UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STATION BLACKOUT RULE (10 CFR 50.63)

CAROLINA POWER & LIGHT COMPANY

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1

DOCKET NO. 50-400

## 1.0 INTRODUCTION

On July 21, 1988, the Code of Federal Regulations, 10 CFR Part 50, was amended to include a new section 50.63, entitled "Loss of All Alternating Current Power,"(Station Blackout). The Station Blackout (SBO) Rule requires that each light-water-cooled nuclear power plant be able to withstand and recover from an SBO of a specified duration. The SBO Rule also requires licensees to submit information as defined in 10 CFR 50.63 and to provide a plan and schedule for conformance to the SBO Rule. The SBO Rule further requires that the baseline assumptions, analyses, and related information be available for NRC review. Guidance for conformance to the SBO Rule is provided by (1) Regulatory Guide (RG) 1.155, Station Blackout, (2) The Nuclear Management and Resources Council, Inc. (NUMARC) 87-00, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, and (3) NUMARC 87-00 Supplemental Questions/Answers and Major Assumptions dated December 27, 1989, (issued to the industry by NUMARC on January 4, 1990).

To facilitate the NRC staff's (hereafter referred to as staff) review of licensee responses to the SBO Rule, the staff endorsed two generic response formats. One response format is for use by plants proposing to use an Alternate AC (AAC) power source, and the other format is for use by plants proposing an AC independent response. The generic response formats provide the staff with a summary of the results from the licensee's analysis of the plant's SBO coping capability. The licensees are expected to verify the accuracy of the results

and maintain documentation that supports the stated results. Compliance to the SBO Rule is verified by a review of the licensee's submittal, an audit review of the supporting documentation as deemed necessary, and possible followup NRC inspections to ensure that the licensee has implemented the appropriate hardware and/or procedure modifications that will be required to comply with the SBO Rule.

Carolina Power & Light Company's (the licensee) response to the SBO Rule was provided by letters from M. A. McDuffie on March 3, 1989, and A. B. Cutter on March 30, 1990, to the U.S. Nuclear Regulatory Commission, Document Control Desk. Also, a teleconference between representatives of the licensee and the NRC staff was conducted on March 8, 1991. The licensee's submittals were reviewed by Science Applications International Corporation (SAIC) under contract to the NRC. The results of the review are documented by an SAIC Technical Evaluation Report (TER) SAIC-91/6655, "SHEARON HARRIS NUCLEAR POWER PLANT, UNIT NUMBER 1, STATION BLACKOUT EVALUATION" dated August 22, 1991, (Attachment 1).

## 2.0 EVALUATION

After reviewing the licensee's submittals and the SAIC TER, the staff concurs with the SAIC analysis and conclusions as identified in the SAIC TER (refer to Attachment 1 for details). The staff findings and recommendations are summarized as follows:

### 2.1 Station Blackout Duration

The licensee has calculated a minimum acceptable SBO duration of 4 hours based on a plant AC power design characteristic Group "P2*", an emergency AC (EAC) power configuration Group "C", and a target Emergency Diesel Generator (EDG) reliability of 0.95. The Group "C" EAC configuration is based on two EDGs not credited as AAC power supplies with one EDG required to operate safe shutdown equipment following a loss of offsite power. The target EDG reliability was based on the Shearon Harris Nuclear Power Plant (Harris) having an average EDG

reliability greater than 0.95 over the last 100 demands. Although this is an acceptable criterion, the guidance of RG 1.155 requires that the EDG reliability statistics for the last 20 and 50 demands also be calculated. The "P2*" grouping is based on plant specific weather data, a severe weather (SW) classification of Group "2", an extremely severe weather (ESW) classification of Group "3", an independence of offsite power classification of Group "I1/2", expected frequency of grid related losses of offsite power (LOOPs) of less than one per 20 years, implementation of plant specific pre-hurricane shutdown requirements and procedures consistent with the guidelines of section 4.2.3 of NUMARC 87-00.

