GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

April 30, 1993

Docket No. STN 52-001

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 Review Schedule - **DFSER Confirmatory Item 9.2.13-1**

Dear Chet:

Enclosed is a SSAR markup and a new Appendix 1C, "ABWR Station Blackout Considerations" addressing DFSER Confirmatory Item 9.2.13-1.

Please provide a copy of this transmittal to Butch Burton.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Norman Fletcher (DOE)
Gail Miller (GE)
John Power (GE)

JF93-119

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(3) The system shall be designed and constructed in accordance with Seismic Category I, ASME code, Section III, Class 3 requirements.

(4) The system shall be powered from Class 1E buses.

(A)

(5) The HECW system shall be protected from missiles in accordance with Subsection 3.5.1.

(6) Design features to preclude the adverse effects of water hammer are in accordance with the SRP section addressing the resolution of USI A-1 discussed in NUREG-0927.

These features shall include:

(a) an elevated surge tank to keep the system filled;

(b) vents provided at all high points in the system;

(c) after any system drainage, venting is assured by personnel training and procedures; and

(d) system valves are slow acting.

(7) The HECW system shall be protected from failures of high and medium energy lines as discussed in Section 3.6.

9.2.13.2 System Description

The HVAC emergency cooling water system consists of subsystems in three divisions. Division A has one refrigerator and pump and Division B and C have two refrigerator units, two pumps, instrumentation and distribution piping and valves to corresponding cooling coils. A chemical addition tank is shared by all HECW divisions. Each HECW division shares a surge tank with the corresponding division of the RCW system. The refrigerator capacity is designed to cool the diesel generator zone and electrical equipment room in its division.

The system is shown in Figure 9.2-3. The refrigerators are located in the control building as shown in Figures 1.2-20 and 1.2-21. This system shares the RCW surge tanks which are in the reactor building as shown in Figure 1.2-12. Equipment is listed in Table 9.2-8. Each cooling coil has a three-way valve controlled by a room thermostat. Alternately, flow may be controlled by a temperature control valve. Condenser cooling is from the corresponding division of RCW.

Piping and valves for the HECW system, as well as the cooling water lines from the RCW system, designed entirely to ASME Code, Section III, Class 3, Quality Group C, Quality Assurance B requirements. The extent of this classification is up to and including drainage block valves. There are no primary or secondary containment penetrations within the system. The HECW system is not expected to contain radioactivity.

High temperature of the returned cooling water causes the standby refrigerator unit to start automatically. Makeup water is supplied from the MUWP system, at the surge tank. Each surge tank has the capacity to replace system water losses for more than 100 days during an emergency. The only non-safety-related portions of the HECW divisions are the chemical addition tank and the piping from the tank to the safety related valves which isolate the safety related portions of the system.

Also, see Subsection 9.2.17.~~5~~ 6 for COL license information requirements.

9.2.13.3 Safety Evaluation

The HECW system is a Seismic Category I system, protected from flooding and tornado missiles. All components of the system are designed to be operable during a loss of normal power by connection to the ESF buses. See Tables 8.3-1 and 8.3-2. Redundant components are provided to ensure that any single component failure does not preclude system operation in Divisions B and C. The system is designed to meet the requirements of Criterion 19 of 10CFR50. ~~Each chiller is isolated in a separate room.~~ (B)

(C)

9.2.13.4 Tests and Inspection

Initial testing of the system includes performance testing of the refrigerators, pumps and coils for conformance with design capacity water

(A) Power shall be available from the Alternate AC (AAC) power source when required.

(B) The refrigerators of each division are in separate rooms.

(C) During a Station Blackout (SBO), the HECW chillers, pumps and instrumentation will be powered by the AAC which will become available in ten minutes. Provisions will be made to ensure prompt restart of the refrigerators as discussed in Subsection 9.2.17.6.

