ABWR Station Blackout Considerations**

Dear Chet:

Enclosed is the final version of Appendix 1C, "ABWR Station Blackout Considerations," (Enclosure 1). This replaces the draft version of this appendix provided in my letter dated April 30, 1993 addressing DFSER Confirmatory Item 9.2.13-1.

Also included is a SSAR markup (Enclosure 2) supporting the final version of Appendix 1C.

Please provide copies of this transmittal to Charlie Thomas and Butch Burton.

Sincerely,

Jack Fox

Jack Fox
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ENCLOSURE 1

Appendix 1C

ABWR STATION BLACKOUT CONSIDERATIONS

(ABWR DESIGN COMPLIANCE WITH 10CFR50.63)

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1C.1 INTRODUCTION

This appendix describes (a) how the ABWR Design addresses Station Blackout (SBO) Events; (b) how the ABWR Design complies with 10CFR50.63 SBO requirements; and (c) where supporting documentation to these conformances exist in the ABWR SSAR.

1C.2 DISCUSSION

1C.2. Station Blackout (SBO) Definitions

For the ABWR design the definitions of Station Blackout, Alternate AC (AAC) Power Source, and Safe Shutdown given in 10CFR50.02 are provided below:

- **Station Blackout**

"*Station blackout* means the complete loss of alternating current (AC) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., the loss of offsite electric power system concurrent with turbine trip and unavailability of the onsite emergency AC power system). Station blackout does not include the loss of available AC power to buses fed by station batteries through inverters or by alternate AC sources as defined in this section, nor does it assume a concurrent single failure or design basis accident."

- **Alternate AC Power Source**

"*Alternate AC source* means an alternating current (AC) power source that is available to and located at or nearby a nuclear power plant and meets the following requirements:

(1) Is connectable to but not normally connected to the offsite or onsite emergency AC power systems;

(2) Has minimum potential for common mode failure with offsite power or the onsite emergency AC power sources;

(3) Is available in a timely manner after the onset of station blackout; and

(4) Has sufficient capacity and reliability for operation of all systems required for coping with station blackout and for the time required to bring and maintain the plant in safe shutdown (non-design basis accident)."

- **Safe Shutdown (SSD)**

"*Safe shutdown (non-design basis accident (non-DBA))* for station blackout means bringing the plant to those shutdown conditions specified in plant technical specifications as Hot Standby or Hot Shutdown, as appropriate..."

1C.2.2 Plant SBO Design Basis

1C.2.2.1 General SBO Design Basis

- The ABWR design will mitigate station blackout events as defined in Section 1C.2.1.

- The ABWR design will comply with 10CFR50.63 requirements relative to the loss of all alternating current power sources.

- The ABWR design will include and utilize an Alternate AC (AAC) power source to comply with 10CFR50.63 requirements and the recommendations for ALWRs, as defined by the NRC in SECY90-016.

- The ABWR design will be consistant with Regulatory Guideline 1.155 and NUMARC 87-00 guidelines relative to an AAC power source.

- The ABWR design AAC power source will supplement and compliment the current off-site AC power connections, the on-site normal AC power sources (transformers), the on-site emergency AC power sources (DGs) and the on-site DC power sources.

1C.2.2.2 Specific SBO Design Basis

- The ABWR AAC power source will be a combustion turbine generator (CTG).

- The normal design function of the CTG will be to act as a standby , non-safety -related power source for the plant investment protection (PIP) non-safety -related loads during loss of preferred power (LOPP) events.

- The CTG will be capable of being manually configured to provide power to a selected safety-related emergency bus within 10 minutes during SBO events.

- The CTG will automatically start, accelerate to rated speed, reache rated voltage and frequency and be ready to accept PIP loads within two minutes of the receipt of its start signal.

- The CTG will be a diverse, self contained unit (including its auxiliarries) and will be independent of the plant preferred and emergency power sources.

- The target reliability of the GTG will be >0.95, as calculated by NSAC-108 methodology.

- The CTG will have capacity to supply the required safe shutdown loads.
- The CTG will be housed in a Uniform Building Code structure which is protected from adverse site weather related conditions.
- The CTG design will minimize potential for single point failure vulnerability with onsite emergency power sources.
- Adequate pneumatic pressure and water make-up sources will be available throughout the SBO duration.
- The ABWR design will confine the SBO duration to 10 minutes or less with the use of the alternate AC power source.
- The CTG will be controllable locally or from the MCR.
- Provisions will be made to facilitate the orderly restoration of off-site and on-site power source during the SBO event.
- Special quality assurance and control practices will be applied to the CTG.
- Special equipment requirements will be applied to the CTG support components.
- The CTG will utilize a separate fuel oil storage tank and transfer system from that of the on-site emergency power sources.
- The CTG will operate during the SBO event without external AC power sources .
- The standby function of the CTG will be to mitigate LOPP or SBO events.
- Dual manually operated circuit breakers will separate the CTG from the on-site emergency power buses.
- The AAC power source will utilize the available station and/or internal batteries for breaker control and initial CTG starting functions.
- The CTG Fuel Oil Supply will be periodically inspected and the oil analyzed.

- The CTG operation will be subject to plant operation, maintenance and testing procedures.
- All operator actions required during SBO events will be demonstrated by training exercises and will be according to appropriate plant procedures.
- CTG power will be used to restore various selected plant environmental control components (HVAC, chillers, etc.) as soon as possible.
- The CTG will not normally be used to provide power connected to the plant loads.
- The CTG will be capable of being inspected, tested, and maintained.
- The CTG capabilities will be demonstrated prior to shipment, during initial pre-operational test, and periodically during power operation.
- Required plant core cooling and containment integrity during the SBO duration (10 minutes) will not depend on any AC power sources.

1C.2.3 Plant SBO Safety Analysis

1C.2.3.1 Plant Event Evaluations

1C.2.3.1.1 Plant Normal Operation

The normal configuration of the on-site AC power distribution system and its individual power sources are described in SSAR Subsections 8.2.1 and 8.3.1. The CTG (AAC) system attributes and its interconnections are described in Subsection 9.5.11 and in Subsection 8.3.1, respectively. Both are shown on SSAR Figure 8.3-1.

The normal preferred AC power sources supply safety -related and non-safety -related loads. Power to these loads are supplied from the unit auxiliary transformers (UATs) units and the reserve auxiliary transformer (RAT).

The CTG is designed to supply standby power to the non-Class 1E 6.9 Kv buses which carry the plant investment protection (PIP) loads. The CTG automatically starts on detection of under voltage on the PIP buses. When the CTG is ready to assume load, if the voltage is still deficient, power automatically transfers to the CTG. (Refer to Figure 8.3-1.)

The CTG can also supply non-Class 1 power to the power generation buses which supply feedwater and recirculating water pumps. These buses normally receive power from the unit auxiliary transformers and supply power to the plant investment protection (PIP) buses through a cross-tie. The cross-tie automatically opens on loss of power but may be manually reclosed if it is desired to operate a condensate or feedwater pump from the combustion turbine generator or the reserve auxiliary transformer which are connectable to the PIP buses. This arrangement allows the powering of load groups of non-class 1E equipment in addition to the Class 1E divisions which may be used to supply water to the reactor vessel. (Refer to Figure 8.3-1.)

1C.2.3.1.2 LOPP Events

The ABWR on-site emergency power sources during LOPP events are the diesel generator (DG) units. These units and their system responses are discussed in SSAR Subsection 8.3.1.1.8. However, the CTG is available to provide backup emergency power during LOPP to safety-related loads by manual reconfiguration of the CTG and the loads.

1C.2.3.1.3 SBO Events

The CTG is the AC power source during an SBO event. The CTG can supply safe shutdown buses through the realignment of pre-selected breakers during SBO events. The CTG will reach operational speed and voltage in 2 minutes and will be available for bus connection within 10 minutes. Upon a LOPP, the CTG is automatically started and configured to non-safety -related PIP loads. Plant operators using appropriate procedures will reconfigure any of the emergency buses to accept CTG power. Refer to SSAR Sections 8.3.1.1.7 and 9.5.11.

1C.2.3.1.4 Other Operational Capabilities

The CTG can be used for postulated prolonged SBO scenarios.

Up to the limits of its capacity, the CTG can be connected to any combination of Class 1E and non-Class 1E buses to supply loads in excess of the minimum required for safe shutdown.

The ABWR design provides for local and main control room operation of the CTG. Communication is available between the CTG area and the main control room.

1C.2.3.2 Alternative AC Power Source Evaluation

The alternate AC power source (1) is a combustion turbine generator, (2) is provided with an immediate fuel supply that is separate from the fuel supply for other onsite emergency AC power systems, (3) fuel will be sampled and analyzed consistent with applicable standards, (4) is capable of operating during and after a station blackout without any AC support systems powered from the preferred power supply or the blacked-out units Class 1E power sourcest (5) is designed to power all of the PIP and/or Class 1E shutdown loads necessary within 10 minutes of the onset of the station blackout, such that the plant is capable of maintaining core cooling and containment integrity (6) will be protected from design basis weather events (except seismic and tornado missiles) to the extend that there will be no common mode failures between offsite preferred sources and the combustion turbine generator power source, (7) will be subject to quality assurance guidelines commensurate with its importance to SBO, (8) will have sufficient capacity and capability to supply one division of Class 1E loads, (9) will have sufficient capacity and capability to supply the required non-Class 1E loads used for a safe shutdown, (10) will undergo factory testing to demonstrate its ability to reliably start, accelerate to rated speed and voltage and supply power within two minutes, (11) will not normally supply power to nuclear safety-related equipment except under specific conditions, (12) will not be a single point single failure detriment to onsite emergency AC power sources, and (13) will be subject to site acceptance testing; periodic preventative maintenance, inspection, testing; operational reliability assurance program goals.

Based on the above, the ABWR design for the Alternate AC power supply complies with 10CFR50.63, with Regulatory Guide 1.155 and with NUMARC 87-00 and meets the SBO rule.

1C.2.4 Plant Conformance With SBO Requirements

A brief review of the general ABWR design conformance with various SBO requirements and guidelines is given below. A more complete in-depth and specific review of each of the SBO regulatory requirements or guidelines is given in the enclosed tables. (Refer to Tables 1C.2-1 thru 1C.2-3.)

1C.2.4.1 10CFR50.63 Requirements

The ABWR complies with the 10CFR50.63 requirements. Special attention was given to the regulation definition of the SBO event, the event conditions, and the requirement for safe shutdown status. The ABWR utilizes the AAC power source option and provides an evaluation of the requirements/compliances in Table 1C.2-1.

1C.2.4.2 New ALWR Requirements (SECY 90-016)

A review of the new ALWR SBO requirements in SECY90-016 recommendations was conducted. The ABWR design is in compliance with the ALWR recommendations.

1C.2.4.3 Regulatory Guide 1.155 Guideline Requirements

A review of the ABWR CTG design relative to Sections 3.3.5, 3.3.6, 3.3.7, 3.4 and Appendix A and B of RG.1.155 was conducted. STET design fully complies with the cited requirements. The use of the CTG as an AAC power source in the ABWR design eliminates the need for a SBO coping analyses by limiting the SBO duration to 10 minutes or less. No operator action is required within the initial ten minutes. Refer to Table 1C.2-2.

1C.2.4.4 NUMARC 87-00 Guidelines

A review of the ABWR CTG design relative to the NUMARC SBO guidelines, Sections 7.1.1 and 7.1.2 and Appendices A and B was conducted. The ABWR design with CTG is consistant with the NUMARC guidelines. Refer to Table 1C.2-3.