After reviewing the available information in the licensee's submittals, RG 1.155, NUMARC 87-00, and SAIC's TER, the staff agrees with the finding of the TER that the licensee's "P2*" grouping is not appropriate for Harris. Based on the TER, the offsite power design characteristic of Harris is "P3*", pending demonstration of compliance with the pre-hurricane shutdown requirements of the NUMARC 87-00, Section 4.2.3, or "P2" if the licensee resolves the difference between its data and that given in the NUMARC Table 3-2. Either the P3* or P2 classification requires a minimum SBO coping duration of 8 hours. The licensee can lower the minimum required coping duration from 8 hours to 4 hours if an EDG target reliability of 0.975 is chosen instead of 0.95. The selection of an 0.95 EDG target reliability requires that the licensee revise and resubmit its analysis for a plant coping duration of 8 hours. This SE is based on a plant coping duration of 4 hours and an EDG target reliability of 0.975.

Recommendations: The licensee should have an analysis showing EDG reliability statistics for the last 20, 50, and 100 demands in the documentation supporting the SBO submittal. The licensee should select an EDG target reliability of 0.975 or resubmit its SBO analysis based on a required SBO coping duration of 8 hours rather than 4 hours.

## 2.2 Station Blackout Coping Capability

The licensee has proposed coping independent of an AAC power source for the SBO coping duration of 4 hours and recovery therefrom. The characteristics of the following plant systems and components were reviewed to assure

that the systems have the availability, adequacy, and capability to achieve and maintain a safe shutdown and to recover from an SBO for a 4-hour coping duration.

### 2.2.1 Condensate Inventory for Decay Heat Removal

The licensee stated that 101,100 gallons of water are required for the decay heat removal during a 4-hour coping period and the minimum permissible emergency feedwater storage tank (EFST) level per Technical Specifications (TS) provides 270,000 gallons of water, which leaves a surplus inventory of 168,900 gallons for coping with 4-hour SBO events. Based on its review, the staff agrees with the licensee that there is sufficient condensate water to cope with and recover from an SBO of 4 hours.

### 2.2.2 Class 1E Battery Capacity

The licensee stated that a battery capacity calculation has been performed pursuant to NUMARC 87-00, Section 7.2.2 to verify that the Class 1E batteries have sufficient capacity to meet SBO loads for 4 hours. The licensee added that IEEE-Std 485 methodology was used for all battery sizing calculations, with a 1.25 aging factor and a 1.04 temperature correction factor (70°F). However, the licensee did not state that the calculation included a design margin of 10 to 15 percent as specified in the Standard. The licensee stated that no load stripping on the Class 1E batteries is required to support SBO coping loads for 4 hours.

For the non-Class 1E batteries, approximately 33 breakers must be load stripped within 1 hour to assure the availability of general area emergency lighting for the control room. The licensee provided assurance that the switchyard breakers have their own battery supply that is independent of any coping loads and the breakers could be closed manually if required.

The licensee's battery calculations were neither received or reviewed. However, based on information submitted and contained in the plant Final Safety Analysis Report (FSAR), it appears that the ampere-hour capacity of the batteries is sufficient to support SBO coping loads for 4 hours.

Recommendation: The licensee should verify that the battery calculations consider a design margin of 10 to 15 percent as recommended in IEEE-Std 485, and that the battery room temperature would never be lower than 70°F prior to an SBO event.

2.2.3 Compressed Air

The licensee stated that with the exception of the steam generator power operated relief valves (PORVs) no air-operated valves are relied upon to cope with an SBO for 4 hours. The 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. Manual action which involves pumping up the accumulator with a manual hydraulic pump per the existing procedures will be required if the DC valve is cycled more than a few times (thereby depleting its accumulator), or if operating procedures result in actuation of several valves. The licensee further stated that plant modifications (i.e., access platforms and additional lighting) will be implemented to enhance operator safety and performance during SBO. Based on its review, the staff agrees with the licensee that, with the exception of the PORVs, no air-operated valves are relied upon to cope with an SBO event, and concludes that the manual action which may be required during an SBO event to refill the PORV accumulator with compressed air is acceptable.

Recommendation: The licensee should provide assurance that the area enclosing the PORVs is habitable.

### 2.2.4 Effects of Loss of Ventilation

The licensee has performed analyses to determine the effects of loss of ventilation in the control room, inverter room, auxiliary feedwater (AFW) pump room, main steam tunnel, reactor building (RAB), and mechanical penetration room during an SBO event. The staff's evaluation of the effects of loss of ventilation in each of these areas is provided below:

#### 2.2.4.1 Control Room

The licensee stated that using the NUMARC 87-00 guidance, the calculated peak temperature for the control room is 111°F. Consequently, the licensee concluded that the control room is not a dominant area of concern (DAC).

