Attachment 1
SAIC-91/6655

TECHNICAL EVALUATION REPORT

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT NUMBER 1

STATION BLACKOUT EVALUATION

TAC No. M 68552

Science Applications International Corporation
An Employee-Owned Company

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TABLE OF CONTENTS

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1.0 BACKGROUND

On July 21, 1988, the Nuclear Regulatory Commission (NRC) amended its regulations in 10 CFR Part 50 by adding a new section, 50.63, "Loss of All Alternating Current Power" (1). The objective of this requirement is to assure that all nuclear power plants are capable of withstanding a station blackout (SBO) and maintaining adequate reactor core cooling and appropriate containment integrity for a required duration. This requirement is based on information developed under the commission study of Unresolved Safety Issue A-44, "Station Blackout" (2-6).

The staff issued Regulatory Guide (RG) 1.155, "Station Blackout," to provide guidance for meeting the requirements of 10 CFR 50.63 (7). Concurrent with the development of this regulatory guide, the Nuclear Utility Management and Resource Council (NUMARC) developed a document entitled, "Guidelines and Technical Basis for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," NUMARC 87-00 (8). This document provides detailed guidelines and procedures on how to assess each plant's capabilities to comply with the SBO rule. The NRC staff reviewed the guidelines and analysis methodology in NUMARC 87-00 and concluded that the NUMARC document provides an acceptable guidance for addressing the 10 CFR 50.63 requirements. The application of this method results in selecting a minimum acceptable SBO duration capability from two to sixteen hours depending on the plant's characteristics and vulnerabilities to the risk from station blackout. The plant's characteristics affecting the required coping capability are: the redundancy of the onsite emergency AC power sources, the reliability of onsite emergency power sources, the frequency of loss of offsite power (LOOP), and the probable time to restore offsite power.

In order to achieve a consistent systematic response from licensees to the SBO rule and to expedite the staff review process, NUMARC developed two generic response documents. These documents were reviewed and endorsed (10) by the NRC staff for the purposes of plant specific submittals. The documents are titled:

1. "Generic Response to Station Blackout Rule for Plants Using Alternate AC Power," and

2. "Generic Response to Station Blackout Rule for Plants Using AC Independent Station Blackout Response Power."

A plant-specific submittal, using one of the above generic formats, provides only a summary of results of the analysis of the plant's station blackout coping capability. Licensees are expected to ensure that the baseline assumptions used in NUMARC 87-00 are applicable to their plants and to verify the accuracy of the stated results. Compliance with the SBO rule requirements is verified by review and evaluation of the licensee's submittal and audit review of the supporting documents as necessary. Follow up NRC inspections assure that the licensee has implemented the necessary changes as required to meet the SBO rule.

In 1989, a joint NRC/SAIC team headed by an NRC staff member performed audit reviews of the methodology and documentation that support the licensees' submittals for several plants. These audits revealed several deficiencies which were not apparent from the review of the licensees' submittals using the agreed upon generic response format. These deficiencies raised a generic question regarding the degree of licensees' conformance to the requirements of the SBO rule. To resolve this question, on January 4, 1990, NUMARC issued additional guidance as NUMARC 87-00 Supplemental Questions/Answers (11) addressing the NRCs concerns regarding the deficiencies. NUMARC requested that the licensees send their supplemental responses to the NRC addressing these concerns by March 30, 1990.

2.0 REVIEW PROCESS

The review of the licensee's submittal is focused on the following areas consistent with the positions of RG 1.155:

A. Minimum acceptable SBO duration (Section 3.1),

B. SBO coping capability (Section 3.2),

C. Procedures and training for SBO (Section 3.4),

D. Proposed modifications (Section 3.3), and

E. Quality assurance and technical specifications for SBO equipment (Section 3.5).

For the determination of the proposed minimum acceptable SBO duration, the following factors in the licensee's submittal are reviewed: a) offsite power design characteristics, b) emergency AC power system configuration, c) determination of the emergency diesel generator (EDG) reliability consistent with NSAC-108 criteria (9), and d) determination of the accepted EDG target reliability. Once these factors are known, Table 3-8 of NUMARC 87-00 or Table 2 of RG 1.155 provides a matrix for determining the required coping duration.

For the SBO coping capability, the licensee's submittal is reviewed to assess the availability, adequacy and capability of the plant systems and components needed to achieve and maintain a safe shutdown condition and recover from an SBO of acceptable duration which is determined above. The review process follows the guidelines given in RG 1.155, Section 3.2, to assure:

a. availability of sufficient condensate inventory for decay heat removal,

b. adequacy of the class-1E battery capacity to support safe shutdown,

c. availability of adequate compressed air for air-operated valves necessary for safe shutdown,

d. adequacy of the ventilation systems in the vital and/or dominant areas that include equipment necessary for safe shutdown of the plant,

e. ability to provide appropriate containment integrity, and

f. ability of the plant to maintain adequate reactor coolant system inventory to ensure core cooling for the required coping duration.

The licensee's submittal is reviewed to verify that required procedures (i.e., revised existing and new) for coping with SBO are identified and that appropriate operator training will be provided.

The licensee's submittal for any proposed modifications to emergency AC sources, battery capacity, condensate capacity, compressed-air capacity, ventilation system, containment isolation valves and primary coolant make-up capability is reviewed. Technical specifications and quality assurance set forth by the licensee to ensure high reliability of the equipment, specifically added or assigned to meet the requirements of the SBO rule, are assessed for their adequacy.