1C.2.5 Other SBO Considerations

Several other SBO considerations are identified below for special compliance or consideration.

1C.2.5.1 Plant Technical Specifications

Surveillance and operational requirements are needed for the CTG in order to assure its reliability or maintainability. However, these will be part of the COL-Applicant maintenance, testing, and inspection procedures. These procedures will not be part of technical specifications.

1C.2.5.2 Design Interface Requirements

The CTG has a limited number of design interface requirements. Fuel oil is initially supplied from a local tank, and then transferred from a fuel oil storage tank, both of which are independent of the DG fuel oil tanks. A seven (7) day oil supply for the CTG sufficient for shutdown loads will be available on-site. The local CTG I&C is powered by the unit itself or supplied from station batteries. Other auxiliary functions are an integral part of the CTG unit.

1C.2.5.3 Station Blackout Procedures

Appropriate procedures will include the use of the CTG and are a COL applicant responsibility. The procedures will consider specific instructions for operation actions responses, timing and related matters during SBO events. The operator actions will include power source switching, load shedding, etc.

1C.2.5.4 Equipment Qualification, Testing and Reliability

The CTG will be qualified (as a non-Class 1E AAC power source) for its intended duties and service. Qualification testing, equipment inspections, and reliability data will be made available.

1C.2.5.5 Periodic Surveillance, Testing, Inspection and Maintenance

Operational reliability assurance program (ORAP) requirements will be established for the CTG.

1C.2.5.6 Power and Control Cable Routing

The CTG power and control cable routing is physically and electrically separated from other power sources to the extent practical. A suggested routing is shown in SSAR Figure 8.2-1.

1C.2.5.7 Plant Battery Recharging

The CTG is capable of recharging the plant batteries during SBO scenarios while supplying safe shutdown loads.

1C.2.5.8 Plant HVAC Restoration Capabilities

The CTG is capable of restoring environmental control components during the SBO duration while supplying the safe shutdown loads.

The Main Control Room environment will not exceed its design basis temperature even during a prolonged SBO event. With the CTG available in ten minutes, MCR HVAC can be restored.

1C.2.5.9 Circuit Breaker Operation

During the realignment of the CTG from non-safety -related buses to safety-related buses, at least two breakers will need to be manually closed. The current plant battery power will be utilized to control these breakers.

The current SBO requirement that at least one emergency bus be powered within ten minutes is achieved by the manual operation of the two breakers between the CTG and the selected emergency bus (see Figure 8.1-3).

In order to maintain a minimum number of direct connections between the CTG and any of the three Class 1E emergency buses, only one Class 1E bus has its supply breaker racked in. It can therefore be controlled directly from the main control room. The other emergency buses have their supply breakers racked out, and therefore, require local operator action to rack in the breakers before main control room operation is available.

1C.2.5.10 CTG - Physical Protection Considerations

The CTG is housed in a building (separate from the building which contains the DGs) above the design flood levels. The building is designed to protect the CTG from site related weather conditions.

1C.3 CONCLUSIONS

In summary:

- The ABWR design will utilize a combustion turbine generator (CTG) as its Alternate AC (ACC) power source in complying with 10CFR50.63 SBO.
- The ABWR design complies with 10CFR50.63 and RG1.155 and is consistant with NUMARC 87-000 guidelines.
- The ABWR design can successfully prevent or mitigate the consequences of an SBO event.

1C.4 REFERENCES

(1) SECY-90-016, *Evolutionary LWR Certification Issues and Their Relationship To Current Regulatory Requirements*, January 12, 1990.

(2) Letter J. Taylor to S. Chilk, *Evolutionary LWR Certification Issues and Their Relationship To Current Regulatory Requirements*, June 26, 1990.

(3) 10CFR50.63, *Loss of All Alternating Current Power (Station Blackout-SBO)*, July 21, 1988.

(4) RG-1.155, *Station Blackout*, July 1988.

(5) NUMARC 87-00, *Guidelines and Technical Bases For NUMARC Initiative Addressing Station Blackout at LWRs* Plus Supplemental Q/A s January 4, 1990.

(6) 10CFR50.02, Definitions.

Table 1C.2-1

ABWR DESIGN COMPLIANCE WITH 10CFR50.63 REGULATIONS

Requirements	Compliance
§ 10CFR50-63 Loss of all alternating current power.	

Table 1C.2-1

ABWR DESIGN COMPLIANCE WITH 10CFR50.63 REGULATIONS (Continued)

Requirements	Compliance
§ 50.63 Loss of all alternating current power. (a) *Requirements*. (1) Each light-water-cooled nuclear power plant licensed to operate must be able to withstand for a specified duration and recover from a station blackout as defined in § 50.2. The specified station blackout duration shall be based on the following factors:	The ABWR design will utilize an alternate AC (AAC) power source to mitigate and recover from station blackout events (defined in 50.2). The AAC power source will be a combustion turbine generator (CTG). The CTG will be totally independent from off-site and on-site emergency sources. A ten (10) minute interval is used as the ABWR design basis for the SBO event duration. The AAC power source provides a diverse power source to the plant. The ABWR design CTG will have sufficient capacity and capabilities to power the necessary reactor core coolant, control and protective systems including station battery and other auxiliary support loads needed to bring the plant to a safe and orderly shutdown condition (defined in 50.2). The CTG supplied will be rated at a minimum of 9 MWe and be capable of accepting shutdown loads within 10 minutes.
(i) The redundancy of the onsite emergency ac power sources	The current plant onsite emergency power sources include three (3) independent and redundant DG divisions which are designed to supply approximately 5 MWe within 1 minute. The DG emergency power sources are also capable of providing power for the SBO event, when available. Additionally, the plant has been designed to accommodate ac power source losses for a period up to 8 hours. The AAC limits the SBO event to 10 minutes.

(a) (Continued) (ii) The reliability of the onsite emergency ac power sources	The current onsite emergency ac power sources will have the following reliability DGs .... 0.975 The GTG will have the following reliability CTG ... 0.95 The above values are used in the ABWR-PRA analysis.

Table 1C.2-1

ABWR DESIGN COMPLIANCE WITH 10CFR50.63 REGULATIONS (Continued)

Requirements	Compliance
(a)(ii) (Continued) (iii) The expected frequency of loss of offsite power; and	The expected frequency of loss of offsite power assumed was 0.1 events/yr.
(iv) The probable time needed to restore offsite power.	The offsite power is expected to be restored within 8 hours.
(2) The reactor core and associated coolant, control, and protection systems, including station batteries and any other necessary support systems, must provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained in the event of a station blackout for the specified duration. The capability for coping with a station blackout of specified duration shall be determined by an appropriate coping analysis. Utilities are expected to have the baseline assumptions, analyses, and related information used in their coping evaluations available for NRC review.	The AAC power source is capable of providing the necessary core, containment and equipment services (e.g. makeup and cooling water, I&C power, etc.) to bring the reactor to hot shutdown and then to cold shutdown conditions. The AAC will limit the SBO duration to 10 minutes. The current plant design assures that during the 10 minute interval, the plant core, containment and other safety functions will be maintained without the use or need for ac power. However, the AAC can operate indefinitely. A seven (7) day supply of oil sufficient for shutdown loads is available on site. Subsequent oil deliveries will be provided.

Table 1C.2-1

ABWR DESIGN COMPLIANCE WITH 10CFR50.63 REQUIREMENTS (Continued)

Requirements	Compliance
(2) (Continued) (b) *Limitation of scope.* (c) *Implementation—(1) Information Submittal.* For each light-water-cooled nuclear power plant licensed to operate after the effective date of this amendment, the licensee shall submit the information defined below to the Director by 270 days after the date of license issuance. (i) A proposed station blackout duration to be used in determining compliance with paragraph (a) of this section, including a justification for the selection based on the four factors identified in paragraph (a) of this section;	In addition to the discussion under (a) above, the following is noted. The ABWR design SBO duration time considerations are consistant with RG1.155 and NUMARC-87-00. Upon loss of off-site power (LOPP) and upon the subsequent loss of all on site AC emergency power sources (three independent and redundant DGs), the CTG can be manually connected to any one of the three safety-related (Class 1E) busses by closing two circuit breakers. The alternative AC (AC) power source will automatically start, and within 2 minutes be up to rated speed and voltage. It will then automatically connect to selected PIP buses (non Class 1E) loads. During the first 10 minutes, the reactor will have automatically tripped, the main steam isolation valves (MSIVs) closed, and the RCIC actuated. The RCIC system will automatically control reactor coolant level. Any necessary relief valve operation will also be automatic. Within the 10 minute SBO interval, none of the above actions will require AC power or manual operator actions. The reconfiguration of the CTG to pick up the Class 1E buses will require manual closure of two circuit breakers from the control room. Upon restoration of power to the safety bus(es), the remaining safe shutdown loads will be energized.

Table 1C.2-1

ABWR DESIGN COMPLIANCE WITH 10CFR50.63 REGULATIONS (Continued)

Requirements	Compliance
(c) (Continued (ii) A description of the procedures that will be implemented for station blackout events for the duration determined in paragraph (c)(1)(i) of this section and for recovery therefrom; and (iii) A list of modifications to equipment and associated procedures, if any, necessary to meet the requirements of paragraph (a) of this section, for the specified station blackout duration determined in paragraph (c)(1)(i) of this section, and a proposed schedule for implementing the stated modifications.	Appropriate plant procedures will be developed by the COL applicant for the ABWR design. These procedures be integrated/coordinated with the plant EOPs, using the EOP methodology. Procedures will consider instructions for operator actions, responses, timing, and related matters during the SBO event. Modifications to equipment and procedures is not applicable since the use of an AAC source and other SBO considerations are included in the ABWR design.

Table 1C.2-1

ABWR DESIGN COMPLIANCE WITH 10CFR50.63 REGULATIONS (Continued)

Requirements	Compliance
(2) Alternate ac source: The alternate ac power source(s), as defined in § 50.2, will constitute acceptable capability to withstand station blackout provided an analysis is performed which demonstrates that the plant has this capability from onset of the station blackout until the alternate ac source(s) and required shutdown equipment are started and lined up to operate. The time required for startup and alignment of the alternate ac power source(s) and this equipment shall be demonstrated by test. Alternate ac source(s) serving a multiple unit site where onsite emergency ac source are not shared between units must have, as a minimum, the capacity and capability for coping with a station blackout in any of the units. At sites where onsite emergency ac sources are shared between units, the alternate ac source(s) must have the capacity and capability as required to ensure that all units can be brought to and maintained in safe shutdown (non-DBA) as defined in § 50.2. If the alternate ac source(s) meets the above requirements and can be demonstrated by test to be available to power the shutdown buses within 10 minutes of the onset of station blackout, then no coping analysis is required. (3) *Regulatory Assessment:* (4) *Implementation Schedule:* (53 FR 23215, June 21, 1988)	The ABWR CTG will be automatically initiated upon the loss of power to the PIP buses. The CTG will achieve rated speed and voltage within 2 minutes. The CTG will be manually connected to safe shutdown loads with 10 minutes. These equipment capabilities will be demonstrated 1) by the manufacturer's component tests and 2) by the CTG initial start-up tests and 3) periodically by the COL-applicant as part of his operational reliability assurance program. The ABWR design is a single unit plant arrangement design. The CTG AAC source is available to power shutdown loads within 10 minutes as described above. Therefore, no coping analysis is required. In addition, the ABWR is designed with an 8-hour battery to accomodate station blackout without the need for AC power. Also, the three independent emergency diesel generator systems will accomodate one DG out of service, plus a single failure, with the remaining DG capable of bringing the plant to safe shutdown.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
RG1.155 - Station Blackout **REGULATORY POSITION** 3.3.5 If an AAC power source is selected specifically for satisfying the requirements for station blackout, the design should meet the following criteria:	
1. The AAC power source should not normally be directly connected to the preferred or the blacked-out unit's onsite emergency ac power system.	The ABWR AAC power source is not normally connected to the preferred or the on-site emergency AC power system. Two open circuit breakers – one Class IE and the other non-Class IE – separate the CTG from the safety-related emergency buses. The AAC power source is also not normally connected to any of the preferred AC power sources or their associated non-safety related buses. A non-Class IE circuit breaker separates the CTG from the PIP buses.
2. There should be a minimum potential for common cause failure with the preferred or the blacked-out unit's onsite emergency ac power sources. No single-point vulnerability should exist whereby a weather-related event or single active failure could disable any portion of the blacked-out unit's onsite emergency ac power sources or the preferred power sources and simultaneously fail the AAC power source.	The ABWR design minimizes the potential for a) common cause failures between the preferred sources and the on-site emergency power sources; b) common cause failures between on-site emergency power sources themselves; c) common cause failures between on-site power sources and the AAC power source; and d) common cause failures between preferred sources and the AAC power source. The design also precludes interactions between preferred, onsite emergency, and AAC power systems resulting from weather related events or single failures such that a single point vulnerability will not simultaneously fail both the AAC power source and the on-site emergency or offsite preferred power