The staff and its consultant reviewed the input parameters used by the licensee for the analysis. They found that non-conservative values were assumed for the initial control room temperature and personnel heat load. The staff agrees with its consultant's conclusion that the effects of these non-conservative parameters on the control room final calculated peak temperature would be significant. If the licensee were to use more conservative values for these input parameters, the final calculated peak temperature in the control room may exceed 120°F. Therefore, the staff has not been able to conclude that the above calculated peak temperature of 111°F for the control room is acceptable.

In addition, the licensee has not addressed the procedure which will require the operators to open instrument cabinet doors within 30 minutes of the onset of an SBO event per the guidance described in NUMARC 87-00. Without this procedure and an acceptable calculated peak temperature, the staff has not been able to conclude that the control room is not a DAC.

Recommendations: The licensee should reevaluate the control room temperature rise using an initial temperature no lower than the maximum allowed by the TS or the administrative procedures, and use conservative values for personnel heat load as describe in the SAIC TER for the heat-up calculation.

The licensee should provide a step in the SBO procedure to open the control room cabinet doors within 30 minutes of the onset of an SBO.

2.2.4.2 Inverter Room

With respect to the heat-up analysis for the inverter room, the calculated peak temperature and the detailed description of the analysis have not been provided by the licensee for staff review. Therefore, the staff has not been able to conclude that the operability of equipment and personnel habitability in this room during an SBO event are acceptable.

Recommendation: The licensee should perform a heat-up analysis using a conservative value for the inverter heat load to ensure that the calculated peak temperature in the inverter room is within the limits described in NUMARC 87-00 for equipment operability and personnel habitability.

2.2.4.3 AFW Pump Room, Main Steam Tunnel, and RAB Mechanical Penetration Room

The calculated peak temperatures for the AFW room, the main steam tunnel and the RAB 236-foot elevation mechanical penetration room are 111°F, 150°F, and 121.8°F, respectively. The temperatures of these areas are well below the equipment operability limits given in NUMARC 87-00, Appendix F. Therefore, the licensee concluded that there is reasonable assurance of operability of SBO response equipment in these areas.

Based on its review, the staff agrees with the licensee that there is reasonable assurance of SBO response equipment operability in the above areas during an SBO event at Harris.

2.2.5 Containment Isolation

The licensee stated 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 SBO conditions can be positioned with

indication independent of the preferred and blacked-out unit's Class-1E power supplies. Accordingly, the licensee concluded that no modifications or procedure changes are necessary to ensure containment integrity during an SBO event.

The licensee provided a list of containment penetrations and justification for exclusion per NUMARC 87-00 for each penetration. These penetrations are: The feedwater loops A, B, and C (penetrations X-4, X-5, and X-6), the containment sump pump discharge (penetration X-74), the residual heat removal (RHR) suction from containment sump (penetrations X-47 and X-48), the RHR suction from hot legs (penetrations X-15 and X-16), and the containment spray suction (penetrations X-49 and X-50). The staff's evaluation of each of these penetrations to ensure containment integrity is provided below:

The licensee stated that the feedwater loops (penetrations X-4, X-5, and X-6) were non-radioactive fluid closed loops and were exempt from the SBO isolation requirements. The staff agrees with the licensee that this is an acceptable exclusion criterion which meets the guidance described in RG 1.155.

With respect to the RHR hot leg suction (penetrations X-15 and X-16) the licensee stated that the isolation valves are electrically interlocked in the closed position during normal operation. Based on its review, the staff finds that the isolation valves for these penetrations are AC-powered and will momentarily lose their position indications in the control room upon loss of AC during an SBO event. However, these isolation valves and the associated RHR system could not be operated during an SBO event when AC power is not available. Therefore, these isolation valves would remain in their pre-existing (closed) positions during an SBO event. The pre-existing positions are specified by the system operating procedures with proper valve position indications in the control room prior to an SBO event. If the RHR system were required when AC power is restored, valve position indications would be

available in the control room. Thus, the staff concludes that the containment isolation valve design and operation for these penetrations have met the intent of the guidance described in RG 1.155 and are acceptable.