This SBO evaluation is based upon the review of the licensee's submittals dated March 3, 1989 (13) and March 30, 1990 (14), the licensee's written response (15) to questions discussed at the March 8, 1991 telephone conference, and the information available in the plant Final Safety Analysis Report (FSAR) (12); it does not include a concurrent site audit review of the supporting documentation. Such an audit may be warranted as an additional confirmatory action. This determination would be made and the audit would be scheduled and performed by the NRC staff at some later date.

3.0 EVALUATION

3.1 Proposed Station Blackout Duration

Licensee's Submittal

The licensee, Carolina Power and Light Company, calculated (13) a minimum acceptable station blackout duration of four hours for the Shearon Harris Nuclear Power Plant (SHNPP) site. The licensee stated that no modifications are required to attain this coping duration.

The plant factors used to estimate the proposed SBO duration are:

1. **Off-site Power Design Characteristics**

   The plant AC power design characteristic group is "P2*" based on:

   a. Independence of the plant offsite power system characteristics of "I1/2,"

   b. Expected frequency of grid-related LOOPs of less than one per 20 years,

   c. Estimated frequency of LOOPs due to extremely severe weather (ESW) which places the plant in ESW Group "3,"

   d. Estimated frequency of LOOPs due to severe weather (SW) which places the plant in SW Group "2," and

   e. Implementation of plant-specific pre-hurricane shutdown requirements and procedures consistent with the guidelines of Section 4.2.3 of NUMARC 87-00.

2. **Emergency AC (EAC) Power Configuration Group**

The EAC power configuration of the plant is "C." Shearon Harris is equipped with two emergency diesel generators. One EAC power supply is necessary to operate safe-shutdown equipment following a loss of offsite power.

3. **Target Emergency Diesel Generator (EDG) Reliability**

The licensee has selected a target EDG reliability of 0.95. The selection of this target reliability is based on having a nuclear unit average EDG reliability for the last 100 demands greater than 0.95, consistent with NUMARC 87-00, Section 3.2.4.

Review of Licensee's Submittal

Factors which affect the estimation of the SBO coping duration are: the independence of the offsite power system grouping, the estimated frequency of LOOPs due to ESW and SW conditions, the expected frequency of grid-related LOOPs, the classification of EAC, the selection of EDG target reliability and the implementation of pre-hurricane shutdown requirements.

The licensee estimated the ESW-caused LOOP frequency to place the site in ESW Group "3," whereas NUMARC 87-00 classifies it as ESW Group "5." In its response to the telephone conversation of March 8, 1991 (15), the licensee stated that the ESW-caused LOOP frequency is based on the hurricane frequency of 1E-3/yr, as reported in the SHNPP FSAR Sections 2.3.1.2.6 and 2.3.1.2.7. The licensee further stated that hurricane force winds (i.e. sustained winds greater than 74 mph) have never been recorded by the Raleigh-Durham Weather Service, which is the basis of the SHNPP FSAR extreme weather analysis. This differs from the frequency of 1E-2 reported in NUMARC 87-00, Table 3-2. The licensee stated that the use of NUMARC 87-00 data would require validation,

because NUMARC did not verify the accuracy of the data in Table 3-2. The licensee chose to use the FSAR data, stating that it had already been submitted to the NRC. Furthermore, the licensee stated that it would consider the use of NUMARC 87-00 data a rejection of the plant's licensing basis and a potential backfit issue.

In its assessment of the proposed station blackout duration for the Shearon Harris site (13), the licensee took credit for the implementation of pre-hurricane shutdown to reduce the required coping duration by putting the plant in a shutdown condition two hours in advance of the onset of hurricane winds in excess of 73 mph. On the other hand, the licensee stated that hurricane winds of greater than 74 mph have never occurred in the area of the plant. 74 mph is the minimum speed criterion for hurricanes in the United States. Therefore, the licensee does not expect to shutdown the plant in advance of a hurricane. Hence, the licensee's position does not appear to be consistent with the intent of the plant-specific pre-hurricane shutdown guidelines provided in Section 4.2.3 of NUMARC 87-00, and thus, the licensee cannot use the relief provided by using this option.

With regard to the NUMARC 87-00 Table 3-2 data, the licensee claimed that this data has not been verified by NUMARC, therefore, it does not represent the site data. It is our understanding that the Table 3-2 data was prepared and provided to NUMARC by the staff, and we consider this data to be correct unless it is proven otherwise. Examination of Table 2.3.1-4 of the Shearon Harris FSAR (12) reveals that the licensee's claim of the frequency of ESW is based on data reported for the Raleigh-Durham airport for the years 1950-1978. The data provided in NUMARC 87-00 is based on a more recent time period and may provide information regarding extremely severe weather not contained in the data provided in the FSAR. Therefore, if the NUMARC data is correct, the licensee may need to revise its FSAR, or resolve the issue with the NRC under a separate task.

Based on the preceding paragraphs, the site would be in ESW Group "5" with the benefit of pre hurricane shutdown implementation, or ESW Group "3" with no benefit for pre shutdown.

Using data from Table 3-3 of NUMARC 87-00 for multiple rights-of-way transmission lines, the expected frequency of LOOPs due to SW conditions place the Shearon Harris site in SW Group "2," which is in agreement with what was stated in the licensee's submittal (13). The licensee's consideration of multiple rights-of-way for the Harris site is based on the transmission line routing scheme depicted in Figure 8.2.1-1 of the plant FSAR (12).