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
2. Continued	source(s). This is accomplished by having on-site emergency and the AAC power sources inside weather protected buildings and by maintaining adequate separation between the four power sources. None of the four standby power sources share emergency buses or loads, auxiliary services or instrumentation and controls prior to the recovery actions from the SBO event. These power sources are physically, electrically, mechanically and environmentally separated.
3. The AAC power source should be available in a timely manner after the onset of station blackout and have provisions to be manually connected to one or all of the redundant safety buses as required. The time required for making this equipment available should not be more than 1 hour as demonstrated by test. If the AAC power source can be demonstrated by test to be available to power the shutdown buses within 10 minutes of the onset of station blackout, no coping analysis is required.	The ABWR AAC design power source will be automatically started and reach rated speed and voltage and be available to supply PIP loads within 2 minutes, and safety-related loads within 10 minutes for any loss of preferred off-site power sources (LOPP). The design has provisions to assure the timely manual interconnection between the AAC (CTG) and any one or more of the safety-related shutdown buses. The ABWR AAC design will be demonstrated by test to show that it can be connected to safety-related buses within 10 minutes. Therefore, no coping analysis is required.
4. The AAC power source should have sufficient capacity to operate the systems necessary for coping with a station blackout for the time required to bring and maintain the plant in safe shutdown.	The ABWR AAC power source is rated at 9 MWe, which is more than sufficient capacity to operate the necessary safe shutdown loads which are less than 5 MWe. .

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
5. The AAC power system should be inspected, maintained, and tested periodically to demonstrate operability and reliability. The reliability of the AAC power system should meet or exceed 95 percent as determined in accordance with NSAC-108 (Ref. 11) or equivalent methodology.	The ABWR design includes previsions to demonstrate the operability and reliability of the AAC power source. The CTG will be subject to surveillance inspection, testing and maintenance in accordance with the manufacturer's requirements, the COL-Applicant it's maintenance program and with operational reliability assurance program requirements. The CTG will meet or exceed a reliability goal of 0.95 in accordance with NSAC-108 or equivalent methodology.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
3.3.6 If a system or component is added specifically to meet the recommendations on station blackout duration in Regulatory Position 3.1, system walk downs and initial tests of new or modified systems or critical components should be performed to verify that the modifications were performed properly. Failures of added components that may be vulnerable to internal or external hazards within the design basis (e.g., seismic events) should not affect the operation of systems required for the design basis accident.	The ABWR design includes the CTG as the AAC power source for SBO mitigation. A test program will be conducted by the manufacturer/equipment vendor to verify the major equipment performance objectives (e.g., start time, rated speed and voltage times, stable voltage outputs, etc.). These tests will be conducted prior to CTG installation at the plant site. Prior to plant operation, the AAC power source will be subject to pre-operational testing to demonstrate that the CTG will perform its intended function. Periodically, the AAC power source will be tested to assure that the reliability/availability goals are being met and maintained. The ABWR design safety evaluations take into account potential plant disturbances that could affect AAC power source reliability. These disturbences could occur as a result of internal and external hazards (e.g., floods, fires and harsh environs, respectively). The adverse effects on AAC power source components due to operational hazards will not affect the operations of safety-related systems required for the design basis events. The effects caused by or upon the AAC power source due to operational events (internal and external hazards) are limited since the AAC power source components are physically, mechanically and essentially electrically isolated from the design basis engineered safety features and other power generation systems and components. Design bases accident events may result in the potential degradation of the AAC power source. However, the resulting effects of the AAC will not diminish the current safety system responses and the current event outcomes.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
3.3.7 The system or component added specifically to meet the recommendations on station blackout duration in Regulatory Position 3.1 should be inspected, maintained, and tested periodically to demonstrate equipment operability and reliability.	The ABWR design AAC power source will be capable of being tested, inspected and maintained on a periodic basis. The CTG location in the Turbine Building provides easy access to the unit. The access and environmental conditions in the CTG area allow physical surveillance, easy maintenance, and testing. The CTG will be periodically started, brought up to speed and voltage, and connected to the PIP buses. The CTG will be subject to periodic test in order to verify the operability and reliability goals in the plant operational reliability assurance program (ORAP)
3.4 Procedures and Training To Cope with Station Blackout Procedures[1] and training should include all operator actions necessary to cope with a station blackout for at least the duration determined according to Regulatory Position 3.1 and to restore normal long-term core cooling/decay heat removal once ac power is restored.	Appropriate plant procedures will be developed by the COL applicant for the ABWR design. These procedures will be integrated/coordinated with the plant EOPs, using the EOP methodology. Procedures will consider instructions for operator actions, responses, timing, and related matters during the SBO event.

[1]Procedures should be integrated with plant-specific technical guidelines and emergency procedures developed using the emergency operating procedure upgrade program established in response to Supplement 1 of NUREG-0737 (Ref. 12). The task analysis portion of the emergency operating procedure upgrade program should include an analysis of instrumentation adequacy during a station blackout.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
3.4 Continued 3.5 Quality Assurance and Specification Guidance for Station Blackout Equipment That Is Not Safety-Related Appendices A and B provide guidance on quality assurance (QA) activities and specifications respectively for non-safety-related equipment used to meet the requirements of § 50.63 and not already covered by existing QA requirements in Appendix B or R of Part 50. Appropriate activities should be implemented from among those listed in these appendices depending on whether the non-safety equipment is being added (new) or is existing. This QA guidance is applicable to non-safety systems and equipment for meeting the requirements of § 50.63 of 10 CFR Part 50. The guidance on QA and specifications incorporates a lesser degree of stringency by eliminating requirements for involvement of parties outside the normal line organization. NRC inspections will focus on the implementation and effectiveness of the quality controls described in Appendices A and B. Additionally, the equipment installed to meet the station blackout rule must be implemented such that it does not degrade the existing safety-related systems. This is to be accomplished by making the non-safety-related equipment as independent as practicable from existing safety-related systems. The non-safety systems identified in Appendix B are acceptable to the NRC staff for responding to a station blackout.	The ABWR AAC power source design addresses the quality assurance and equipment specification guidance indicated in Appendices A and B of this guide. The specific responses to Appendices A and B are presented in the following sections in this table.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
APPENDIX A – QUALITY ASSURANCE The QA guidance provided here is applicable to non-safety systems and equipment used to meet the requirements of § 50.63 and not already explicitly covered by existing QA requirements in 10 CFR Part 50 in Appendix B or R. Additionally, non-safety equipment installed to meet the station blackout rule must be implemented so that it does not degrade the existing safety-related systems. This is accomplished by making the non-safety equipment as independent as practicable from existing safety-related systems. The guidance provided in this section outlined an acceptable QA program for non-safety equipment used for meeting the station blackout rule and not already covered by existing QA requirements. Activities should be implemented from this section as appropriate depending on whether the equipment is being added (new) or is existing.	The ABWR AAC power source design is in compliance with the following QA guidelines in 10CFR50.63 as indicated below:
1. Design Control and Procurement Document Control Measures should be established to ensure that all design-related guidances used in complying with § 50.63 are included in design and procurement documents, and that deviations therefrom are controlled.	The GE and the COL-Applicant QA programs will comply with this requirement.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
2. Instructions, Procedures, and Drawings	
Inspections, tests, administrative controls, and training necessary for compliance with § 50.63 should be prescribed by documented instructions, procedures, and drawings and should be accomplished in accordance with these documents.	The GE and the COL-Applicant QA programs will comply with this requirement.
3. Control of Purchased Material, Equipment, and Services	
Measures should be established to ensure that purchased material, equipment, and services conform to the procurement documents.	The GE and the COL-Applicant QA programs will comply with this requirement.
4. Inspection	
A program for independent inspection of activities required to comply with § 50.63 should be established and executed by (or for) the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.	The GE and the COL-Applicant QA programs will comply with this requirement.
5.	
Testing and Test Control	
A test program should be established and implemented to ensure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.	The GE and the COL applicant QA programs will comply with this requirement.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements	Compliance
6. Inspection, Test, and Operating Status	
Measures should be established to identify items that have satisfactorily passed required tests and inspections.	The GE and the COL applicant QA programs will comply with this request.
7. Nonconforming Items	
Measures should be established to control items that do not conform to specified requirements to prevent inadvertent base or installation.	The GE and the COL applicant QA programs will comply with this request.
8. Corrective Action	
Measures should be established to ensure that failures, malfunctions, deficiencies, deviations, defective components, and nonconformances are promptly identified, reported, and corrected.	The GE and the COL applicant QA programs will comply with this request.
9. Records	
Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities required to comply with § 50.63.	The GE and the COL applicant QA programs will comply with this request.
10. Audits	
Audits should be conducted and documented to verify compliance with design and procurement documents, instructions, procedures, drawings, and inspection and test activities developed to comply with § 50.63.	The GE and the COL applicant QA programs will comply with this request.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements		Compliance
APPENDIX B – GUIDANCE REGARDING SYSTEMS/COMPONENTS		
	Alternate AC Sources	**ABWR AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E electrical systems must continue to meet all applicable safety-related criteria.	Existing on-site emergency power sources, buses and loads will continue to meet all applicable safety-related criteria
Redundancy	Not required.	—
Diversity from Existing EDGs	See Regulatory Position 3.3.4 of this guide.	The ABWR design will utilize a AAC diverse power source from that of the EDGs. A qualified combustion turbine generator will be used as the AAC.
Independence from Existing Safety-Related Systems	Required if connected to Class 1E buses. Separation to be provided by 2 circuit breakers in series (1 Class 1E at the Class 1E bus and 1 non-Class 1E).	Two breakers separate the on-site emergency power buses from the CTG. One breaker is Class 1E and the breaker closest to the CTG is non-Class 1E (see Figure 8.3-1).
Seismic Qualification	Not required.	—
Environmental Consideration	If normal cooling is lost, needed for station black-out event only and not for design basis accident (DBA) conditions. Procedures should be in place to affect the actions necessary to maintain acceptable environmental conditions for the required equipment. See Regulatory Position 3.2.4.	The use of the ACC power source will assure that the plant equipment/environment cooling loss will be limited to 10 to 60 minutes (SBO duration). Normal plant cooling loads will be restored after shutdown loads are reestablished. Temperature rise conditions will be limited to minutes rather than hours.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements		Compliance
	Alternate AC Sources	**ABWR AAC Power Source**
Capacity	Specified in § 50.63 and Regulatory Position 3.3.4.	The AAC power source is capable of powering more than the minimum required shutdown loads.
Quality Assurance	Indicated in Regulatory Position 3.5.	The ABWR design will be subjected to the quality assurance standards cited in Appendix A.
Technical Specification for Maintenance, Limiting Condition, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	The AAC power source operational and test requirements will be defined by the Plant Maintenance Program and the ORAP. They will also be consistent with the Interim Commission Policy Statement on Tech Specs.
Instrumentation and Monitoring	Must meet system functional requirements.	The AAC power source instrumentation, controls and monitoring will be of such number, type and quality to assure that the CTG reliability goals are met.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety related equipment.	The AAC power source will be physically, mechanically and electrically independent of the off-site and on-site power systems.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

