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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING STATION BLACKOUT RULE (10 CFR 50.63)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

DOCKET NOS. 50-325 AND 50-324

1.0 INTRODUCTION:

On July 21, 1988, Title 10 of the Code of Federal Regulations, Part 50, was amended to include a new Section 50.63, "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 specified duration, requires licensees to submit information as defined in 10 CFR 50.63 and requires licensees to provide a plan and schedule for conformance to the SBO rule. The SBO rule further requires that the baseline assumptions, analysis and related information be available for NRC review. Guidance for conformance to the rule is provided by: (1) Regulatory Guide (RG) 1.155, Station Blackout, (2) 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 January 4, 1990).

To facilitate the NRC staff's (hereafter referred to as the 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.

The Brunswick Steam Electric Plant, Units 1 and 2, (Brunswick) has proposed using existing emergency diesel generators (non-blackout EDGs) as an AAC power source and has submitted its response in the applicable generic response format. The licensee's original response to the SBO rule was provided by letter from M. A. McDuffie (Carolina Power & Light Company) to the Nuclear Regulatory Commission (NRC) dated March 3, 1989. In addition, the licensee

provided a revised response from A. B. Cutter (Carolina Power & Light Company) to NRC, dated October 10, 1989, and a response to the NUMARC 87-00 Supplemental Questions/Answers by a letter from A. B. Cutter to NRC dated March 30, 1990. The licensee responses were reviewed by Science Applications International Corporation (SAIC) under contract to the NRC. Brunswick was one of the plants selected by the NRC for a site audit review. The site audit was performed by a joint NRC/SAIC team headed by a NRC staff member on June 26-30, 1989. The results of the review and site audit are documented by the enclosed a SAIC Technical Evaluation Report (TER), SAIC-89-1156, "Brunswick Steam Electric Plant, Units 1&2, Station Blackout Evaluation," dated August 24, 1990.

2.0 EVALUATION

After reviewing the licensee's submittal and the SAIC TER and in consideration of the information obtained by the NRC staff during the site audit review, the staff concurs with the SAIC analysis and conclusions identified in the TER (refer to TER for details of review). Based on this review, 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 the plant AC power design characteristic group pre-hurricane Shutdown requirement (P3), an emergency AC (EAC) Power configuration Group "C", and the target Emergency Diesel Generator (EDG) reliability of 0.975. The target EDG reliability was based on the Brunswick EDG having a reliability greater than 0.95 over the last 100 demands. The P3 grouping is based on an independence of offsite power classification of Group I3 in accordance with Section 3 of NURMAC 87-00, a severe weather (SW) classification of Group 2 and an extremely severe weather (ESW) classification of Group 5.

After reviewing the supporting documentation, RG 1.155, NUMARC 87-00 and SAIC's TER, the staff agrees with the licensee's evaluation of 4 hour SBO coping duration.

2.2 Alternate AC Power Source

The licensee has proposed using the emergency AC power sources as an AAC power source to operate systems necessary for SBO coping duration and recovery therefrom.

2.2.1 General staff position on AAC power sources

The definition in 10 CFR 50.2, RG 1.155 and NUMARC 87-00 define AAC power source in terms of four attributes: (1) connections to the offsite or the onsite AC power systems, (2) minimum potential for common cause failure with offsite power or the onsite emergency AC power sources, (3) timely availability, and (4) required capacity and reliability. More specifically, in regard to the fourth attribute, the SBO rule reads as follows:

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

In view of the variety of types, capacities and capabilities of power sources proposed as AAC sources by various licensees, the staff has characterized proposed AAC power sources as being either optimum, fully capable or minimally capable. This characterization, which relates only to the capacity attribute cited above, was necessary in order to facilitate the staff review of licensee responses to the SBO rule. It does not invalidate or revoke any of the requirements or guidance applicable to AAC power sources.

An optimum AAC power source design is one that is capable of powering simultaneously both safety trains of normal safe shutdown systems and equipment. Such a design, following actuation of the AAC source, would provide completely redundant normal safe shutdown capability during an SBO and recovery therefrom from the main control room.

A fully capable AAC power source design is one that is capable of powering at least one complete safety train of normal safe shutdown systems and equipment. This includes decay heat removal, battery charging, HVAC (heating, ventilation and air conditioning), emergency lighting, and the associated controls and instrumentation. Thus, although redundant capability is not available, a fully capable AAC source would enable attainment of safe shutdown during an SBO and recovery therefrom from the main control room.