The response to SBO is discussed in Chapter 1, Appendix 1C. During the SBO, little heat will be generated in the areas cooled by HECW because only battery powered equipment will be operating. When AAC power becomes available, the fans will start supplying outside air and exhausting any hot air from these areas. When chilled water becomes available, cooled air will be recirculated in these areas to restore normal temperature.

DRAFT

APPENDIX 1C
STATION BLACKOUT CONSIDERATIONS

SECTION 1C

CONTENTS

1C.1 INTRODUCTION

This appendix briefly (a) identifies the design elements and requirements relative to the prevention, mitigation, and accommodation aspects of a full spectrum of plant station blackout (SBO) events; (b) discusses the ability of the ABWR to successfully address and terminate these events; (c) cites the results of evaluations of ABWR design relative to SBO Industry and Regulatory requirements; and (d) it examines the specific use of the Alternate AC Power Source (Combustion Turbine Generator) in SBO events.

This appendix serves as an integration compendium relative to the SBO scenarios and the ABWR systems and equipment descriptions and evaluation provided throughout the other SSAR sections. This appendix will freely cite or reference more appropriate and detailed discussions else in the SSAR. These will include loss of power sequences and equipment capabilities to accommodate them.

> In summary, the mission of the appendix is to i) describe how the ABWR design addresses plant SBO event, ii) summarize, clarify and support the ABWR design conformance with all SBO requirements, iii) indicate how the CTG integrates in the plant current SBO protection features. This new enhanced electrical power network ,in essence, will result in a significant reduction in the attended risk associated with this event category.

1C.2 SUMMARY CONCLUSIONS

The described and documented ABWR design in the SSAR fully complies with:

(1) all of the design regulatory requirements relative to current deterministic DBA safety evaluations including special event considerations (e.g., GDC regulations, regulatory guides), SRP requirements

(2) all of the standard design regulatory requirements relative to current PRA evaluations (with only the use of Off-Site Power sources or On-Site DG Power sources after an 8 hour coping period).

(3) all of the new ABWR design requirements relative to current NRC, EPRI and NUMARC guidelines (with additional use of the CTG as an AAC source).

(4) all of the NRC-Staff DFSER SBO requirements (with On-site/Offsite Power sources, On-Site DGs sources, and On-Site AAC sources).

(5) the analyses assumptions cited in the ABWR-SSAR PRA evaluation (Chapter 19) (with both AAC power source use and without).

The incorporation and use of the combustion turbine generator (CTG) as an alternate alternating current (AAC) power sources sufficiently reduces the risk from the full spectrum of SBO events:

(1) In non-accident SBO events - the AAC is designed to provide immediate power to selective power generation equipment (PIP) busses, avoiding any equipment damage. Within 10 minutes, its can be made really available to power safe shutdown equipment should these be a reason to do so.

(2) During DBA events - the AAC power source can provide timely (within 10 minutes) emergency power to emergency core and containment cooling equipment with a minimum amount of operator action or diversion.

(3) During Severe Accidents - extended SBO events, the AAC has an enhanced capability to provide a wide variety of power service over long periods of time related to core and containment cooling radiological aspects, etc.

The current ABWR design features - redundant, diverse and independent power sources (off-site, on-site DG batteries) can alone ope with an eight hour outage. However, the AAC can restore power within 10 minutes to 1 hour. This significantly reduces the exposure of the power outage risk to prolonged SBO events and their effects. Power restoration within the 10 to 60 minute time domain is viewed as being a risk reduction significant element. Refer also to Subsection 19.3.1.5.

SECTION 1C.3

CONTENTS

SECTION 1C.3

CONTENTS (Continued)

1C.3 DISCUSSION

1C.3.1 Background Information

A brief review of the evaluation of the ABWR SBO evaluation is give below.