	Requirements	Compliance
	Water Source (Existing Condensate Storage Tank or Alternate	**SBO Recovery with AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E systems must continue to meet all applicable safety-related criteria.	The ABWR design Condensate Storage Tank will provide primary make-up water via the RCIC or HPCF. The suppression pool will serve as the secondary water source. The AAC powered RCWS and RSWS pumps will provide heat removal service to the plant systems including chillers and HVAC cooling subsystems.
Redundancy	Not required.	—
Diversity	Not required.	—
Independence from Existing Safety-Related Systems	Ensure that the existing safety functions are not compromised, including the capability to isolate components, subsystems, or piping, if necessary.	The loss of all AC power (SBO) will automatically cause reactor scram, MSIV closure, and initiation of the RCIC. The AAC power source will re-energize the lost shutdown loads (emergency make-up water, heat removal and HVAC services) due to the SBO condition within ten (10) to 60 minutes. The condensate storage tank will used during the first ten minutes and throughout the hot shutdown transition period. A significant amount of water is available from the CST (e.g. 600,000 gal). After restoration of power via AAC other plant make-up and cooling water sources will be made available.
Seismic Qualification	Not required.	—
Environmental Consideration	Need for station blackout event only and not for DBA conditions. See Regulatory Position 3.2.4. Procedures should be in place to effect the actions necessary to maintain acceptable environmental conditions for required equipment.	The AAC power source does not need plant service or cooling water for operation. It's a self (air) cooled, self-lubricated and self-controlled machine.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements		Compliance
	Water Source (Existing Condensate Storage Tank or Alternate	**SBO Recovery with AAC Power Source**
Capacity	Capability to provide sufficient water for core cooling in the event of a station blackout for the specified duration to meet § 50.63 and this regulatory guide.	The Condensate Storage Tank (CST) is capable of providing at least 8 hours of make-up water without replenishment. With the use of the AAC power sources other water sources are readily available for make-up, heat removal, and plant equipment cooling.
Quality Assurance	As indicated in Regulatory Position 3.5.	The ABWR design's immediate response to an SBO event does utilize a non-safety make-up water source (the CST). The AAC power source will allow the use of non-safety water sources.
Technical Specifications for Maintenance, Surveillance, Limiting Conditions, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	No additional non-safety-related water sources are required during the duration of the 10 to 60 minute SBO event. Use of other sources during cold shutdown activities is optional.
Instrumentation and Monitoring	Must meet system functional requirements.	The make-up water source instrumentation and controls, used during the SBO duration, are safety-related and divisionally separated.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related systems.	The primary make-up water source (Condensate Storage Tank) and the secondary make-up water source (Suppression Pool), utilized during the 10 minute SBO duration, are physically, mechanically and environmentally separated from one another.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements		**Compliance**
	Instrument Air (Compressed Air System)	**SBO Recovery with AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E systems must continue to meet all applicable safety-related criteria.	Use of Plant Instrument Air/Compressed Air Systems during the 10 minute SBO duration is not required. Plant air systems availability is restored after 10 minutes by the AAC power source. Safety-related SRV nitrogen gas sources are available during the SBO event and are independent of non-safety air systems.
Redundancy	Not required.	—
Diversity	Not required.	—
Independence from Existing Safety-Related Systems	Ensure that the existing safety functions are not compromised, including the capability to isolate components, subsystems, or piping, if necessary.	Air systems are not required to operate during the SBO duration. The CTG unit does not depend on an air starter system nor air supplied services. The CTG does have a self-contained intake and exhaust system. This is provided by the machine power sources itself.
Seismic Qualification	Not required.	—
Environmental Consideration	Needed for station blackout event only and not for DBA conditions. See Regulatory Position 3.2.4. Procedures should be in place to effect the actions necessary to maintain acceptable environmental conditions for required equipment.	The CTG does not require special air or environmental control services before, during or after the SBO event.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements		Compliance
	Water Source (Existing Condensate Storage Tank or Alternate	**SBO Recovery with AAC Power Source**
Capacity	Sufficient compressed air to components, as necessary, to ensure that the core is cooled and appropriate containment integrity is maintained for the specified duration of station blackout to meet § 50.63 and ______.	Air service may be utilized later in the SBO recovery stage to reconfigure plant system to normal operation alignments.
Quality Assurance	As indicated in Regulatory Position 3.3.	Non-safety related air systems are not utilized during the 10 minute SBO duration.
Technical Specifications for Maintenance, Surveillance, Limiting Conditions, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	The CTG does not require air start services. The unit is started by a self-contained diesel engine starting system.
Instrumentation and Monitoring	Must meet system functional requirements.	Plant air system instrumentation, control and monitoring is not required during the 10 minute SBO duration.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related systems.	—

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements		**Compliance**
	Water Delivery System (Alternative to Auxiliary Feedwater System, RCIC System, or Isolation Condenser Makeup)	**SBO Recovery with AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E systems must continue to meet all applicable safety-related criteria.	The ABWR AAC power source design response during the 10 minute SBO duration does not require additional water make-up sources beyond the CST and/or the Suppression Pool. Later in the SBO recovery sequence, the ABWR will utilize the normal plant water systems by powering selective divisions with the AAC power source (e.g. reactor service water and reactor cooling water systems).
Redundancy	Not required.	—
Diversity	Not required.	—
Independence from Existing Safety-Related Systems	Ensure that the existing safety functions are not compromised, including the capability to isolate components, subsystems, or piping, if necessary.	The powering of the normal plant water sources by the AAC power source during SBO will not be inconsistent or contrary with their current DBA design basis.
Seismic Qualification	Not required.	—
Environmental Consideration	Need for station blackout event only and not for DBA conditions. See Regulatory Position 3.2.4. Procedures should be in place to effect the actions necessary to maintain acceptable environmental conditions for required equipment.	The use of the normal plant cooling water systems will not require prior equipment environment controls or cooling. Their operation will be provided concurrently with the powering of water make-up sources.

Table 1C.2-2

ABWR DESIGN COMPLIANCE WITH RG1.155 GUIDELINES (Continued)

Requirements		Compliance
	Water Delivery System (Alternative to Auxiliary Feedwater System, RCIC System, or Isolation Condenser Makeup)	**SBO Recovery with AAC Power Source**
Capacity	Capability to provide sufficient water for core cooling in the event of a station blackout for the specified duration to meet § 50.63 and this regulatory guide.	The emergency water make-up sources include the condensate storage tank and the suppression pool inventory. The normal plant water make-up sources (component and service water, etc.) are in addition to other alternative core and containment make-up sources (e.g., feedwater, fire pumps, make-up water systems, etc.) all of these systems can supply make-up or cooling water.
Quality Assurance	As indicated in Regulatory Position 3.5.	The plant normal make-up water systems are subject to quality assurance evaluations (e.g. CST and the SP).
Technical Specifications for Maintenance, Surveillance, Limiting Conditions, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	Emergency water make-up systems are subject to Tech Spec requirements.
Instrumentation and Monitoring	Must meet system functional requirements.	Instrumentation and controls for normal plant make-up water systems are qualified for their functional services.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related systems.	The use of additional plant water make-up systems (post SBO) will not degrade the operation or reliability of the necessary make-up systems (RCIC, HPCF, etc.). The CTG has sufficient capacity to power necessary shutdown loads and selective other safety and non-safety loads needed for water make-up.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
7.0 COPING EVALUATIONS	
7.1.1 Coping Methods For purposes of this assessment, coping methods are separated into two different approaches. The first is referred to as the "AC-Independent" approach. In this approach, plants rely on available process steam, DC power, and compressed air to operate equipment necessary to achieve safe shutdown conditions (i.e., Hot Standby or Hot Shutdown, as appropriate) until off-site or emergency AC power is restored. A second approach is called the "Alternate AC" approach. This method is named for its use of equipment that is capable of being electrically isolated from the preferred off-site and emergency on-site AC power sources. Station blackout coping using the Alternate AC power approach would entail a short period of time in an AC-Independent state (up to one hour) while the operators initiate power from the backup source. Once power is available, the plant would transition to the Alternate AC state and provide decay heat removal until off-site or emergency AC-power becomes available. The AC power sources used in the Alternate AC power approach would be subject to the Appendix B criteria including electrical isolation requirements in order to assure their availibility in the event of a station blackout. Appendix A provides a definition of Alternate AC power sources. Appendix B provides detailed acceptance criteria for an Alternate AC power source.	The ABWR design utilizes the "Alternate AC (ACC)" approach as defined in Appendix A. The AAC power source will be available to be connected to the core inventory make-up and decay heat removal loads within ten (10) minutes. The AAC power source is capable of being electrically isolated from the preferred off-site and emergency on-site AC power sources and complies with the Appendix B criteria including electrical isolation requirements.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
7.1.2 Coping Duration AC Independent plants must meet the requirements of this methodology for at least four hours (or at least two hours for plants in both emergency AC group A and off-site power group P1). Plants using an Alternate AC power source must assess their ability to cope for one hour. However, if an Alternate AC power source can be shown by test to be available within 10 minutes of the onset of station blackout, then no coping assessment is required. Available within 10 minutes means that circuit breakers necessary to bring power to safe shutdown buses are capable of being actuated in the control room within that period.	The ABWR design will demonstrate by test that the AAC CTG is capable of being available within ten (10) minutes of the onset of a SBO event and therefore no formal coping evaluation is necessary or required. All actions during the 10 minute period are safety-related and automatic. The ABWR design provides the operator in the main control room with the means to reconfigure the electrical distribution system including circuit breakers, and to connect the AAC power source to the necessary shutdown buses and loads within the ten (10) minute interval.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
APPENDIX A – DEFINITIONS This appendix defines the terminology used throughout the guide. ALTERNATE AC POWER SOURCE. An alternating current (AC) power source that is available to and located at or nearby a nuclear power plant and meets the following requirements: (i) is connectable to but not normally connected to the preferred or on-site emergency AC power systems: (ii) has minimal potential for common cause failure with off-site power or the on-site AC power sources: (iii) is available in a timely manner after the onset of station blackout; (iv) has sufficient capacity and reliability for operation of all systems necessary for coping with a station blackout and for the time required to bring and maintain the plant in safe shutdown (Hot Shutdown or Hot Standby, as appropriate); and, (v) is inspected, maintained, and tested periodically to demonstrate operability and reliability as set forth in Appendix B.	The ABWR AAC power source design will meet the following requirements: (i) The design is connectable to (but not normally connected to) the preferred or on-site emergency AC power sources. Two normally open breakers separate the AAC CTG from the safety-related on-site emergency power buses. A single normally open breaker separates the AAC CTG from the non-safety related PIP buses (preferred power) (see Figure 8.3-1). (ii) The ABWR design has a minimal potential for common cause failure between preferred power or on-site AC power sources. The ABWR AAC power source is a diverse power supply to the normal on-site emergency DGs. The AAC power supply is totally independent of the preferred and on-site power sources. The AAC power source automatically starts and is available for loading in two minutes. The AAC power supply is connectable to a Class 1E bus through the actuation of two (2) manual operated circuit breakers. The AAC power source is normally electrically, physically, mechanically, and environmentally isolated from the preferred and on-site power sources. The AAC power source is normally used during LOPP and SBO events. However, the CTG can be used for a number of operational services (i.e. peak loading, maintenance backup, etc.).