A minimally capable AAC power source design is one that is not capable of powering all (or any) normal safety train related safe shutdown equipment; but it is capable of powering specific equipment that, in conjunction with extensive manual operator actions both inside and outside of the control room, is critical for attaining safe shutdown during an SBO. Appendix R diesels proposed as an AAC sources are examples of minimally capable AAC sources. With this design, operability of the main control room could not be assured unless the batteries were sized to operate for the SBO duration, or battery charging capability was provided by the AAC source.

2.2.1.1 <u>EDGs used as AAC power sources</u>

The guidance on the use of existing emergency diesel generators (EDGs) as AAC power sources is documented in the station blackout rule 10 CFR 50.63, RG 1.155 Position C.3.3.5 and NUMARC 87-00 (Section 2.3.1(3)). This guidance is further explained in NUMARC 87-00 Supplemental Questions and Answers dated December 27, 1989, under questions 3.4 and B.3. The station blackout rule states:

> At multi-unit sites, where the combination of emergency ac power sources exceeds the minimum redundancy requirements for safe shutdown (non-DBA) of all units, the remaining emergency ac power sources may be used as alternate ac power sources provided they meet the applicable requirements.

The rule statement requires minimum redundancy. This means that in order to qualify as an AAC source, there must be an EDG available in the non-blackout (NBO) unit that is in addition to the number of EDGs required to meet the minimum EDG redundancy requirement for powering a normal safe shutdown for a loss of offsite power (LOOP) event. Thus, the EDG's in a two unit site with two dedicated EDG's per unit would not qualify as AAC sources because the two EDGs per unit just meet the minimum redundancy requirement, i.e., there is no excess EDG.

However, there are some plants at two unit sites which just meet minimum redundancy but where each EDG is of sufficient capacity to fully power all the normal LOOP loads of the NBO unit, and also has sufficient excess capacity for powering the required safe shutdown loads of the SBO unit. In recognition of the existence of this type of situation, the staff has interpreted the excess EDG redundancy requirement of the SBO rule to allow EDGs just meeting the minimum EDG redundancy requirement to qualify as AAC sources on the basis of excess capacity, provided the other applicable requirements for AAC sources are also met.

The NRC's basic position on the use of EDGs as AAC power sources on the basis of excess capacity is that such excess capacity should not be attained by load shedding in the NBO unit which results in a degradation of its normally available safe shutdown capability for the loss-of-offsite-power (LOOP) condition. Any actions that would add to the burden of operators that are already in a high stress environment, such as load switching or disablement of information readouts or alarms in the control room, are considered to be a degradation of normal safe shutdown capability for LOOP in the NBO unit. The staff position is, therefore, that the normal equipment complement should remain available with adequate EDG capacity for use should it become necessary. The NBO unit should have the capability for hot shutdown/hot standby forced cooling, cooldown and depressurization as required. While additional events are not explicitly being postulated, it is not prudent to diminish the capability of the NBO unit to mitigate problems should they arise. It is not in the interest of safety to reduce the capability to handle various eventualities in one unit for the purpose of meeting the SBO rule in another unit. Each unit must meet the SBO rule on its own merits without reducing another unit's capability to respond to its own potential problems.

Therefore, a multi-unit site with the dedicated EDGs just meeting the minimum redundancy requirement, but not having the excess capacity defined above for qualifying as an AAC source, does not meet the SBO rule AAC source option requirements. Further measures are required such as a separate AAC source or a coping analysis which shows the plant can cope with and recover from an SBO for the required duration.

2.2.1.2 Connectability of AAC power sources

The basic criteria governing the connectability of an AAC power source are contained in 10 CFR 50.2 (the AAC source should be connectable to but normally not connected to the offsite or onsite emergency AC power systems), 10 CFR 50.63 (SBO should not assume a concurrent single failure or design basis accident), and in Appendix A of 10 CFR Part 50 (the single failure criterion and the independence requirements apply to the NBO unit). Therefore, in a one unit site, as a minimum, an AAC source need only be connectable to one set of safe shutdown equipment, regardless of whether that equipment is part of a safety train or not, or whether the AAC source is an excess redundancy EDG or an independent power source.