The licensee stated that the independence of the plant offsite power system grouping is "I1/2." A review of the Shearon Harris FSAR shows that, see Figure 1 (12):

1. All offsite sources are connected to the plant through a single 230 kV switchyard;

2. During normal operation, the essential buses (two emergency trains) are powered from the main generator through the unit auxiliary transformers;

3. Upon loss of power from the main generator, each emergency train is powered from an independent offsite power source through a start-up transformer;

4. Upon loss of power from one of the start-up transformers, there is no auto or manual transfer to an alternate power source.

Based on the above, the plant independence of offsite power system group is "I3." This determination is based on the guidance of Table 5 of RG 1.155 which states that if the normal source of offsite power is from the main generator, there needs to be an automatic and a manual/automatic

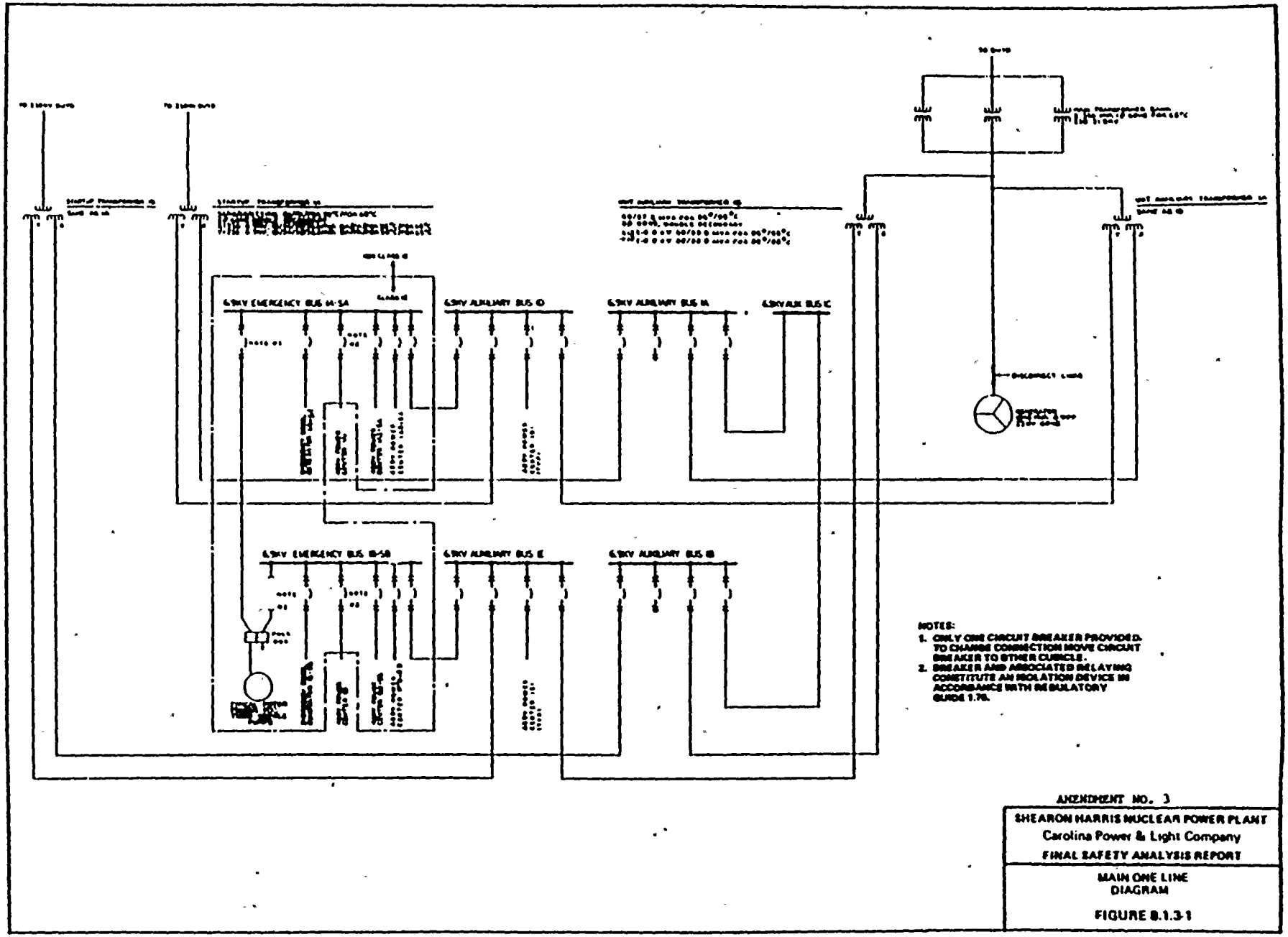

Figure 1: Shearon Harris Nuclear Power Plant Main One-Line Diagram

transfer of all safety buses to the preferred and alternate power sources. It appears that the licensee has assumed the capability to disconnect the main generator and backfeed power to the emergency buses from the grid as a viable transfer to an alternate offsite power source to support the independence of offsite power system group classification of "I1/2." The removal of a disconnect link typically takes several hours to complete and cannot be considered an acceptable means of transfer, according to the guidelines of NUMARC 87-00 Supplemental Questions/Answers (11).

Establishment of the proper Emergency AC (EAC) Configuration Group is based on the number of available EAC sources and the number of EAC sources required to operate safe shutdown equipment following a LOOP. Harris has two dedicated EAC sources, one of which is required after a LOOP. We agree with the licensee's assessment which places the plant in EAC Group "C."