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
ALTERNATE AC POWER SOURCE (Continued)	(iii) The ABWR AAC power source is available in a timely manner after the onset of a SBO event. The AAC power source automatically starts on LOPP, attains rated speed and voltage within two (2) minutes, and is capable of being connected to shutdown loads within ten (10) minutes. (iv) The ABWR AAC power source is rated a minimum of 9 MWe. The shutdown loads are less than 5 MWe. The CTG reliability is 0.95. The ABWR is expected to be in hot shutdown condition in twenty four (24) hours, and in cold shutdown condition in ninety-six (96) hours. The CTG, is designed to run indefinitely under SBO conditions at rated load. A seven-day fuel supply is available on the site for the CTG. (v) The ABWR AAC power source will be capable of being inspected, maintained and tested periodically to demonstrate its operability and reliability to guidelines set forth in Appendix B.
REQUIRED COPING DURATION – the time between the onset of station blackout and the restoration of off-site AC power to safe shutdown buses.	The ABWR AAC power source design does not require a formal SBO coping analysis. The AAC power source will be available to supply shutdown loads within ten (10) minutes. The current design requirements associated with DBA events assure that the plant will be able to cope with a ten (10) minute SBO event.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
SAFE SHUTDOWN – For the purpose of this procedure safe shutdown is the plant conditions defined in plant technical specifications as Hot Standby or Hot Shutdown, as appropriate.	The ABWR design will assure safe shutdown plant conditions as defined by the Plant Technical Specifications and the definition in 10CFR50.63.
STATION BLACKOUT – means the complete loss of alternating current (AC) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., loss of off-site electric power system concurrent with turbine trip and unavailability of on-site emergency AC power system). Station Blackout does not include the loss of available AC power to buses fed by station batteries through inverters or by Alternate AC power sources as defined in this appendix, nor does it assume a concurrent single failure or a design basis accident. At a multi-unit site, station blackout is assumed to occur in only one unit unless the emergency AC power sources are totally shared between the units.	The ABWR design accomodates the SBO definition and the other definitions defined in 10CFR50.63. The ABWR design utilizes the current available station batteries throughout the event. The station batteries will be recharged as necessary by the AAC power source.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
APPENDIX B. ALTERNATE AC POWER CRITERIA This appendix describes the criteria that must be met by a power supply in order to be classified as an Alternate AC power source. The criteria focus on ensuring that station blackout equipment is not unduly susceptible to dependent failure by establishing independence of the AAC system from the emergency and non-Class 1E AC power systems. **AAC Power Source Criteria**	
B.1 The AAC system and its components need not be designed to meet Class 1E or safety system requirements. If a Class 1E EDG is used as an Alternate AC power source, this existing Class 1E EDG must continue to meet all applicable safety-related criteria.	The ABWR AAC power source is a non-safety-related CTG.
B.2 Unless otherwise provided in this criteria, the AAC system need not be protected against the effects of: (a) failure or misoperation of mechanical equipment, including (i) fire, (ii) pipe whip, (iii) jet impingement, (iv) water spray, (v) flooding from a pipe break, (vi) radiation, pressurization, elevated temperature or humidity caused by high or medium energy pipe break, and (vii) missiles resulting from the failure of rotating equipment or high energy systems; or (b) seismic events.	The ABWR AAC power source is housed in a Uniform Building Code Building (Turbine Building). The AAC power source is physically, mechanically, electrically and environmentally separated from the preferred and on-site power sources. The AAC power source is protected from normal plant and site environmental perturbations (e.g., wind, temperature, etc.).

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
B.3 Components and subsystems shall be protected against the effects of likely weather-related events that may initiate the loss of off-site power event. Protection may be provided by enclosing AAC components within structures that conform with the Uniform Building Code, and burying exposed electrical cable run between buildings (i.e., connections between the AAC power source and the shutdown busses).	The ABWR AAC power source is protected against the effects of weather-related events that may initiate the loss of off-site power events. The AAC power source is located above the maximum flood level in the Turbine Building. The power and control cables from the CTG to the shutdown buses are routed separately from the offsite preferred power and control cables to the shutdown buses in the Reactor Building. The Turbine Building design basis capabilities will provide adequate protection for the enclosed equipment in compliance with their equipment design basis requirements.
B.4 Physical separation of AAC components from safety related components or equipment shall conform with the separation criteria applicable for the unit's licensing basis.	The ABWR AAC power source design maintains physical separation between safety-related components or equipment and the CTG by adhering to applicable separation criteria used in the plant licensing basis.
Connectability to AC Power Systems	
B.5 Failure of AAC components shall not adversely affect Class 1E AC power systems.	The ABWR AAC power source design and its associated components failures will not adversely affect Class 1E AC power systems. Class 1E AC power system failures will not affect AAC power source operability.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
B.6 Electrical isolation of AAC power shall be provided through an appropriate isolation device. If the AAC source is connected to Class 1E buses, isolation shall be provided by two circuit breakers in series (one Class 1E breaker at the Class 1E bus and one non-Class 1E breaker to protect the source).	The ABWR AAC power source is electrically isolated from the Class 1E power sources by two (2) circuit breakers in series (one Class 1E at the Class 1E buses and one non-Class 1E breaker at the CTG bus). Power to the breakers will be from appropriate DC sources.
B.7 The AAC power source shall not normally be directly connected to the preferred or on-site emergency AC power system for the unit affected by the blackout. In addition, the AAC system shall not be capable of automatic loading of shutdown equipment from the blacked-out unit unless licensed with such capability.	The ABWR AAC power source will not normally be connected to the preferred or on-site emergency AC power system. However, the COL applicant may use the CTG for other services (e.g. peak loading, maintenance backup, etc.). The AAC power system will not automatically connect to or load any shutdown equipment on safety-related emergency buses. The AAC power source will automatically start upon occurrence of a LOPP event. It is connected automatically to the non-safety-related Plant Investment Protection (PIP) buses. It is capable of being manually connected to safety-related buses. It is also be capable of being manually connected to non-safety power generation loads (feedwater pumps, condensate pumps, etc.).
Minimum Potential for Common Cause Failure	
B.8 There shall be minimal potential for common cause failure of the AAC power source(s). The following system features provide assurance that the minimal potential for common cause failure has been adequately addressed.	The ABWR AAC power source design contains a number of design and operational features which provide assurance of minimal potential for common cause failure.
(a) The AAC power system shall be equipped with a DC power source that is electrically independent from the blacked-out unit's preferred and Class 1E power system.	The AAC power system is equipped with sufficient plant or self-contained non-Class 1E DC power supplies (separate from the Class 1E DC power supplies) to facilitate successful operation.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
(a) Continued	During normal operation, the plant electrical distribution systems will provide charging power to the plant battery systems.
(b) The AAC power system shall be equipped with an air start system, as applicable, that is independent of the preferred and the blacked-out unit's preferred and Class 1E power supply.	The AAC power system is equipped with a self-contained, independent diesel engine hydraulic starting system. This starter is designed for SBO conditions. The entire starter assembly is mounted on the same skid with the CTG.
(c) The AAC power system shall be provided with a fuel oil supply, as applicable, that is separate from the fuel oil supply for the onsite emergency AC power system. A separate day tank supplied from a common storage tank is acceptable provided the fuel oil is sampled and analyzed consistent with applicable standards prior to transfer to the day tank.	The AAC power supply is equipped with a fuel system separate from that of the DGs. An external fuel supply transfer system will also be provided. A seven (7) day supply of oil for use by the CTG to achieve safe shutdown is available on site. The CTG oil storage and transfer system is physically and mechanically independent of the DG oil storage and transfer system.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
(d) If the AAC power source is an identical machine to the emergency onsite AC power source, active failures of the emergency AC power source shall be evaluated for applicability and corrective action taken to reduce subsequent failures.	The ABWR AAC power source is an independent and diverse power supply from the on-site emergency DG power sources. The AAC power source is a combustion turbine generator.
(e) No single point vulnerability shall exist whereby a likely weather-related event or single active failure could disable any portion of the onsite emergency AC power sources or the preferred power sources, and simultaneously fail the AAC power source(s).	The ABWR of the AAC power source design precludes single point vulnerabilities, weather-related events effects, or single active failures that could disable any portion of the on-site emergency AC power sources or the preferred power sources and simultaneously fail the AAC power source. The AAC power source is physically, mechanically, electrically and environmentally separated from the other plant power systems (e.g. circuit breaker separation, separate oil supplies, separate auto start circuits, etc.).

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
(f) The AAC power system shall be capable of operating during and after a station blackout without any support systems powered from the preferred power supply, or the blacked-out unit's Class 1E power source affected by the event.	The ABWR AAC power source design does not require preferred or on-site ac power sources to support the operation of the CTG unit. The CTG and its auxiliary support systems are maintained in their standby status by normal plant power sources. Upon reaching design speed and voltage, the CTG operation is supported by a self-powered internal control package. This package assures continued operation without external power or auxiliary service needs.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
(g) The portions of the AAC power system subjected to maintenance activities shall be tested prior to returning the AAC power system to service.	The ABWR AAC power source is capable of being tested and will be periodically tested: (i) to demonstrate its reliability and its availability; (ii) to demonstrate that it can be connected to shutdown buses within ten (10) minutes from the MCR; (iii) to demonstrate the operability after maintenance has been performed on the CTG.
Availability After Onset of Station Blackout B.9 The AAC power system shall be sized to carry the required shutdown loads for the required coping duration determined in Section 3.2.5, and be capable of maintaining voltage and frequency within limits consistent with established industry standards that will not degrade the performance of any shutdown system or component. At a multi-unit site, except for 1/2 Shared or 2/3 emergency AC power configurations, an adjacent unit's Class 1E power source may be used as an AAC power source for the blacked-out unit if it is capable of powering the required loads at both units.	The ABWR AAC power source is designed to provide reliable power to shutdown loads during and after the SBO duration. The CTG will maintain supply voltage and frequency within the limits currently required during normal operation, and during loading transients, etc.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
Capacity and Reliability	
B.10 Unless otherwise governed by technical specifications, the AAC power source shall be started and brought to operating conditions that are consistent with its function as an AAC source at intervals not longer than three months, following manufacturer's recommendations or in accordance with plant-developed procedures. Once every refueling outage, a timed start (within the time period specified under blackout conditions) and rated load capacity test shall be performed.	The ABWR AAC power source will be started and brought to operating conditions consistent with manufacturer's recommendations, the plant ORAP, or in accordance with specific plant developed procedures. This is a COL-Applicant interface item. The AAC power source is capable of being started and connected to the preferred power source for load capacity testing.. The COL applicant will provide testing procedures based on plant specific ORAP objectives.
B.11 Unless otherwise governed by technical specifications, surveillance and maintenance procedures for the AAC system shall be implemented considering manufacturer's recommendations or in accordance with plant-developed procedures.	Plant specific surveillance and maintenance procedures based on the appropriate manufacturer's/vendor's recommendations, operational reliability assurance programs, plant maintenance effectiveness programs and plant operational requirementswill be provided by the COL applicant.
B.12 Unless otherwise governed by technical specifications, the AAC system shall be demonstrated by initial test to be capable of powering required shutdown equipment within one hour of a station blackout event.	The ABWR AAC power source design will be tested to demonstrate that the CTG is capable of powering shutdown equipment within 10 minutes of the SBO event.