However, at a two (or more) unit site where the EDGs meet the AAC source excess redundancy or excess capacity criterion, one intertie circuit between units is acceptable provided it is separately connectable to each safety (EDG) bus in both units. This follows from the application of the above criteria and the required assumptions that an SBO can occur in either unit and that the single failure in the NBO unit can be on either one of its EDGs or on its respective safety bus.

2.2.2 Proposed AAC power source

The Brunswick Station is a two unit site with two EDGs per unit. The proposed AAC power source for the blacked out unit is an existing EDG on the NBO unit, via the cross ties between Units 1 & 2 4kV emergency buses. The AAC power source is used to energize one division of battery charger and power portions of the 480V emergency buses to ensure the operability and position indication of certain ac powered containment isolation valves in the blacked out unit. The AAC power source is available within one hour of the onset of an SBO event and has sufficient capacity and capability to operate the systems necessary for coping with an SBO for the required duration of 4 hours. The licensee further stated that the power source meets the criteria specified in Appendix B to NUMARC 87-00 and the assumptions stated in Section 2.3.1 of NUMARC 87-00.

The staff assessment of the proposed AAC source indicates that it falls into the minimally capable AAC power source category cited above (Section 2.2.1). Each EDG has a continuous rating of 3500kW and a 2,000 hour rating of 3850kW. Each EDG has at least 470 kW excess capacity in its 2000 hour rating that can be used to support the selected loads in the blacked out unit. The estimated SBO loads are less than 400kW. Therefore, each EDG (AAC source) has sufficient capacity to supply the normal LOOP loads in the NBO unit and the SBO loads in the blacked out unit. This is in accordance with paragraph B.9 of Appendix B, NUMARC 87-00 and is, therefore, acceptable. However, paragraph B.12 of NUMARC 87-00, Appendix B, states that the AAC system should be demonstrated by initial test to be capable of powering the necessary equipment within one hour and should be capable of maintaining the voltage and frequency within the limits of established industry standards.

Recommendation: A test of the operability of the 4kV and 480V cross tie circuits under SBO conditions should be performed to ensure that the AAC source meets the guidelines of NUMARC 87-00, Appendix B, Item B.12.

2.3 Station Blackout Coping Capability

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 recover from an SBO for a 4-hour coping duration.

2.3.1 Condensate inventory for decay heat removal

The licensee's analysis indicates that 97,390 gallons of water are required for decay heat removal and reactor cooldown for the proposed SBO duration for 4 hours. The Brunswick Technical Specifications condensate storage tank minimum inventory reserved for HPCI/RCIC operation is 103,738 gallons. The staff, therefore, concludes that there is sufficient condensate water to cope with an SBO of 4 hours.

2.3.2 Class 1E battery capacity

The licensee determined that Class 1E batteries were inadequate to meet SBO loads for four hours and, therefore, proposed to power the blacked out unit's battery charger from the proposed AAC power source (NBO unit's EDGs).

The battery is needed to cope with an SBO (for 1 hour or less) until such time as the cross-connection to the unaffected unit is completed and the battery chargers are energized from the proposed AAC source. The licensee has performed calculations and determined that there is sufficient battery capacity for one hour at which time the AAC source will be available to power one division of battery chargers. With no operator action, the battery which is supplying the uninterruptible power supply (UPS) has the capacity to last for 70 minutes. By transferring the UPS to the second battery, the batteries can last up to two hours. Based on the above, Brunswick conforms with the guidance of RG 1.155 and NUMARC 87-00.

2.3.3 Compressed air

The licensee states that the air operated valves needed to cope with an SBO for a 4-hour coping duration have sufficient backup sources independent of the preferred and blacked-out unit's Class 1E power supply. The only air operated valves required to cope with an SBO are the scram valves and automatic depressurization system valves. They have an adequate supply of air and nitrogen to perform their intended functions. The staff, therefore, concludes that there is reasonable assurance that such valves will remain operable.

2.3.4 Effects of loss of ventilation

The licensee analyzed the affects of post-SBO steady state air temperatures for plant areas containing SBO equipment. With compensatory procedural actions, the licensee stated that steady-state room air temperatures can be maintained within limits to provide reasonable assurance of SBO equipment operability (refer to TER for details).