The licensee selected (13) the EDG target reliability of 0.95 based upon having a nuclear unit average EDG reliability greater than 0.95 for the last 100 demands. Although this is an acceptable criterion for choosing an EDG target reliability, the guidance of RG 1.155 requires that the EDG statistics for the last 20 and 50 demands also be calculated. Without this information, it is difficult to judge how well the EDGs have performed in the past and if there should be any concern. We are unable to verify the demonstrated start and load-run reliability of the plant EDGs. This information is only available onsite as part of the submittal's supporting documents. Reliability data from NSAC-108 was not available in this case, as Shearon Harris was not licensed until May, 1987 and NSAC-108 covers the years 1983-1985. Nevertheless, the licensee needs to have an analysis showing the EDG reliability statistics for the last 20, 50 and 100 demands in its SBO submittal supporting documents.

With regard to the EDG reliability program, the licensee stated (14) its understanding that the target reliability is to be maintained consistent with the final resolution of Generic Issue B-56.

With regard to the expected frequency of grid-related LOOPs at the site, we can not confirm the stated results. The available information in NUREG/CR-3992 (3), which gives a compendium of information on the loss of offsite power at nuclear power plants in the U.S., only covers these incidents through the calender year 1984. Shearon Harris did not enter commercial operation until 1987. In the absence of any contradictory information, we agree with the licensee's statement.

A final characteristic needed to establish the required coping duration for the SHNPP is the implementation of pre-hurricane shutdown requirements and procedures which provide an enhanced coping capability under anticipated hurricane conditions. In its original submittal (13) the licensee stated that plant-specific pre-hurricane shutdown requirements and procedures which meet the guidelines of Section 4.2.3 of NUMARC 87-00 have been implemented, with the exception of load testing the emergency diesel generators due to conflicts with the post operating maintenance requirements imposed by Technical Specifications which would render the diesels inoperable for some duration. The licensee did not provide any additional information in its subsequent submittals (14 and 15) which addressed the diesel generator issue. Thus, the licensee's compliance with the pre-hurricane shutdown requirements of NUMARC 87-00 still needs to be resolved.

Based on the above, the offsite power design characteristic of the Shearon Harris site is "P3*," pending demonstration of compliance with the pre-hurricane shutdown requirements of NUMARC 87-00, Section 4.2.3., or "P2" if the licensee resolves the differences between its data and that given in NUMARC Table 3-2. In either case, it requires a minimum SBO coping duration of eight hours. Even if we were to consider the licensee's estimates for the ESW and SW groupings, the site would still require a minimum SBO coping duration of eight hours, based on a "P2" offsite power design characteristic group matrix for hurricane exposed plants, Table 3-6b of NUMARC 87-00, and an "I3" independence of offsite power system classification. The licensee can lower the minimum required

coping duration from eight hours to four hours if a commitment is made to choose an EDG target reliability of 0.975 instead of 0.95. Therefore, our review of the plant coping capability will be based on this commitment, i.e. minimum coping duration of four hours. A selection of 0.95 EDG target reliability requires that the licensee revise and re-submit the plant coping analysis for eight hours.

3.2 Station Blackout Coping Capability

Based on the assumption that the licensee will commit to choose a 0.975 EDG target reliability, the plant coping capability with an SBO event for a required duration of four hours is assessed based on the following results:

1. Condensate Inventory for Decay Heat Removal

Licensee's Submittal

The licensee's submittal stated (13) that 91,400 gallons of water are required for the decay heat removal during the four-hour coping period. Subsequently, the licensee revised (15) its estimate to include the effect of steam generator level shrinkage, resulting in a new total inventory requirement of 101,100 gallons. The licensee added that the minimum permissible emergency feedwater storage tank (EFST) level per Technical Specifications provides 270,000 gallons of water, which provides for a surplus inventory of 168,900 gallons for coping with a 4-hour SBO event.

Review of Licensee's Submittal

Using the expression provided in NUMARC 87-00, we estimated that 61,383 gallons of water would be required to remove decay heat during a four-hour SBO event, assuming no primary system cooldown. This estimate is based on the maximum licensed core thermal rating of 2755 MWt listed in the Shearon Harris FSAR (12).

The licensee indicated that the primary system will be cooled down, requiring an additional 39, 717 gallons of condensate. Although we didn't repeat the licensee's calculations, we concur with the licensee that, based on a minimum available EFST volume of 270,000 gallons, the site has sufficient condensate for both decay heat removal and cooldown during a four hour SBO event.

2. **Class-1E Battery Capacity**

Licensee's Submittal

The licensee stated (13) that a battery capacity calculation has been performed pursuant to NUMARC 87-00, Section 7.2.2 to verify that Class 1E batteries have sufficient capacity to meet SBO loads for four hours.

In its response to questions raised during the telephone conference on March 8, 1991 (15), the licensee stated that no load stripping of the class 1E batteries is required to support SBO coping loads for four hours. For the non-Class 1E batteries, approximately 33 breakers must be load stripped within one hour to assure the availability of general area emergency lighting for the control room. The licensee added that IEEE-Std 485 methodology was used for all battery sizing calculations, with a 1.25 aging factor and 1.04 temperature coefficient (70°F). The licensee did not state that a 10% to 15% design margin was included in the calculations. The licensee provided assurance that the switchyard breakers have their own battery supply that is independent of any coping loads and they could be closed manually if required.