Table 1C.2-3

ABWR DESIGN COMPLIANCE WITH NUMARC 87-00 GUIDELINES (Continued)

Requirements	Compliance
Capacity and Reliability B.13 The Non-Class 1E AAC system should attempt to meet the target reliability and availability goals specified below, depending on normal system state. In this content, reliability and availability goals apply to the overall AAC system rather than individual machines, where a system may comprise more than one AAC power source. (a) Systems Not Normally Operated (Standby Systems) System reliability should be maintained at or below 0.95 per demand, as determined in accordance with NSAC-108 methodology (or equivalent). (b) Systems Normally operated (Online Systems) Availability: AAC systems normally online should attempt to be available to its associated unit at least 95% of the time the reactor is operating. Reliability: No reliability targets or standards are established for online systems.	The ABWR AAC power source satisfies the following reliability and availability goal: System reliability will be maintained at or above 0.95 per demand as determined in accordance with NSAC-108 methodology or its equivalent. Periodic testing and maintenance, to assure this reliability, will be performed.

ENCLOSURE 2

INSERT SBO-A (Insert at end of last paragraph of 9.5.11.4 as marked)

the plant maintenance program, and the operational reliability program (see 9.5.13.17).

INSERT SBO-B (Insert in 1.2.2.17.2 as marked)

(Paragraph break) The fuel supply for the combustion turbine generator (CTG) is separate from the DG fuel tanks. In event of a station blackout, sufficient fuel is available on the site to supply the CTG for seven days operation of safe shutdown loads (see Appendix 1C).

INSERT SBO-C (Insert at end of 8.3.1.1.7 as marked)

(9) **Station blackout (SBO) considerations**: A station blackout event is defined as the total loss of all off-site (preferred) and on-site ac normal and emergency power systems. In such an event, the combustion turbine generator (CTG) will automatically start and achieve rated speed and voltage within two minutes. The CTG will then automatically assume pre-selected loads on the PIP buses. With the diesel generators unavailable, the reactor operator will manually shed PIP loads and connect the non-Class 1E CTG with the required shutdown loads within ten minutes of the event initiation. Specifically, the operator will energize one of the Class 1E emergency power buses by closing each of the two circuit breakers (via controls in the main control room) between the CTG unit and the Class 1E bus. The circuit breaker closest to the CTG is non-Class 1E and the circuit breaker closest to the Class 1E bus is Class 1E. Later, the operator will energize other safety and non-safety loads, as appropriate, to complete the shutdown process. See Appendix 1C and 9.5.11 for further information on Station Blackout and the CTG, respectively.

INSERT SBO-D (Insert as new 9.5.13.17 as marked)

9.5.13.17 Periodic Testing of Combustion Turbine Generator (CTG)

Appropriate plant operating procedures shall include periodic testing and/or analysis to verify the adequacy of the CTG to meet alternate ac (AAC) requirements for station blackout. As a minimum, such procedures shall verify the following: 1) The CTG can be started and connected to a preselected Class 1E bus (Division II is preferred) within ten minutes following the CTG start signal. 2) The operator can accomplish this from the main control room. 3) One Class 1E circuit breaker and one non-Class 1E circuit breaker exist and are functional between each of the Class 1E diesel generator buses and the CTG. (Note that only the circuit breakers for the preselected division are racked in. The remaining two divisions have their Class 1E breakers normally racked out, as shown in Figure 8.3-1.) 4) The capacity of the CTG is sufficient to carry the loads necessary to achieve safe shutdown (i.e., perform a load capacity test). 5) The reliability of the CTG is at least 0.95.

9.5.13.18 Operating Procedures for Station Blackout

Appropriate operating procedures and personnel training shall be developed to:

1) Address the operation of the AAC-CTG during an SBO event;
2) Restore other plant off-site (preferred) and on-site emergency power sources as soon as possible;
3) Recover plant HVAC systems as soon as possible to limit heat rises;
4) Provide additional core, containment, and vital equipment makeup and cooling services, as necessary; and to
5) Establish orderly plant safe shutdown conditions.

9.5.13.19 Quality Assurance Requirements for CTG

Quality assurance standards and practices shall be developed to assure continued operational reliability of the CTG as an alternate ac (AAC) power source for SBO events, in accordance with Regulatory Guide 1.155 and 10CFR 50.63.

INSERT SBO-E (Insert replaces first two paragraphs of 9.5.11.1)

The primary functions of the combustion turbine generator (CTG) are: 1) the alternative ac (AAC) power source during the station blackout (SBO) event as defined in Regulatory Guide 1.155 (see Appendix 1C); 2) a standby non-safety-related power source located on site to energize non-safety-related plant investment protection (PIP) loads during loss-of-preferred-power (LOPP) events; and 3) a standby power source during shutdown operations.

INSERT SBO-F (Insert in 9.5.11.1 as marked)

(2) The CTG shall be capable of being manually connected to SBO shutdown loads (via any one of the Class 1E diesel generator buses) from the main control room within ten minutes from the beginning of the event. The CTG shall also be capable of being manually connected to the remaining Class 1E buses. However, the CTG shall not be normally connected to the plant safety buses nor require any external ac power to operate. There shall be two circuit breakers (one Class 1E and one non-Class 1E) in series between the CTG and each Class 1E bus.

INSERT SBO-G (Insert in 9.5.11.1 as marked)

As a minimum, the CTG shall have sufficient capacity to energize required shutdown loads.

INSERT SBO-H (Insert at the end of 9.5.11.1 as marked)

(8) The non-Class 1E CTG shall be physically and electrically independent from the Class 1E emergency diesel generators such that weather-related failures, common cause failure, or single-point vulnerabilities are minimized or precluded.

(9) The CTG shall be capable of being periodically inspected, tested and maintained (see 9.5.13.17 for COL license information).

INSERT SBO-I (Insert in 9.5.11.2 as marked)

The reconfiguration necessary to shed PIP loads and connect the CTG to a preselected bus for emergency shutdown loads can be accomplished from the main control room within 10 minutes of the onset of a postulated station blackout event. Thus, the CTG meets the requirements for an alternate ac (AAC) source (per Regulatory Guide 1.155) such that a station blackout coping analysis is not required. The additional connection capability for the remaining Class 1E buses enable the operator to start and operate redundant shutdown loads and other equipment loads if necessary.

INSERT SBO-J (Insert in 9.5.11.5 as marked)

Controls are also provided in the main control room for manual startup of the CTG, and to facilitate connections to the Class 1E buses, should a station blackout occur.

INSERT SBO-K (Insert at end of 9.5.11.3 as marked)

Relative to its function as an AAC source, the CTG complies with 9.5.14, references 7, 8, and 9.

For detailed assessment of the ABWR during station blackout, see Appendix 1C.

INSERT SBO-L (Insert at end of 9.5.14 as marked)

7. 10CFR 50.63 - Loss of All Alternating Current Power.

8. Regulatory Guide 1.155 - Station Blackout

9. NUMARC-87-00 - Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors.

INSERT SBO-M (Replace second paragraph of 8.1.2.2 as marked)

A combustion turbine generator (CTG) supplies automatic standby power to permanent non-Class 1E loads. These loads are grouped on the three plant investment protection (PIP) buses as shown in Figure 8.3-1. The CTG also has capability to be manually connected to any of the three Class 1E buses, for mitigation of the station blackout (SBO) event [see Subsection (9) of 8.3.1.1.7].

1.2.2.16.10 Reactor Building

The reactor building includes the containment, drywell, and major portions of the nuclear steam supply system, steam tunnel, refueling area, diesel enerators, essential power, non-essential power, emergency core cooling systems, HVAC and supporting systems;

1.2.2.16.11 Turbine Building

The turbine building houses all equipment associated with the main turbine generator. Other auxiliary equipment is also located in this building.

1.2.2.16.12 Control Building

The control building includes the control room, the computer facility, the cable tunnels, some of the plant essential switchgear, some of the essential power, reactor building water system and the essential HVAC system.

1.2.2.16.13 Radwaste Building

The radwaste building houses all equipment associated with the collection and processing of solid and liquid radioactive waste generated by the plant.

1.2.2.16.14 Service Building

The service building houses the personnel facilities, and portions of the non-essential HVAC.

1.2.2.17 Yard Structures and Equipment

1.2.2.17.1 Stack

The plant stack is located on the reactor building and rises to an elevation of 76 meters above grade level. The stack is a steel shell construction supported by an external steel tubular frame work. The stack vents the reactor building, turbine building, radwaste building, control and service buildings.

1.2.2.17.2 Oil Storage and Transfer System

The major components of this system are the fuel-oil storage tanks, pumps, and day tanks. Each diesel generator (DG) has its own individual supply components. Each DG storage tank is designed to supply the diesel needs during the post-LOCA period and each DG day tank has capacity for ~~two~~ eight hours of diesel generator operation. Each DG fuel oil pump is controlled automatically by day-tank level and feeds its day tank from the storage tank. Additional fuel oil pumps supply fuel to each diesel fuel manifold from the day tank.

Insert SBO-B

1.2.2.17.3 Site Security

Site Security is summarized in Subsection 13.6.3.1.