1C.3.1.1 Deterministic SBO Evaluations

Early traditional NRC requirements focused on deterministic safety evaluation principles which included compliance with GDCs, RGs, SRPs. Chapter 15 analyses address only short term SBO events. The ABWR design is evaluated and included in Chapter 15. Recovery power sources includes only DGs. Other SSAR sections usually or primarily address DBA events, effects, etc. The ABWR SSAR however, also addresses prolonged SBO plant conditions (e.g., ECCS room heat-ups, etc.), and scenarios

1C.3.1.2 Probabilistic SBO Evaluations

Later PRA evaluations (e.g., guidelines for PRA evaluations) required assessments of the sequences or scenarios involving prolonged loss of all off-site and/or on-site power sources). Early PRA evaluations identified BWR vulnerabilities to extended SBO power outages. These were mainly due to early battery degradation. Later analysis which more realistically examined battery loads, their shedding, discharge patterns, etc. focused on RCICS room temperature concern.s These two areas were subjected to close scrutiny and were adjusted such that a 4 to 8 hour coping internal was possible and probable. These matters are addressed in the ABWR design. Eight hour battery service availability and continued RCIS use were specifically evaluated. Evaluations are included in the appropriate SSAR Sections. Refere to Subsection 8.3.2.1.3.1.

1C.3.1.3 New Evolutionary Plant Requirements

Three sets of new SBO requirements evolved over the last 10 years. Early in 1984, concern over off-site power availability due to weather conditions and the reliability of DG units triggered the first NRC/Industry Initiative - SBO Quantitative Evaluations and Coping Studies. A new set of NUMARC related guidelines were developed in 1988 to establish a standard plant SBO vulnerability/avoidance (Reference 5) profile, also in 1988, the NRC established and issued specific SBO requirements in 10CFR50.63 (Reference 3) . An evaluation of ABWR was conducted. Worst case assumptions were used. The coping study showed a 10 hour capability without AC power.

The second initiative was introduced in 1988 also by EPRI in their Utility Requirements Document (URD). It recommended the for ALWR design that an additional site alternative AC power source (AAC) should be an integral part of the plant design (Reference 6). That the unit could be reviewed as a equipment protection investment to be used when ever power anomalies occur and to serve as a backup to existing systems. It would be a non-safety related component.

The NRC responded with a RG 1.155 revision to take into account AAC aspects (Reference 4) of both the URD + NUMARC guidelines.

The third initiative was introduced by the NRC in 1990. (References 1 and 2). This initiative required that an AAC be added to all evolutionary ALWRs and specifically applicable to ABWR design. A series of requirements were also cited during the ABWR early review by the NRC. Question and answers relative to these requirements are an integral part of the SSAR. The ABWR design long had viewed the benefits of the AAC. It was included in the design but in a more subtle manner in Section 9. The ABWR was also cognizant of its use for a variety of power loss-equipment plant inherent protection (PIP) needs. Its adaptability and its current use is not accidental but a product of good design perspective. The interaction between the AAC and the other part of the electrical power distribution design in Chapter 8 (e.g., checks and balances at electrical breakers) have been evaluated. The incorporation of the AAC into the SBO network is, therefore, in agreement with all of the previous Section 8 design considerations.

1C.3.2 Plant Design Basis

A brief listing of the plant power sources are given below:

1C.3.2.1 Off-Site AC Power Systems

Off-site transmission sources connect to on-site loads are through a set of four transformers. The power unit-auxiliary, start-up and reserve transformers provide sufficient power connections to satisfy GDC 17. Refer to Section 8.2.1 and 8.3.1 for design details.

1C.3.2.2 On-Site AC Power Systems

Three load groups each with a Class 1E safety related loads and separate independent non-safety loads and voltage groups - - under 6.9 Kv, 480 V, 120 VAC loads are provided. A three load DC bus load arrangement matches the above normal AC feed busses. A set of inverter/charger arrangements enterconnect AC and DC sources. Refer to Subsection 8.3.1 for detailed design aspects and their evaluations.