With respect to the RHR and containment spray suction line (penetrations X-47, X-48, X-49, and X-50), the isolation valves for these penetrations are closed during normal operation, remain closed upon power failure, and are required to open during the safety injection recirculation phase following a loss of coolant accident (LOCA).

Based on its review and rationales similar to those described above for the penetrations X-15 and X-16, the staff concludes that the containment isolation valve design and operation for the penetrations X-47, X-48, X-49, and X-50 have met the intent of the guidance described in RG 1.155 and are acceptable.

With respect to the containment sump pump discharge penetration X-74, the isolation valves for this penetration are normally open and remain open upon power failure. Although the staff finds that this penetration is not part of an engineered safety feature system and that it is not required to function during an SBO, the staff's position is that it does not meet the requirements of 10 CFR 50.63(a)(2) for ensuring that "...appropriate containment integrity is maintained...." The containment isolation valve design and operation for this penetration must be in accordance with the guidance described in RG 1.155.

Based on its review, and pending resolution of the isolation valve for the containment sump pump discharge line discussed above, the staff concludes that containment integrity at the Harris plant could be maintained during an SBO event.

Recommendation: The licensee should implement a procedural change or a design modification for the isolation valves of the penetration X-74, list these valves in an appropriate procedure, and identify the actions necessary to ensure that they are fully closed during an SBO event. The valve closure should be confirmed by position indication (local, mechanical, remote, process

information, etc.). This information should also be included with the other documentation that is to be maintained by the licensee in support of the SBO submittals.

2.2.6 Reactor Coolant Inventory

The licensee stated that the ability to maintain adequate reactor coolant system (RCS) inventory to ensure that the core is cooled for 4 hours has been assessed. The licensee referred to an analysis contained in Westinghouse Owners Group Background Document ECA-0.0 "Loss of All AC Power" developed for Emergency Response Guidelines (ERG) for this assessment. The licensee concluded that the expected rates of reactor coolant inventory loss under SBO conditions did not result in uncovering the core.

The licensee's use of Westinghouse ERG ECA-0.0 without specific justification for its applicability to the plant is not acceptable. However, the staff's consultant, SAIC, performed an independent evaluation of RCS inventory based on a cooldown to 350°F, an RCS leakage of 25 gallons per minute (gpm) per pump in accordance with NUMARC guidelines, and 11 gpm system leakage allowed by TS. The calculation indicated that there is sufficient RCS inventory to keep the core covered during an SBO event of 4 hours. After reviewing the supporting documentation and SAIC's TER, the staff agrees with the licensee's assessment that there will be sufficient reactor coolant inventory to keep the core covered during an SBO event of 4 hours.

The reactor coolant inventory evaluation was based on the guidance of NUMARC 87-00 for seal leakage of 25 gpm per recirculation pump for pressurized water reactors. The 25 gpm recirculation pump leakage 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 recirculation pump seal leakage rates than assumed for the RCS inventory evaluation, the licensee should be aware of the potential impact of this resolution on its analysis and actions addressing conformance to the SBO Rule.

## 2.3 Procedures and Training

The licensee stated that the plant procedures in the areas of SBO response guidelines, AC power restoration, and severe weather have been reviewed and that the changes made to meet NUMARC 87-00, Sections 4 and 7, guidelines will be completed within 2 years after notification provided by the staff in accordance with 10 CFR 50.63 (c)(3).

The staff did not review the procedures or proposed procedure modifications. The staff expects the licensee to maintain and implement these procedures including any others that may be required to ensure an appropriate response to an SBO event. Although personnel training requirements for an SBO response were not specifically addressed by the licensee's submittal, the staff expects the licensee to implement appropriate training to ensure an effective response to an SBO.

## 2.4 Proposed Modifications

The licensee identified plant modifications in addition to the previously described procedure changes that are needed to satisfy the 4-hour coping duration and enhance operator ability to perform required actions associated with an SBO event. These modifications are:

1) Modification of the power source(s) for control room emergency lighting capability.

2) Adding emergency lighting, sound powered phone jacks, and improved access to each main steam PORV.

3) A permanent access platform/ladder will be built for access to CS-V517 reactor coolant pump (RCP) seal leakoff isolation valve.