Review of Licensee's Submittal

The batteries should be able to provide the normal plant monitoring and control for the entire SBO duration. The licensee's battery calculations were neither received nor reviewed. Based on information contained in the plant FSAR (12), each class-1E battery is rated at 1170 Ah for a four hour rate of discharge to 1.75V per cell at 25 °C (77°F). However, the actual designed final discharge voltage following an emergency discharge is 1.81 volts per cell (108.69 volts per battery). The battery room ambient temperature range is 70 to 85°F, with a design temperature of 77°F. Upon review of the 125V DC safety-related loads supplied from each battery, as shown in FSAR Tables 8.3.2-1 and 8.3.2-2, it appears that the ampere-hour capacity of the batteries is sufficient to support SBO coping loads for four hours. However, the licensee needs to verify that the battery calculations consider a design margin of 10 to 15 percent as recommended in IEEE-Std 485. In addition, the licensee needs to provide administrative control to ensure that the temperature remains above 70°F at all times.

3. Compressed Air

Licensee's Submittal

In its original submittal (13), the licensee stated that no air-operated valves are relied upon to cope with an SBO for four hours.

In the written response to questions raised during the telephone conference on March 8, 1991 (15), the licensee stated that the steam generator power operated relief valves (PORVs) are required for steam relief to the atmosphere during an SBO. There are three main steam PORVs, each with its own accumulator, however, only one PORV has power available from a DC source. The licensee further stated that a manual action which involves pumping up

the accumulator with a manual hydraulic pump will be required if the DC valve is cycled more than a few times, thereby depleting its accumulator, or if the operating procedures actuate several valves. The licensee stated that plant modifications (i.e. access platforms and additional lighting) will be implemented to enhance operator safety and performance in these areas during an SBO.

Review of Licensee's Submittal

Examination of the plant FSAR (12) reveals that flow control in the Auxiliary Feedwater System (AFW) is provided by three electro-hydraulic DC operated flow control valves to each of the three steam generators. These valves fail open upon a loss of power. In the written response to questions raised in the telephone conference on March 8, 1991 (15), the licensee stated that no local manual actions are required to control the AFW flow control valves during an SBO. Thus, this verifies that the plant can remotely control AFW flow during an SBO.

Local operation of the hydraulically-operated steam PORVs is required to remove decay heat from the RCS. The licensee recognizes this and has proposed several modifications to enhance operator performance (see Section 3.4). However, it did not provide an assurance that the area enclosing the PORVs is habitable. The licensee stated (14) that the temperature in the Main Steam Tunnel where the PORVs are located during an SBO is expected to reach 150°F. Although this temperature does not appear to impact equipment operability, it may be of a concern from a habitability point of view. The licensee needs to consider as a part of its proposed modifications the issue of habitability to ensure manual operation of the PORVs.

4. **Effects of Loss of Ventilation**

Licensee's Submittal

In its original response (13), the licensee provided the results of the steady state ambient air temperatures in the steam-driven AFW pump room (111°F) and the control room (111°F) during an SBO induced loss of ventilation. The licensee stated that reasonable assurance of the operability of SBO response equipment in the above areas has been assessed using Appendix F to NUMARC 87-00.

In its supplemental response (14), the licensee stated that the control room temperature rise calculation was based upon an earlier CP&L comprehensive calculation combined with NUMARC 87-00 guidance. Further, the licensee examined two potential dominant areas of concern , the Main Steam Tunnel and the RAB 236 elevation Mechanical Penetration Area, and found the temperatures of these areas to be well below the equipment operability limits given in NUMARC 87-00, Appendix F. The licensee concluded that no modifications are necessary to provide reasonable assurance of equipment operability during an SBO event.

In response to questions raised during the March 8, 1991 telephone conference, the licensee identified (15) the following assumptions that were used for performing all temperature rise calculations:

1. Battery-powered emergency lights are assumed to be 25 watts/bulb.

2. Emergency lights which run off inverter power are assumed to be 150 watts.

3. Lighting loads are based on assumptions 1 and 2 and the number of fixtures indicated on SHNPP lighting drawings.

4. Insulated steam lines and steam generator blowdown lines are assumed to be 150°F on contact with the outside of the insulation.

5. Room surface areas are scaled from station general arrangement drawings.

6. Control room staff is considered to be five men contributing to the heat load with each individual contributing 400 BTU/hr.

7. All doors were assumed to be closed.

8. Electrical loads that could be shed were included in the determination of the total heat inputs.

9. The following initial temperatures were assumed:

   a. Control room - 75°F
   b. Auxiliary building and general plant areas - 104°F

In addition, the licensee stated (15) that the control room heat-up calculation was performed in accordance with the methods defined in NUMARC 87-00, with equipment heat loads being extracted from existing control room HVAC calculations.

Review of Licensee's Submittal

The licensee's temperature rise calculations were neither received nor reviewed. Therefore, this review is based on summaries provided by the licensee in its submittals. As such, the review only covers the assumptions and methods identified by the licensee, and

assumes the calculated temperatures to be accurate, pending future verification.

The following table summarizes the information provided by the licensee for each of the rooms that were considered:

Area:	Initial Temp. (°F)	Final Temp. (°F)
• AFW Pump Room	104	111
• Control Room	75	111
• Main Steam Tunnel	104	150
• RAB 236' Mechanical Penetration	104	121.8

The licensee stated (13 and 14) that it has applied NUMARC methods to identify the aforementioned areas as potential dominant areas of concern, and that reasonable assurance of operability of SBO response equipment in these areas has been assessed using NUMARC 87-00 Appendix F.

Based on the information provided by the licensee, a summary of the significant comments from our review is as follows:

Control Room

- The licensee assumed an initial temperature of 75°F for the control room which is non-conservative instead of using the maximum technical specification allowed temperature of 85°F. The licensee can use this lower temperature if it establishes administrative controls which assure that this temperature would not be exceeded under any conditions.