1C.3.2.3 On-Site DC Power Sources

A DC power system is provided for safety and non-safety switch gear control, control power, instrumentation, critical motors, and emergency lighting. Four independent Class 1E 125 VDC divisions, three independent non-safety related 125 VDC load groups and one 250 VDC non-safety related computer system are provided. Refer to SSAR Subsection 8.3.2 for detailed design and evaluations.

1C.3.2.4 Alternative AC On-Site Power Systems

A single combustion turbine generator (CTG) acts as a standby alternative on-site AC power source. It is primarily configured to non-safety loads for LOOP situations. It can be re configured to selective Class 1E loads upon need. The unit is identified as an AAC power source.

Refer to Subsection 9.5.11, 8.3.1, 8.3.1.1.1, 8.3.1.1.7, and 8.3.1.4.

The plant electrical design is enhanced by a number of other considerations.

1C.3.2.5 Plant SBO Inherencies

The ABWR design provides a number of unique features. The use of low heat-up I&C components reduces the need for HVAC during SBO and extends the SBO coping interval out to 8 hours (e.g., MCR I&C temperature rise will be limited to ~30°F due to I&C heat load limits). The MCR is supplemented by the more open remote shutdown panel rooms during SBO events. The RCIS room is isolated from HPCS and RHR equipment and subject only to its own requirement heatup. External fire pump water makeup sources are also available.

1C.3.2.6 CTG SBO Inherencies

The CTG can restore HVAC and other support/auxiliary services within ten minutes. GTC is self contained and not influenced by turbine building environmental conditions. CTG is not complicated by plant ESF-type equipment turn-off devices. The CTG is not dependent on any house auxiliary service system. The CTG can be connected to three different non-safety buses (feedwater, circulating water) and three different safety related buses (three DG load buses).

1C.3.3 Plant Safety Evaluation

A brief review of the ABWR design relative to various LOOP and SBO situations is give below.

1C.3.3.1 Normal and Transient Operation

The ABWR design operates and reacts similar to any other BWR design on power source perturbations (e.g., LOOP). The plant will utilize traditional protective and recovery actions. On loss of power sources, the plant will search for conventional alternative sources while sequencing emergency sources (e.g., DG). Load shedding and normal reconfigurations will occur. However, a special extensive analysis of the interaction between alternate GTG will be used initially to supply non-safety loads and subsequently to supply safety loads then re-configured to this service by manual oper... action. Also refer to Subsections 8.3.1, 8.3.2 and 9.5.11.

1C.3.3.2 DBA Events

The ABWR design functions like other BWR previous designs under DBA-LOCA conditions. However, a special comprehensive discussion is given in Subsection 8.3.1.1.7. Again, the use of the CTG is available but generally considered unnecessary due to the redundant diversity, and independence of the other power sources (e.g., DGs). Current analysis do not expect DBA + LOOPs although the current design basis assumes no credit for off-site AC. However, if this scenario includes an SBO sequence, the CTG is available for use in 10 to 60 minute interval. Also refer to Subsection 8.3.1, 8.3.2 and 9.5.11.

1C.3.3.3. Special Events - SBO (Non-accident)

The use of the CTG for an extented non-accident SBO events was envisioned by the NUMARC guidelines as a creditable SBO consideration. With isolation like conditions prevailing, reconfiguration of the CTG to safety load service within 10 minutes to 60 minutes is expected to be a fairly normal operator action. Use of MCR for the entire refiguration is expected although front panel control and load breaker control are possible.

1C.3.3.4 Severe Accident - SBO (Extended Outages)

The use of the CTG for extended SBO conditions is not expected since the immediate use of CTG will negate a potential prolonged SBO before it can occur. The CTG is available whenever its use is desirable. There does not appear to be any impediment to its use before, during or after a prolonged SBO event. An extended SBO alone, the failure of coping equipment, etc. and the need for immediate use of CTG are far beyond the design basis requirements. However, the CTG is available throughout the event to use to service safety and non-safety loads.