The licensee stated that these modifications will be completed within 2 years after the notification provided by the NRC in accordance with 10 CFR 50.63(c)(3).

The staff agrees that the proposed modifications are needed to enhance the plant's ability to cope with an SBO for the required coping duration.

Recommendation: The licensee should include a full description of the proposed plant modifications in the documentation that is to be maintained by the licensee in support of the SBO submittals.

## 2.5 Quality Assurance and Technical Specifications

The licensee did not specifically address Quality Assurance (QA) programs or TS for the SBO equipment. The TS for the SBO equipment are currently being considered generically by the NRC in the context of the Technical Specification Improvement Program and remain an open item at this time. However, the staff would expect that the plant procedures will reflect the appropriate testing and surveillance requirements to ensure the operability of the necessary SBO equipment. If the staff later determines that TS regarding the SBO equipment are warranted, the licensee will be notified of the implementation requirements.

Recommendation: The licensee should verify that the SBO equipment is covered by an appropriate QA program consistent with the guidance of RG 1.155. This evaluation should be documented as part of the documentation supporting the SBO Rule response.

## 2.6 EDG Reliability Program

The submittal did not specifically address the commitment to implement an EDG reliability program to conform to the guidance of RG 1.155, Position 1.2.

Recommendation: It is the staff's position that an EDG reliability program should be developed in accordance with the guidance of RG 1.155, Section 1.2. If an EDG reliability program currently exists, the program should be evaluated and adjusted in accordance with RG 1.155. Confirmation that such a program is in place or will be implemented should be included in the documentation that is to be maintained by the licensee in support of the SBO submittals.

## 2.8 Scope of Staff Review

The SBO Rule (10 CFR 50.63) requires licensees to submit a response containing specifically defined information. It also requires utilities "... to have baseline assumptions, analyses, and related information used in their coping evaluations available for NRC review." The staff and its contractor (SAIC) did not perform a detailed review of the proposed hardware and procedural modifications which are scheduled for later implementation. However, based on our review of the licensee's supporting documentation, we have identified the following areas for focus in any followup inspection or assessment that may be undertaken by the NRC to verify conformance with the SBO Rule. Additional items may be added as a result of the staff review of the actions taken by the licensee in response to this SE.

a. Hardware and procedural modifications;

b. SBO procedures in accordance with R.G. 1.155, Position 3.4, and NUMARC 87-00, Section 4;

c. Operator staffing and training to follow the identified actions in the SBO procedures;

d. EDG reliability program to meet, as a minimum, the guidelines of RG 1.155;

e. Equipment and components required to cope with an SBO are incorporated in a QA program that meets the guidance of RG 1.155, Appendix A; and

f. Actions taken pertaining to the specific recommendations noted above in the SE.

## 3.0 SUMMARY AND CONCLUSION

The staff has reviewed the licensee's responses to the SBO Rule (10 CFR 50.63) and the TER prepared by the staff's consultant, SAIC. Based on our review, some actions and verifications need to be completed as described in the recommendations itemized herein. These include the selection of an EDG target reliability of 0.975 or a reanalysis of the plant's capability to cope with an SBO of 8 hours, verification of the design margin of the Class-1E batteries, verification of the habitability in the area enclosing the PORVs, reevaluation of the control room temperature rise with more conservative input values for the initial temperature and personnel heat load, evaluation of the inverter room temperature rise with a conservative value for the inverter heat load, ensuring that the instrumentation and control cabinet doors will be opened within 30 minutes of the onset of the SBO, confirmation by position indication of CIV closure for the penetration X-74, ensuring that the SBO equipment is covered by a QA program consistent with RG 1.155, Appendix A, and implementation of an EDG reliability program in accordance with the guidance of RG 1.155 Section 1.2. The licensee should include the documentation associated with the above actions and verifications with the other documentation supporting the SBO submittal, and maintain this documentation for further inspection and assessment as may be undertaken by the NRC to further verify conformance with the SBO Rule.

Based on our review of the submittals, we find the licensee's responses and proposed method of dealing with an SBO to be in conformance with the SBO Rule, contingent upon receipt of confirmation from the licensee within 30 days that the recommendations documented in this SE will be implemented. The schedule for implementation should also be provided in accordance with 10 CFR 50.63(c)(4).

Principal Contributor:
S. K. Mitra

Date: DEC 11 1991