- The licensee assumed five personnel in the control room area, each having a heat load of 400 BTU per hour, or 130 Watts. This is a non-conservative assumption. A more representative value according to the ASHRAE handbook (16) would be 230 to 250 Watts per person. The licensee also needs to justify why only five personnel will be present in the control room during an SBO.

- The licensee needs to provide a procedural step in the SBO procedure to open the control room cabinet door, in the absence of air conditioning, within 30 minutes of the onset of an SBO, consistent with the NUMARC 87-00 Supplemental Questions and Answers (11).

- Based on the above points, the licensee may need to revise the control room heat-up calculation and provide the final results.

Inverter Area

- During the telephone conference on March 8, 1991, the licensee stated that during an SBO the inverters will all be operating in a single room located next to the control room. The licensee further stated that the total heat loss of all operating inverters is 1600 W. This information has not been documented in the licensee's response. This assumption appears to be very non-conservative. In general, the inverters are constant heat loss equipment, i.e. each having an efficiency of 0.8 on its rated capacity. At lower capacity, the heat generation rate is assumed to be the same as that for full load. The licensee needs to verify that the assumed inverter heat generation rate is consistent with the expected heat loss and revise the heatup calculation for this area accordingly.

AFW Pump Room

- The licensee calculated that the final temperature of the AFW pump room during an SBO to be 111°F. Based on an assumed initial temperature of 104°F, the calculated temperature rise of 7°F appears to be small.

Main Steam Tunnel and RAB 236' Mechanical Penetration Area

- As stated earlier, the licensee did not provide information regarding the method used to evaluate the temperature rise for these areas, thus, we were unable to review the analyses.

5. **Containment Isolation**

Licensee's Submittal

In its original submittal, the licensee stated (13) that the plant list of containment isolation valves (CIVs) has been reviewed to verify that valves which must be capable of being closed or that must be operated (cycled) under station blackout conditions can be positioned with indication independent of the preferred and blacked-out unit's class-1E power supplies. The licensee stated that the following procedure changes are required to ensure that appropriate containment integrity can be provided under SBO conditions:

- A procedural change will be added to manually close the containment sump pump discharge isolation valve when establishing containment isolation under SBO. This valve and its counterpart inside containment are normally open and fail as-is on loss of AC power.

- Guidance will be provided for isolation of the containment spray and RHR recirculation sump suction lines in the event these valves are open. These valves are normally closed, have DC indications and fail as-is on loss of AC power.

During the telephone conference on March 8, 1991, the licensee was asked to explain the basis for the following penetrations being acceptable per NUMARC 87-00:

X-4, 5, 6	Feedwater Loops A, B and C
X-15, 16	RHR train A/B hot leg suction
X-47, 48	RHR suction from containment sump
X-49, 50	Containment Spray suction from sump
X-74	Containment sump pump discharge

The licensee stated in its response (15) that the feedwater loops were non-radioactive fluid closed loops and were exempt from SBO isolation requirements. With respect to the RHR hot leg suction trains (X-15, 16), the licensee stated that the isolation valve is electrically interlocked in the closed position and cannot be opened during normal operation, and thus, there was no additional SBO isolation verification requirement. With respect to the RHR and Containment Spray sump suction lines and containment sump pump discharge (X-47, 48, 49, 50, 74), the licensee stated that the isolation valve inside containment is inaccessible and that if isolation is required the valve can remotely be confirmed closed, or the valve downstream can be closed manually.

Review of Licensee's Submittal

Upon examination of the containment isolation system data in FSAR Table 6.2.4-1, the licensee was provided with a list of ten containment penetrations for which questions arose concerning

whether or not adequate assurance of containment integrity had been provided. Review of the licensee's response to the question of containment isolation for the aforementioned set of penetrations, resulted in one significant comment regarding penetration X-74. For the other penetrations, the licensee's justifications are consistent with the intent of RG 1.155.

In its original submittal, the licensee correctly identified the containment sump pump discharge isolation valve (X-74) as requiring procedural changes to ensure containment integrity. The isolation valve is normally open and fails as-is. The use of a downstream valve to satisfy containment isolation requirements, as suggested by the licensee, is not consistent with the guidance. It is our position that this change needs to be implemented. The valve closure needs to be confirmed by position indication; (i.e. local, manual, remote, mechanical, etc.).

6. Reactor Coolant Inventory

Licensee's Submittal

The licensee stated that the ability to maintain adequate reactor coolant system (RCS) inventory to ensure that the core is cooled has been assessed for each primary coolant pump. The licensee used a plant-applicable analysis contained in Westinghouse Owners Group Background Document ECA-00 "Loss of All AC Power" for this assessment. The licensee concluded that the expected rates of reactor coolant inventory loss under SBO conditions did not result in core uncovery in an SBO for 4 hours.

Review of Licensee's Submittal

The licensee's use of Westinghouse Report ECA-00 without specific justification for its applicability to the plant is not acceptable. We

performed an independent evaluation of RCS inventory using the available information in the plant FSAR. Table 5.1.0-1 of the FSAR (12) reports a total liquid volume for the primary system of 8798 ft^3, at a nominal operating pressure of 2250 psia and a reactor vessel outlet temperature of 620.2°F. In its written response to questions raised at the telephone conference on March 8, 1991, the licensee reported (15) that the assumed RCS leakage consisted of 25 gpm/pump from NUMARC plus 11 gpm system leakage from Technical Specifications. The licensee also assumed a cooldown to 350°F. Using this information, we calculated the volume of water remaining in the core to be 3696 ft^3 which appears adequate for ensuring that the core remains covered. Thus, we agree with the licensee's conclusion that the core will not be uncovered during a four hour SBO event.