1C.3.4 Plant SBO Conformance

A brief review of the ABWR design conformance to various SBO requirements is given below.

1C.3.4.1 Current and New NRC Requirements

The ABWR fully complies with 10CFR50.63 requirements. An 8 hour SBO duration was chosen to be conservative. An 8 hour coping study was performed and the results were acceptable. The subject equipment was demonstrated to have sufficient margin to function as required during or after the event. The ABWR fully complies with ALWR requirements. An alternative source was proposed. Procedures to cope with SBO will be developed. Training will be conducted. Reliability and environmental data will be maintained. Equipmnet qualifications will be conducted.

A review of the new SBO SECY 90-016 requirements concludes that ABWR is in compliance with the intent of the ALWR initiative.

1C.3.4.2 EPRI Utility Requirements Document

The ABWR fully complies with the URD Section 11. The independent off-site power source connections are provided. Sufficient on-site power sources, configurations and battery capabilities are included in the ABWR design to meet specified requirements.

An alternate AC power source is provided with sufficient capacity to sustain safe shutdown loads. The CTG reliability shall be 0.90.

The CTG will be periodically tested and maintained to vendor standards.

A review of the individual requirement concludes that the ABWR design is in compliance with the subject URD objectives.

1C.3.4.3 NRC DFSER Requirements

A very comprehensive evaluation of the SSAR information related to plant LOOPs and SBOs was conducted by the staff and reported in Subsection 8.3.9. Clear and concise requirements of the ABWR design were listed. The staff evaluation concluded that the current design complies with the SECY ALWR requirements, with the SBO Rule and with the traditional DBA. design basis.

A thorough review of the NRC-DFSER comments concluded that ABWR design reflected in the SSAR was in agreement with the staff findings.

1C.3.4.4 Regulatory Guide 1.155 Requirements

A review was conducted of the ABWR design relative to the RG 1.155 requirements in regards to the normal emergency power systems (off-site, on-site, DG, batteries), refer to Subsection 8.3.2.2.2. The ABWR is in full agreement with the intent of the SBO guidelines.

A separate, special review was conducted of the ABWR-CTG design relative to RG 1.155. (Specifically to RG Section 3.3.5.) The ABWR-CTG design was in compliance with the five cited requirements. The use of the CTG in the ABWR design (less than 1hr SBO) reducesthe RG compliance considerations for the normal emergency sources by reducing the coping study requirements.

1C.3.4.5 NUMARC 87-00 Guidelines

A review was conducted of the ABWR design relative to the NUMARC SBO guideline/requirement report. Special attention was given to Appendices A, B and C relative to the AAC design and its capabilities.

The review concluded that the ABWR design and its evaluation comply with the NUMARC guidelines.

Several requirements are COL applicant responsibility items (e.g., EOPs, testing, maintenance, etc.).

1C.3.4.6 Current SSAR Considerations

The active use of CTG was not initially part of the SSAR. Most of the current SBO evaluations are based on non-ACC availability (e.g., 8hr coping study). The use of CTG will obvious relax some of the stringent equipment aspects.

In summary, the ABWR is in full compliance with all Industry and NRC SBO requirements.

The SBO requirements compliance is reflected throughout the SSAR in individual sections.

1C.3.5 Other Considerations

Several other considerations are singled out for special compliance or requirements attention. These are listed below.

1C.3.5.1 Plant Technical Specifications

The current DBA design basis oriented Tech Specs will continue to be all that's required to assure safe and order·· plant operation, transient accommodation and accident mitigation. There is little need to require surveillance or operational requirements for the CTG other than those required to assure a reliable and maintainable plant equipment status for the alternative power source. Manufacturers maintenance, testing and inspection requirements will be part of the plant PM program. Refer to SSAR Section 16 for Tech Spec Requirements on other power sources.