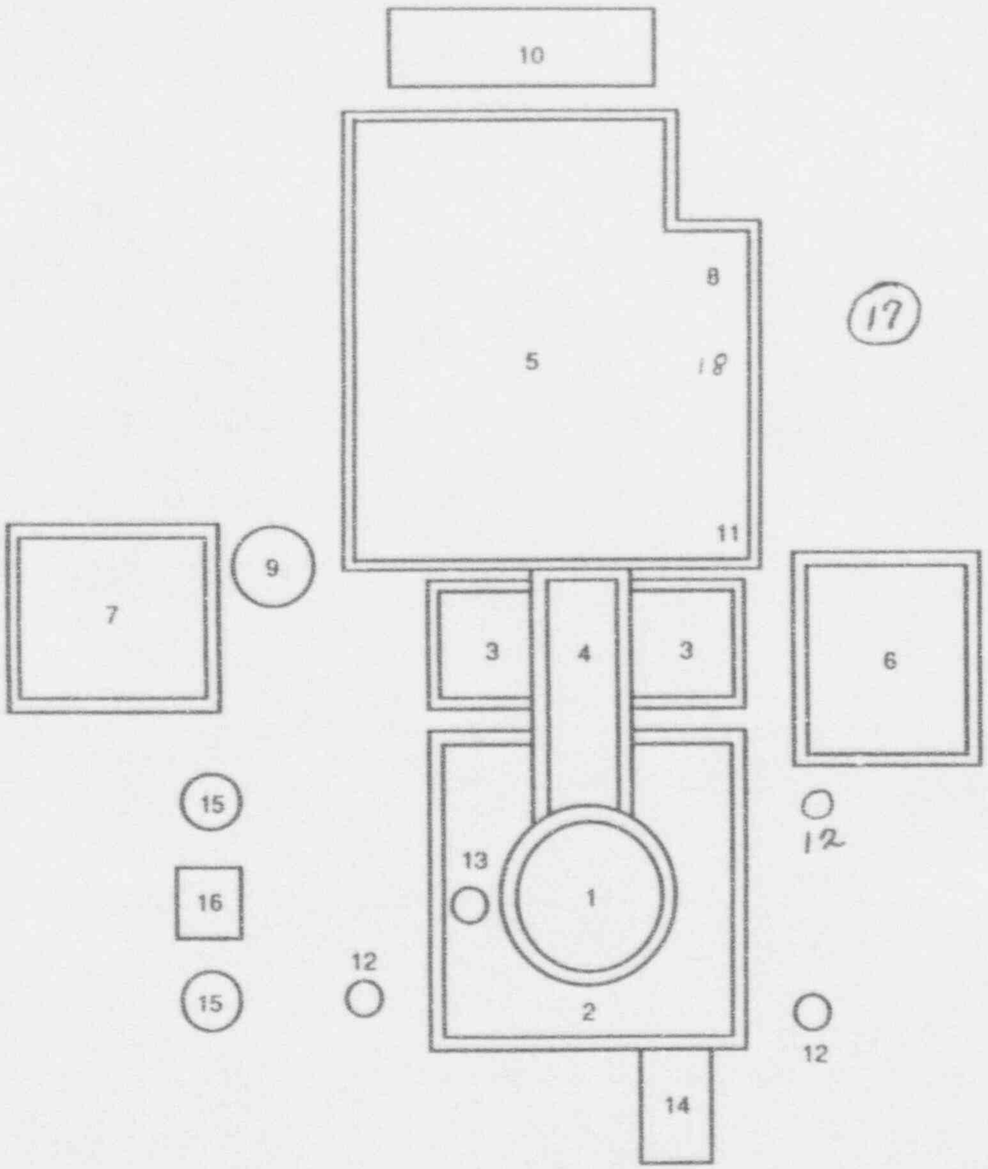

FIGURE 1.2-1 SITE PLAN

NO.	FACILITY
1	REACTOR CONTAINMENT
2	REACTOR BUILDING
3	CONTROL BUILDING
4	MAIN STEAM/FEEDWATER TUNNEL
5	TURBINE BUILDING
6	SERVICE BUILDING
7	RADWASTE BUILDING
8	HOUSE BOILER
9	CONDENSATE STORAGE TANK
10	MAIN TRANSFORMER (3) UNIT AUXILIARY
11	NORMAL SWITCHGEAR
12	DIESEL OIL STORAGE TANK (3)
13	STACK
14	EQUIPMENT ENTRY LOCK
15	FIRE PROTECTION WATER STORAGE TANK (2)
16	FIRE PROTECTION PUMPHOUSE
17	BUNKER FUEL TANK
18	COMBUSTION TURBINE GENERATOR

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 37.5 MVA unit reserve auxiliary transformer (RAT) provides power via one secondary winding for the Class 1E buses as an alternate to the "Normal Preferred" power. The other secondary winding supplies reserve power to the non Class 1E buses. This is truly a reserve transformer because unit startup is accomplished from the normal preferred power, which is backfed from the offsite power transmission system over the main power circuit to the unit auxiliary transformers. The two low voltage windings of the reserve transformer are rated 18.75 MVA each.

8.1.2.2 Description of Onsite AC Power Distribution System

Three non Class 1E buses and one Class 1E division receive power from the single unit auxiliary transformer assigned to each load group. Load groups A, B and C line up with Divisions I, II and III, respectively. One winding of the reserve auxiliary transformer may be utilized to supply reserve power to the non-Class 1E buses either directly or indirectly through bus tie breakers. The three Class 1E buses may be supplied power from the other winding of the reserve auxiliary transformer.

Insert SBO-M

~~A combustion turbine generator supplies standby power to permanent non-Class 1E loads. These loads are grouped on one of the 6.9KV buses per load group. Power is also provided from the combustion turbine generator to the three Class 1E medium voltage buses via breakers that are normally racked out for Divisions I and III, and remote manually closed under administrative control for Division II.~~

In general, motors larger than 300 KW are supplied from the 6.9Kv Metal Clad (M/C) bus. Motors 300KW or smaller but larger than 100KW are supplied power from 480V power center (P/C) switchgear. Motors 100KW or smaller are supplied power from 480V motor control centers (MCC). The 6.9KV and 480V single line diagrams are shown in Figure 8.3-1.

During normal plant operation all of the non-Class 1E buses and two of the Class 1E buses are supplied with power from the main turbine generator through the unit auxiliary transformers. The remaining Class 1E bus is supplied from the reserve auxiliary transformer. This division is immediately available, without a bus transfer, if the normal preferred power is lost to the other two divisions.

Three diesel generator standby ac power supplies provide a separate onsite source of power for each Class 1E division when normal or 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.

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

Subsequent bus transfer will be as described above. These bus voltage monitoring schemes are designed in accordance with Section 5.1.2 of IEEE 741.

Insert SBO-C

Equipment is qualified for continuous operation with voltage ±10% of nominal and for degraded voltages below 90% for the time period established in the load analysis* for the degraded voltage protective time delay relay. (See 8.3.4.20 for COL license information.)

FOOTNOTE

* A complete load analysis shall be performed in accordance with Chapter 3 of IEEE 141, and IEEE's 242 and 399, for the power distribution system to demonstrate proper sizing of power source and distribution equipment. Such analysis shall provide the basis for the degraded voltage protective relay timer settings and other protective relay settings.

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 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.

See Subsection 9.5.13.8 for COL license information.

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 or a 5% frequency drop measured at the bus.

(3) Each diesel generator is capable of starting, accelerating and running its

switch. The standby charger is fed from a load Group A control building motor control center. Selection of the normal or the standby charger is controlled by key interlocked breakers. A 250 Vdc central distribution board is provided for connection of the loads, all of which are non-class 1E.

8.3.2.1.3.4 Ventilation

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

8.3.2.1.3.5 Station Blackout

8.3.1.1.7(9) and Appendix 1C.

Station blackout performance is discussed in ~~Subsection 19E.2.1.2.2. An assessment of Regulatory Guide 1.155 is provided in Appendix 1C.~~ See Subsections ~~8.3.4.16~~ for COL license information.
9.5.13.17, 9.5.13.18 and 9.5.13.19.

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 8.3-4). 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 in 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:

(1) The unlikely loss of one 125 Vdc system does not jeopardize the Class 1E feed supply to the Class 1E buses.

(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 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 failures 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 room whenever the breakers are racked in for service. (See Subsection 8.3.1.1.6.2).

8.3.4.15 Administrative Controls for Manual Interconnections

As indicated in 8.3.1.2(4)(b), the ABWR has capability for manually connecting any plant loads to receive power from any of the six sources. Appropriate plant operating procedures shall prevent paralleling of the redundant onsite Class 1E power supplies.

8.3.4.16 ~~Emergency Operating Procedures for Station Blackout~~ (Deleted)

~~COL applicants will provide instructions in their plant ~~Emergency~~ Operating Procedures for operator actions during a postulated station blackout event and the CTG is not available. 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. (See Subsection 8.3.2.1.3.5).~~

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 Class 1E and non-Class 1E equipment. Such standards would include ANSI, ASTM, IEEE, NEMA, UL, etc. (See Subsection 8.3.5).

8.3.4.18 Administrative Controls for Switching 125 Vdc Standby Charger

Administrative controls shall be provided to assure all input and output circuit breakers are normally open when standby battery chargers are not in use (See Figure 8.3-4, Note 1). Administrative controls shall also be provided to assure at least two circuit breakers (in series) are open between redundant divisions when placing the standby charger into service. This includes controls for the keys associated with the switching interlocks. The only exception is an emergency condition requiring one division's loads be assumed by a redundant division by manual connection via the standby charger interface.

8.3.4.19 Control of Access to Class 1E Power Equipment

Administrative control of access to Class 1E power equipment areas and/or distribution panels shall be provided (see Section 13.6.3).

8.3.4.20 Periodic Testing of Voltage Protection Equipment

Appropriate plant procedures shall include periodic testing of instruments, timers, and other electrical equipment designed to protect the distribution system from: 1) loss of offsite voltage, and 2) degradation of offsite voltage. These protection features are described in Subsection 8.3.1.1.7.

8.3.4.21 Diesel Generator Parallel Test Mode

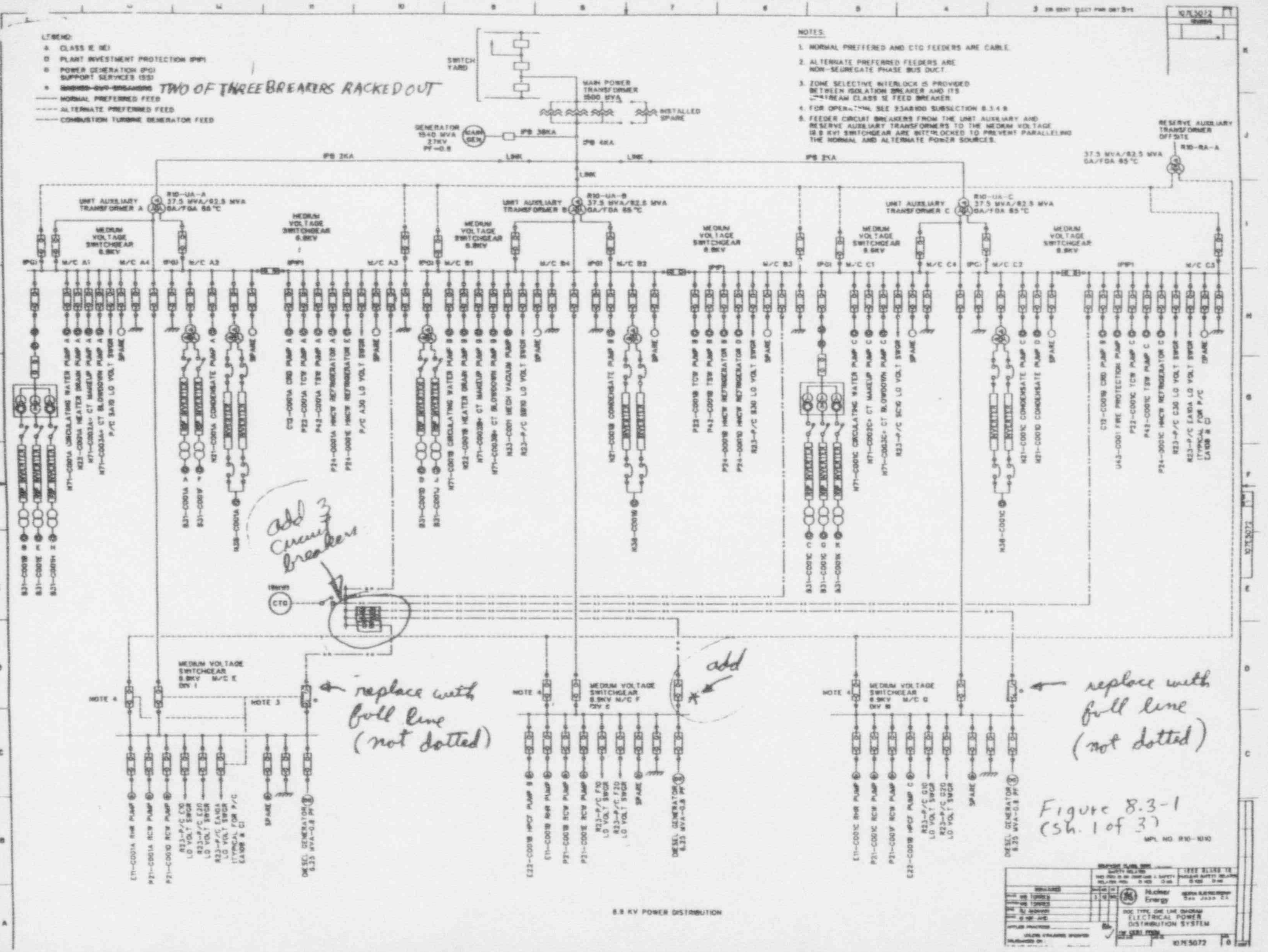

Figure 8.3-1 (Sh. 1 of 3)

through three isolation transformers. These isolation transformers provide two functions in the RIP power supply systems. They step down the MG set voltage output to the level compatible with the rectifier circuit in the ASD. Also, by phase-shifting the output of the three transformers by plus or minus 20 degrees among one another, a majority of the harmonic currents produced by the 6-pulse ASD converter is canceled, thus preventing most of the negative-phase-sequence current from flowing back into the generator.