NOTE:

The 25-gpm RCP seal leak rate was agreed to between NUMARC and the NRC staff pending resolution of Generic Issue (GI) 23. If the final resolution of GI-23 defines higher RCP seal leak rates than assumed for the RCS inventory evaluation, the licensee needs to be aware of the potential impact of this resolution on its analyses and actions addressing conformance to the SBO rule.

3.3 Proposed Procedure and Training

Licensee's Submittal

The licensee stated (13) that plant procedures will be reviewed and modified, if necessary, to meet the guidelines of NUMARC 87-00, Section 4 in the following areas:

- AC power restoration

  - Procedure DTRM-GP-2; Restoration of Service Following a System Shutdown - Eastern Area

  - Operating Procedure OP-156.02; AC Electrical Distribution, Section 8.17: Restoration of Offsite Power to Emergency Buses Following Complete Loss of Power.

- Severe weather

The licensee also states that plant procedures have been reviewed and changes necessary to meet NUMARC 87-00 will be implemented in the following areas:

- Station blackout response

  - Emergency Operating Procedure EOP-EPP-001; Loss of Power to 1A-SA and 1B-SB Busses

  - Emergency Operating Procedure EOP-EPP-002; Loss of All AC Power Recovery Without SI Required

  - Emergency Operating Procedure EOP-EPP-003; Loss of All AC Power Recovery With SI Required

- Procedure changes associated with any modifications required after assessing coping capability per NUMARC 87-00, Section 7.

The licensee stated that these procedure changes will be completed within two years after the notification provided by the NRC in accordance with 10 CFR 50.63 (c)(3).

Review of Licensee's Submittal

We neither received nor reviewed the affected procedures, although several procedure changes have been identified as being required to maintain containment integrity under SBO conditions. We consider these procedures to be plant-specific actions concerning the required activities to cope with an SBO. It is the licensee's responsibility to revise and implement these procedures, as needed, to mitigate an SBO event and to assure that these procedures are complete and correct, and that the associated training needs are carried out accordingly.

3.4 Proposed Modification

Licensee's Submittal

Plant modifications were identified to satisfy the 4-hour coping duration and enhance operator ability to perform required actions associated with an SBO event. These modifications are as follows:

- The emergency lighting for the Main Control Room currently does not satisfy the 4-hour duration. Control room emergency lighting capability will be provided by modifying, as appropriate, the power source(s) for Control Room emergency lighting.

- Local operation of the Main Steam PORVs is required to remove decay heat from the RCS. The following changes will be made:

    - Add emergency lighting in the vicinity of the Main Steam PORVs,

    - Add sound powered phone jacks at each Main Steam PORV, and

    - Improve access to each Main Steam PORV

- Local operation of CS-V517, RCP seal leakoff isolation valve is required to cope with an SBO event. A permanent access platform/ladder will be built for access to CS-V517. Access can currently be made by use of a temporary ladder.

The licensee stated that these modifications will be completed within two years after the notification provided by the NRC in accordance with 10 CFR 50.63 (c)(3).

Review of Licensee's Submittal

In addition to the modifications described above, the licensee needs to consider the issue of habitability in the Main Steam Tunnel area to ensure manual operation of the PORVs during an SBO, as the temperature in this area is expected to reach 150°F.

Our review has also identified several concerns which may require additional modifications for their resolution.

3.5 Quality Assurance and Technical Specifications

The licensee did not provide any information on how the plant complies with the requirement of RG 1.155, Appendices A and B.

4.0 CONCLUSIONS

Based on our review of the licensee's submittals and the information available in the FSAR for Shearon Harris Station Unit Number 1, we find that the submittal conforms with the requirements of the SBO rule and the guidance of RG 1.155 with the following exceptions:

1. **Proposed Station Blackout Duration**

   Based on the technical evaluation described in this report, the offsite power design characteristic of the Shearon Harris site is "P3*," pending demonstration of compliance with the pre-hurricane shutdown requirements of NUMARC 87-00, Section 4.2.3., or "P2" if the licensee resolves the differences between its data and that given in NUMARC Table 3-2. In addition, even if we consider the licensee's estimate of ESW and SW the site is still classified as "P2" with the independence of offsite power characteristic of "I3." In either case, a minimum SBO coping duration of eight hours is required for an EDG target reliability of 0.95. The licensee can lower the minimum required coping duration from eight hours to four hours if a commitment is made to choose an EDG target reliability of 0.975 instead of 0.95. A selection of 0.95 EDG target reliability requires that the licensee revise and submit the plant coping analysis for eight hours. If the licensee does not commit to an EDG target reliability of 0.975, it needs to provide a new submittal based on an eight hour coping duration.

2. Class-1E Battery Capacity

   The licensee stated that IEEE-std 485 methodology was used to verify that the Class 1E batteries have sufficient capacity to support the needed loads during an SBO. Since no battery sizing calculations were provided, our review is based on the licensee's

submittals and the information available in the FSAR. Upon review of the 125V DC safety-related loads supplied from each battery, as shown in FSAR Tables 8.3.2-1 and 8.3.2-2, it appears that the ampere-hour capacity of the batteries is sufficient to support SBO coping loads for four hours. However, the licensee needs to verify that the battery calculations consider a design margin of 10 to 15 percent as recommended in IEEE-Std 485. In addition, the licensee needs to provide administrative control to ensure that the temperature remains above 70°F at all times.

3. Compressed Air

Although the licensee proposes several modifications to improve the accessibility and operation of the PORVs, it does not provide assurance that this area will be habitable to perform local manual actions during an SBO. The licensee calculated the expected temperature of thePORVs area during an SBO to be 150°F. The licensee needs to ensure that this area is habitable during a four hour SBO.