1C.3.5.2 Design Interface Requirements

Few plant auxiliary service or support system interfaces exist between the self-contained, skid mounted CTG unit and the plant system serviced by the CTG. Electrical power cable connections to the plant electrical distribution system represents one of the few interface connections. These power cable raceways are independent and separate from other plant electrical power distribution cabling. Most operational I&C is on front panel mounted. Operating performance considerations are in the MCR. Connection breakers are at the load centers.

Diesel oil support sampling requirements equally apply to the CTG. They are already cited for the DB in Subsection 9.5.13.13.

1C.3.5.3 Emergency Operating Procedures (EOP)

Plant EOPs will include considerations relative to the use of the CTG under a variety of plant power perturbutions conditions. These are considered COL applicant responsibility items. The EOP should consider specific instructions, timing and related matters during SBO events or their symptoms. They shall specifiy specific operator actions relative to emergency power distribution alignments.

1C.3.5.4 ITAAC Aspects

The CTG is addressed in the Tier 1 documentation (ITAAC).

1C.3.5.5 Equipment Qualification, Testing and Reliability

The subject CTB must be qualified for its intended service and reliability by the vendor/supplier. Qualification testing, inspections and reliability shall be a COL applicant responsibility item.

1C.3.5.6 Periodic Surveillance, Testing, Inspection and Maintenance

A very strict and comprehensive reliability assurance program exist for the normal plant emergency power system (DGs). This is considered a COL applicant irresponsibility ITEM. Likewise, a comprehensivereliability/availability/surveiaalnce/inspection and testing program for the CTG is a COL applicant item.

1C.3.5.7 Power Feed Cable Routing

The power feed cable routing shall be physically separated from other alternate sources to the extent practical. A suggested routing is shown in SSAR.

1C.3.5.8 CTG Capabilities

The CTG will be capable of recharge the plant batteries during an elongated SBO scenario. The CTG should be sized to carry the necessary safe and orderly shutdown loads with margin.

1C.3.6 Alternate AC Power Source Operational Capabilities

1C.3.6.1 Plant Normal Operation

The normal operation and configuration of the on-site AC power network and its individual power sources are described in SSAR Subsections 8.2.1 and 8.3.1. The CTG (AAC) system operational attributes and its interconnections are described in Subsection 9.5.12 and are shown on SSAR Figure 8.3-1.

The CTG is designed normally to supply standby power to one of the two turbine buildings located (non-Class 1E0 6.9 Kv buses which carry the plant investment protection (PIP) loads. (The other PIP lines receives back-up power from the auxiliary transformer fed from an alternate off-site power source.) The CTG automatically starts on detection of voltage drop of less than 70 % or its downstream bus. When the CTG is ready to synchronize, if the voltage is still deficient, power automatically transferred from the unit auxiliary transformer to the CTG. Refer to Figure 8.3-1)

The CTG can also feed non-Class 1 buses powering feedwater and recirculating water pumps. These buses normally receive power from the unit auxiliary transformer and supply power to the third bus (plant investment protection (PIP) in the load group 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 or the reserve auxiliary transformer which are connectable to the PIP buses. This cross-tie arrangement allows advantage to be taken of the fact that the feedwater pumps are motor driven through an adjustable speed drive so that they have low starting currents and can be started and run at low power. The combustion turbine and reserve auxiliary transformer have sufficient capacity to start either or both of the reactor feedwater and condensate pumps in a load group. This provides three load groups of non-safety grade equipment in addition to the divisional 1E load groups which may be used to supply water to the reactor vessel in emergencies. (Refere to Figure 8.3-1).

1C.3.6.2 Non-Accident SBO Events

The CTG is readily available to provide backup emergency power service during LOOP or SBO (non accident) events. The current primary emergency power sources -- diesel generator units - - for complete LOOP events are discussed in SSAR Subsection 8.3.1.1.8 and the electrical network response is given for a wide spectrum of LOOP (and LOOP related) events in SSAR Subsection 8.3.1.1.7.