The MG set will be started with no load. This is accomplished by first leaving all connected ASD loads in their tripped position. The MG set motor is started by a control switch in the main control room, and accelerates directly to the rated speed. The connected ASD loads are then sequentially placed on-line by the control room operator through issuance of proper mode switch commands. The MG set output varies from no load to full load in accordance with the variable operating speed of the exact reverse of the start-up.

9.5.10.3 Safety Evaluation

The MG set equipment performs no safety-related function. Failure of the MG set equipment does not compromise any safety-related system or component and does not prevent safe reactor shutdown.

However, the equipment does include some inherent passive design features which help to alleviate the consequence of a complete loss of AC power bus or momentary voltage drop event. This feature involves automatic extension of electrical coastdown power to the connected RIPs during a bus failure event.

In normal operation, the consequence of having one MG set failure is no worse than that of any three-RIP trip event.

9.5.10.4 Tests and Inspection

Each major component of the MG set, including the motor, generator, flywheel and control panel will be tested in the vendor's facility for verification of design and functional conformance. The motor and generator components will be measured for moment of inertia and inspected for mechanical integrity. The electrical properties and load characteristics of the individual motor and generator components will also be tested.

The complete, assembled MG set will be tested in the factory for control panel function, as well as for normal and transient performance response. The normal performance test will be repeated at the site during plant startup.

The MG set equipment is always in service during plant operation, hence its operability is continuously demonstrated. Its extended coastdown performance is a result of its inherent design that does not require special demonstration by periodic testing.

9.5.10.5 Instrumentation Requirements

The operation of the MG set equipment is monitored by instrumentation for early detection of abnormal behavior. The motor input voltage, generator output voltage, current and speed signals are available for display in the control room. In addition, protective relays are supplied with the equipment for automatic detection and alarm annunciation of control panel malfunction, unbalanced loads, breaker trip, and open or short circuit conditions.

9.5.11 Combustion Turbine/Generator

9.5.11.1 Design Basis

Insert SBO-E

~~The primary function of the combustion turbine generator (CTG) is to act as a standby on-site non-safety power source to feed permanent non-safety loads during LOOP events.~~

~~The unit also provides an alternate AC power source in case of a station blackout event, as defined by Appendix B of Regulatory Guide 1.155.~~

The design bases of the equipment shall meet the following performance criteria:

(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.

Insert SBO-F

0.95

3 ~~(2)~~ The ~~target~~ reliability of the CTG unit, based on successful starts and successful load runs, shall be ≥ ~~0.98~~, as calculated by methods defined in NSAC 108, The Reliability of Emergency Diesel Generators at US Nuclear Power Plants.

4 ~~(3)~~ The gas turbine shall have an ISO rating (continuous rating at 15°C ~~59°F~~ and at sea level) of at least 9 mW, with nominal output voltage of 6.9 kV at 60 Hz.

5 ~~(4)~~ The generator output shall have a steady-state voltage regulation within 0.5% of rated voltage when the load is varied from no load to rated kVA and all transients have decayed to zero. Insert SBO-G

6 ~~(5)~~ The transient response of the generator shall be capable of assuming sudden application of up to 20% of the generator NEMA rating when the generator, exciter, and regulator are operating at no load, and rated voltage and frequency results in less than 25% excursion from rated voltage. Recovery shall be within 5% of rated voltage, with no more than one undershoot or one overshoot within one second.

7 ~~(6)~~ With the generator initially operating at rated voltage, and with a constant load between 0 and 100% at rated power factor, the change in the regulated output shall not exceed 1% of rated voltage for any 30-minute period at a constant ambient temperature.

Insert SBO-H

9.5.11.2 System Description

The interconnections for the CTG are shown on the power distribution system single line diagram (SLD), Figure 8.3-1.

The CTG is designed to supply standby power to selected loads on ~~all of~~ the three turbine building (non-Class 1E) 6.9kV buses which carry the plant investment protection loads during LOPP events.

The CTG automatically starts on detection of a voltage drop of less than 70% on its downstream bus. When the CTG is ready to load ~~synchronize~~, if the voltage level is still deficient, power is automatically transferred from the unit auxiliary transformers to the CTG.

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. Insert SBO-I

The CTG is provided with a fuel supply that is separate from the fuel supply from the onsite emergency ac power system. ~~(that is, a separate day tank supplied from a common storage tank).~~ The fuel shall be sampled and analyzed to maintain quality consistent with standards recommended by the CTG manufacturer.

The CTG is completely independent, and located in a separate building, from the emergency ac power sources. Thus, no single point vulnerability exists between them.

The CTG consists of a completely-packaged, fully-assembled and tested, skid-mounted unit with the following components:

(1) A gas turbine with diesel hydraulic start system (i.e., capable of black start). The unit shall be operated with liquid fuel.

(2) A generator with brushless excitation system and terminal box.

(3) A reduction drive gear system between the turbine and generator.

(4) Lubrication system.

(5) An oil cooling system. ~~air cooling system with radiator and AC motor-driven fans for oil cooling.~~

(6) Accessory gearbox.

(7) Air intake and exhaust equipment.

(8) Microprocessor-based control system with control and protective circuits.

(9) Panels, junction boxes and other accessories as required.

See 1.2.2.17.2 for oil storage and transfer.

9.5.11.3 Safety Evaluations

The CTG is non-Class 1E and its failure will not affect safe shutdown of the plant. The unit is not required for safety, but is provided ~~to~~ as an alternate ac (AAC) source to mitigate ~~assist in mitigating~~ the consequences of a station blackout (SBO) ~~event~~. However, the plant can cope with a station blackout without the CTG. The CTG does not supply power to nuclear safety related equipment except on condition of complete failure of the emergency diesel generators and all off-site power (SBO event). Under this condition, the CTG can provide emergency back-up power through manually-actuated Class-1E breakers in the same interface manner as the off-site power sources. This provides a diverse

source
power in accordance with RG 1.155. Adequate protection of the CTG against sabotage is provided by locating the unit inside the security protected area.
Insert SBO-K

9.5.11.4 Tests and Inspections

The initial test qualification requirements described in IEEE 387, IEEE Standard Criteria for Diesel Units Applied as Standby Power Supplies for Nuclear Power Generating Stations, shall also be applied to the CTG in order to ensure adequate system reliability. However, the factory-test portion of this requirement may be waived if the identically designed unit has been shown capable of maintaining a reliability of 0.99 over a five-year period.

Site acceptance testing, periodic surveillance testing and preventive maintenance, inspections, etc., shall be performed in accordance with the manufacture's recommendations, including time intervals for parts replacement.

9.5.11.5 Instrumentation Requirements

Insert SBO-A

The CTG is provided with local instrumentation and control systems suitable for manual start-up and shutdown, and for monitoring and control during operation. Automatic start-up and load sequencing is controlled via the control ~~console located in the main control room.~~

Insert SBO-J

Mechanical and electrical instrumentation linked to control room displays are provided to monitor starting, lubricating and fuel supply systems, the combustion air in-take and exhaust system, and the excitation, voltage regulation and synchronization systems.

Generator output voltage, current, kVA, power factor, Hz, etc., are also displayed in the control room. Annunciators and computer logs provide early detection of abnormal behavior.

9.5.12 Lower Drywell Flooder

9.5.12.1 Design Basis

The function of the lower drywell flooder (LDF) is to flood the lower drywell with water from the suppression pool in the unlikely event of a severe accident where the core melts and causes a subsequent vessel failure to occur.

The equipment shall meet the following performance criteria:

(1) The LDF shall provide a flow path from the suppression pool to the lower drywell when the drywell air space temperature reaches 260°C.

(2) The LDF shall pass sufficient flow from the suppression pool to the lower drywell to quench all of the postulated corium, cover the corium, and remove the corium decay heat, as confirmed by severe accident analysis (Appendix 19E).

(3) The LDF shall operate automatically in a passive manner.

(4) The LDF outlet shall be at least one meter above the lower drywell floor.

(5) The LDF inlet shall be located as far below the bottom of the first horizontal drywell-to-wetwell vent as possible while still meeting the requirements for the location of the LDF outlet.

(6) The LDF shall not become a flow path from the suppression pool to the lower drywell during design basis accidents (DBAs) such as loss-of-coolant accidents (LOCAs) or during normal plant operation.

(7) The LDF shall distribute flow evenly around the circumference of the lower drywell.

9.5.12.2 System Description

The LDF is shown schematically in Figure 9.5-3.

The LDF provides a flow path for suppression pool water into the lower drywell area during a severe accident scenario that leads to core meltdown, vessel failure, and deposition of molten corium on the lower drywell floor. Molten corium is a molten mixture of fuel, reactor internals, the vessel bottom head and control rod drive components. The flow path is opened when the lower drywell airspace temperature reaches 260°C.

The flow of suppression pool water to the lower drywell through the LDF quenches the

9.5.12.16 NUREG/CR-0660 Diesel Generator Reliability Recommendations

Programs shall be developed to address NUREG/CR-0660 recommendations regarding training, preventive maintenance, and root-cause analysis of component and system failures.

Insert SBO-D

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.

5. Life Safety Code, NFPA 101, National Fire Protection Association.

Insert U

Insert SBO-L

MARK-UP TEXT INSERTS

A capacity and voltage drop analysis will be performed in accordance with IEEE 141 to assure that power sources and distribution equipment will be capable of transmitting sufficient energy to start and operate all required loads for all plant conditions.

INSERT S (87 CONF)

(7) The bus tie arrangment, and the capacity and capability of the CTG, is designed such that the time to place the CTG on line to feed any one train of shutdown loads (i.e., includes manual connection to any one Class 1E bus) shall be within 10 minutes.

INSERT T (87 CONF - RG 1.155, Sect. 3.3.5 assessment)

The reliability of the CTG should meet or exceed 95 percent as determined in accordance with NSAC-108 or equivalent methodology.

INSERT U (87 CONF - RG 1.155, Sect. 3.3.5 assessment)

6. Electric Power Research Institute, "Reliability of Emergency Diesel Generators at U.S. Nuclear Power Plants," NSAC-108, September 1986.

INSERT V (66 CONF)

Light fixtures in safety areas are seismically supported, and are designed with appropriate grids or diffusers, such that broken material will be contained and will not become a hazard to personnel or safety equipment during or following a seismic event.

INSERT W (Needed to backup ITAAC)**

Displays provided in the Main Control Room (MCR) consist of (but are not necessarily limited to) the following: Main Generator output voltage, amperes, watts, VARS (or power factor), frequency, and synchronization; also, distribution system medium voltage (M/C) switchgear voltages, feeder and load amperes, and circuit breaker positions.

Manual controls are provided in the MCR for the Main Generator output circuit breaker, the medium voltage (M/C) switchgear feeder circuit breakers, and load circuit breakers to power centers or motor control centers.