4. Effects of Loss of Ventilation

Based on the information provided by the licensee, a summary of the significant comments from our review is as follows:

Control Room

- The licensee assumed an initial temperature of 75°F for the control room which is non-conservative instead of using the maximum technical specification allowed temperature of 85°F. The licensee can use this lower temperature if it establishes administrative controls which assure that this temperature would not be exceeded under any conditions.

- The licensee assumed five personnel in the control room area, each having a heat load of 400 BTU per hour, or 130 Watts. This is a non-conservative assumption. A more representative value according to the ASHRAE handbook (16) would be 230 to 250 Watts per person. The licensee also needs to justify why only five personnel in the will be present in the control room during an SBO.
- The licensee needs to provide a procedural step in the SBO procedure to open the control room cabinet door, in the absence of air conditioning, within 30 minutes of the onset of an SBO, consistent with the NUMARC 87-00 Supplemental Questions and Answers (11).

- Based on the above points, the licensee may need to revise the control room heatup calculation and provide the final results.

Inverter Area

- During the telephone conference on March 8, 1991, the licensee stated that during an SBO the inverters will all be operating in a single room located next to the control room. The licensee further stated that the total heat loss of all operating inverters is 1600 W. This information has not been documented in the licensee's response. This assumption appears to be very non-conservative. In general, the inverters are constant heat loss equipment, i.e. each having an efficiency of 0.8 on its rated capacity. At lower capacity, the heat generation rate is assumed to be the same as that for full load. The licensee needs to verify that the assumed inverter heat generation rate is consistent with the expected heat loss and revise the heatup calculation for this area accordingly.

AFW Pump Room

- The licensee calculated that the final temperature of the AFW pump room during an SBO to be 111°F. Based on an assumed initial temperature of 104°F, the calculated temperature rise of 7°F appears to be small.

5. Containment Isolation

Review of the licensee's response to the question of containment isolation for the aforementioned set of penetrations, resulted in one significant comment regarding penetration X-74. In its original submittal, the licensee correctly identified the containment sump pump discharge isolation valve (X-74) as requiring procedural changes to ensure containment integrity. The isolation valve is normally open and fails as-is. The use of a downstream valve to satisfy containment isolation requirements, as suggested by the licensee, is not consistent with the guidance. It is our position that this change needs to be implemented. The valve closure needs to be confirmed by position indication; (i.e. local, manual, remote, mechanical, etc.).

6. Proposed Modifications

Our review has identified several concerns which may require additional modifications for their resolution. The licensee needs to consider the issue of habitability in the Main Steam Tunnel area to ensure manual operation of the PORVs during an SBO, as the temperature in this area is expected to reach 150°F.

7. Quality Assurance and Technical Specifications

The licensee's submittal does not document the conformance of the plant's SBO equipment with the guidance of RG 1.155, Appendices A, and B.

5.0 REFERENCES

1. The Office of Federal Register, "Code of Federal Regulations Title 10 Part 50.63," 10 CFR 50.63, January 1, 1989.

2. U.S. Nuclear Regulatory Commission, "Evaluation of Station Blackout Accidents at Nuclear Power Plants - Technical Findings Related to Unresolved Safety Issue A-44," NUREG-1032, Baranowsky, P.W., June 1988.

3. U.S. Nuclear Regulatory Commission, "Collection and Evaluation of Complete and Partial Losses of Offsite Power at Nuclear Power Plants," NUREG/CR-3992, February 1985.

4. U.S. Nuclear Regulatory Commission, "Reliability of Emergency AC Power System at Nuclear Power Plants," NUREG/CR-2989, July 1983.

5. U.S. Nuclear Regulatory Commission, "Emergency Diesel Generator Operating Experience, 1981-1983," NUREG/CR-4347, December 1985.

6. U.S. Nuclear Regulatory Commission, "Station Blackout Accident Analyses (Part of NRC Task Action Plan A-44)," NUREG/CR-3226, May 1983.

7. U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory Research, "Regulatory Guide 1.155 Station Blackout," August 1988.

8. Nuclear Management and Resources Council, Inc., "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," NUMARC 87-00, November 1987.

9. Nuclear Safety Analysis Center, "The Reliability of Emergency Diesel Generators at U.S. Nuclear Power Plants," NSAC-108, Wyckoff, H., September 1986.

10. Thadani, A. C., Letter to W. H. Rasin of NUMARC, "Approval of NUMARC Documents on Station Blackout (TAC-40577)," dated October 7, 1988.

11. Thadani, A. C., letter to A. Marion of NUMARC, "Publicly-Noticed Meeting December 27, 1989," dated January 3, 1990, (Confirming "NUMARC 87-00 Supplemental Questions/Answers," December 27, 1989).

12. Shearon Harris Nuclear Power Plant, Unit Number 1 Final Safety Analysis Report (FSAR).

13. McDuffie M. A., letter to NRC Document Control Desk, "Response to Station Blackout Rule," Docket No. 50-400, dated March 3, 1989.

14. Cutter A. B., letter to NRC Document Control Desk, "Supplemental Response to Station Blackout Rule," Docket Number 50-400, dated March 30, 1990.

15. Floyd, S. D., memorandum to A. S. Gill, "Additional Information for Station Blackout Review of Shearon Harris Nuclear Power Plant," Docket Number 50-400, dated April 5, 1991.

16. ASHRAE Handbook and Product Manual 1977 Fundamentals, published by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.