The use of the CTG is fairly simple and straightforward. Review of Figure 8.3-1 shows that the CTG can feed safe and orderly shutdown buses through the realignment of two or three pre-selected breakers.

The CTG will be up to operational sped in 2 minutes and is available for bus connection in 10 minutes. The difference in time is to allow the normal primary emergency sources to be used to energize required buses and loads.

EOPs to re configure the emergency sources to required bus/loads will be provided to assure safe and orderly energization of the necessary buses/loads.

1C.3.6.3 Other Capabilities

The CTG can be easily used for other SBO events including potentially prolonged SBO scenarios. The early use of the CTG will normally terminate the SBO in the 10 minute to 1 hour interval. Events like DBA-LOCAs, site weather conditions, prolonged degradation of normal emergency sources (e.g., DGs) can be effectively mitigated by the use of the CTG option.

The CTG can be connected to one or more of the three Safety-related bus divisions; to one or more of the three non-safety related bus divisions; to one of the feedwater and circulating water buses; to one or more of the MCR or palnt HVAC chiller systrems; or to one or more of the DC battery charger divisions.

The operation of the CTG from the MCR and the unit front panel in concert with a variety of plant system situation has been evaluated. Comunication between CTG and other plant locations has been assured even during SBOs.

In summary, the CTG is indeed amulti purpose plant investment protection system even under most severe plant conditions of LOOP, SBO and DBAs.

SECTION 1C.4

CONTENTS

1C.4 CONCLUSIONS

1C.4.1 General Observations

The following general observations can be concluded from the SSAR design descriptionand evaluations.

(1) The ABWR design fully complies with a wide spectrum of SBO NRC requirements, regulations, regulatory guides and staff positions and with extensive Industry guidelines and requirements.

(2) The ABWR design provides a full spectrum of prevention, mitigation or accommodation services for a wide variety of SBO events.

(3) The ABWR design SBO ESFs are made up of wide assortment or network of diverse, redundant and independent services, systems, functions and equipment.

(4) The ABWR design provides a substantial time intervention period for remedial or recovery actions.

(5) The ABWR design has factored in a substantial amount of plant operating experience feedback, equipment reliability and availability considerations, human man-machine aspects, environmental considerations and utilize basically time proven equipment and technologies into its SBO protection services.

(6) The CTG provides a significant enhancement to the existing SBO mitigation protection network.

1C.4.2 Specific Observations

Three key areas support the ABWR design capabilities and their compliance with SBO requirements. The critically important elements of the ABWR design are cited below for each of the key areas.

Re-establishment of AC power to the Class 1E Distribution System During SBO Events

The ABWR design assures that (1) any one of the three divisions of RHR will be sufficient to safely shutdown the plant, (2) restoration of AC power to any one division at the end of the 8 hour coping period will with margin be capable of maintaining the plan within required design limits and to permit completion of plant shutdown, (3) the three independent diesel generators will be designed with bypass valves for their DC solenoids such that each can be started manually without DC power (i.e. assuming the DC batteries are discharged following 8 hours of coping), (4) the combustion turbine generator will be able to be started by a smaller self-contained diesel with its own battery, (5) AC power from any one of the three diesel generators will be capable of being manually connected to required loads within its associated division without DC control power, and (6) AC power from the off-site preferred system or from the combustion turbine generator will be capable of being manually connected to required loads within each of the three Class 1E AC divisions without DC control power.

Based on the above considerations, its concluded that the ABWR design for reestablishing of AC power meets the SBO rule.

Coping Capability During SBO Events

The ABWR design assures that (1) the plant design is to be such that specified temperature limits will not be exceeded in the RCIC or required control rooms for at least 8 hours following station blackout, (2) equipment required for the SBO event located in the RCIC room will be designed and qualified to a temperature event in excess of 66°C (i.e., the specified temperature limit), (3) equipment required for the SBO event located in the main control room will be designed and qualified to a temperature in excess of 122°F (i.e., the specified temperature limit), (4) the initial temperature in the heat-up calculations of 40°C for the RCIC room will prevent the equipment from reaching the design temperature of 66°C for at least 8 hours, (5) the initial temperature in the heat-up calculations of 26°C for the main control room will prevent the equipment from reaching the design temperature of 50°C for at least 8 hours, (6) environments expected during and following the 8 hour coping time through out the plant for the station blackout event will not exceed the environment for which the required safe and orderly shutdown equipment is designed and qualified, (7) the division I battery will be sized with sufficient capacity to supply all required SBO loads without load shedding, and (8) the RCIC systems will have sufficient capacity and capability to maintain the plant in a safe shutdown condition for 8 hours.

Based on the above considerations, it is concluded that the ABWR design will be capable of coping with the SBO event and meet the SBO rule.

Combustion Turbine Generator (CTG) use During SBO Events

The ABWR design will include a fully qualified alternate AC power source. The staff understands that this alternate AC power source (1) will be a combustion turbine generator, (2) will be provided with an immediate fuel supply that is separate from the fuel supply for the onsite emergency AC power system (i.e., a separate day tank supplied from a common storage tank), (3) fuel will be sampled and analyzed consistent with applicable standards, (4) will be capable of operating during and after a station blackout without any AC support systems powered from the preferred power supply or the blacked-out units Class 1E power sources affected by the event, (5) will be designed to power all the normal and/or Class 1E shutdown loads necessary within 1 hour or less of the onset of the station blackout, such that the plant is capable of maintaining core cooling and containment integrity, (6) will be protected from design basis weather events (except seismic and tornado missiles) to the extent that there will be no common mode failures between offsite preferred sources and the combustion turbine generator power source, (7) will be subject to quality assurance guidelines commensurate with its importance to safety, (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 normal non-Class 1E loads used for a safe shutdown, (10) will undergo factory testing similar to those required for the Class 1E diesel generator, (11) will not supply power to nuclear safety related equipment except on condition of complete failure of the emergency diesel generators and all offsite power, (12) will be no single point vulnerability with onsite emergency AC power sources, and (13) will be subject to site acceptance testing, periodic preventative maintenance, inspection, etc.

Based on the above, its concluded that the ABWR design for the Alternate AC power supply will comply with Regulatory Guide 1.155 and meets the SBO rule.

1C.4.3 Special Observations

The response of the ABWR to a wide spectrum of SBO events (non-accident LOOP, DBA with LOOP, external SBO with severe accident consequences) has been evaluated both qualitatively (deterministic analysis) and quantitatively (probabilistic analysis). The use of CTG significantly enhances the already significantly inherent ABWR prevention, mitigation and accommodation capabilities. The strict compliance with several deverse sets of very restrictive requirements (e.g., Industry and NRC ALWR requirements) further assures the potentially and severe dominate risk contributor SBO has been significantly reduced. Refer also to NRC ALWR requirements.

1C.5 SUMMARY STATEMENTS

The ABWR design is capable of preventing, mitigating and accommodating a wide spectrum of SBO scenarios with a network of redundant, diverse and independent emergency power sources.

The ABWR design utilizing the traditional off-site and on-site power sources fully complies with all standard plant SBO requirements (reliable power sources, 8 hour coping study, recovery procedures, etc.).

The addition of the CTG to the plant power network significantly reduces plant and public risk from SBO events. However, its primary purpose is to service a s a back-up power source for normal LOOP events. It can however, prevent and mitigate more severe, potentially prolonged SBO scenarios when necessary.

1C.6 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/As January 4, 1990.

(6) EPRI-URD, *EPRI-Utility Requirements Document For Evolutionary ALWR* , July1990.

(7) NUREG-1469, *Draft Safety Evaluation Report - Design Certification of GE-ABWR (DFSER)*, October, 1992.