After reviewing the available documentation, SAIC's TER and the NUMARC guidance the staff concurs with the SAIC assessment that the licensee stated results are acceptable except in the following areas: 1) EDG building switchgear rooms, 2) containment/drywell, and 3) the control room. The licensee should establish procedural controls to monitor the control room and switchgear room temperatures and open cabinet doors within 30 minutes to be consistent with NUMARC 87-00 Supplemental Questions/Answers. Regarding containment and drywell temperature analyses, the licensee is required to verify that the assumptions in the LOCA analysis are consistent with those of the SBO scenario, and that the SBO equipment remains operable for the 4 hour duration.

Recommendation: The licensee should verify that the assumptions in the LOCA analysis are consistent with those of the SBO scenario for the containment areas. If the licensee's verification shows that additional procedure changes or hardware modifications are necessary to ensure equipment operability in the above areas, then the licensee should implement the required procedure changes and/or modifications as necessary to ensure equipment operability. In addition, the licensee should (1) establish procedural controls to monitor the control room and switchgear room temperatures and to open the cabinet doors in the control room and the switchgear room within 30 minutes from the onset of SBO to provide adequate air mixing to maintain cabinet temperatures within equipment operable limits or (2) assess the equipment in the switchgear rooms to determine its operability for the temperatures expected in these rooms. This verification and any resulting modifications should be included in the documentation supporting the SBO submittals that is to be maintained by the licensee.

2.3.5 Containment isolation

The licensee states that the valves which must be capable of being closed or being operated under station blackout conditions can be positioned (with indication) independent of the preferred and blacked out unit's Class 1E power supplies. The licensee identified 6 core spray and 12 RHR MOVs that are inaccessible and has committed to power these valves from the AAC source through the four 480V MCCs. This approach for containment isolation is in accordance with RG 1.155, Section 3.2.7, and is, therefore, acceptable.

2.3.6 Reactor coolant inventory

The licensee has stated that their analysis has shown that the expected rates of the reactor coolant inventory loss under SBO conditions do not result in core uncovery or suppression pool boiling during the 4 hour SBO duration. Therefore, make-up systems, in addition to those currently available under SBO conditions, are not required to maintain core cooling under normal circulation.

The licensee's analysis shows that the expected rates of the reactor coolant inventory loss under SBO conditions do not result in core uncovery or suppression pool boiling during the 4 hour SBO duration. Additionally, the licensee has provided an analysis verifying that the suppression pool has sufficient volume

for condensate addition when coping with an SBO event. The licensee assumed that the only reactor coolant inventory losses are the automatic depressurization system (ADS) discharge to the suppression pool and the 25 gpm allowed by Technical Specification 3.4.3.2.

The staff assessment of the reactor coolant inventory indicates that the licensee, when calculating condensate water usage, did not take into account the suppression pool heatup by the steam released from the reactor via the ADS valves and through the HPCI and/or RCIC exhaust. The licensee calculated a final suppression pool temperature of 188°F. However, the SAIC calculations (see TER) indicate that the suppression pool temperature will exceed the licensee calculated 188°F by about 10°F. This is below the Technical Specification limit of 200°F and. therefore, is acceptable. In addition, the licensee has calculated that the suppression pool level will rise 20.5 inches to a distance of 7.5 inches below the torus center line and may affect the operation of the HPCI or RCIC systems.

Recommendation: The licensee should verify that the rise in suppression pool level (see TER) will not affect the operation of the HPCI and RCIC systems and include this verification in the documentation supporting the SBO submittals that is to be maintained by the licensee.

2.4 Procedures and Training

The licensee has stated that the appropriate procedures have been reviewed and modified. Furthermore, the licensee has stated that the revised procedures will meet the guidelines of NUMARC 87-00 and will be implemented.

The proposed procedure modifications indicated above were not reviewed. With the exception of the hurricane procedure, none of the SBO procedures have been implemented. The staff expects the licensee to maintain and implement these procedures, including any others that may be required, as part of the revised response 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 the appropriate training to ensure an effective response to an SBO.

2.5 Proposed Modifications

The licensee plans to modify the circuitry of cross-connected breakers. The breakers will be keylocked, and the cubicles will be conspicuously labeled that no switches are to be operated to energize breaker control circuits except during SBO. The modifications and associated procedure changes will be completed within 2 years. In addition to the modifications associated with establishing an AAC source, the licensee has committed to provide an AC independent containment pressure indicator. These modifications meet 10 CFR 50.63 and are, therefore, acceptable.

Recommendation: The licensee should include a full description, including the nature and objectives, of the required modifications identified above in the documentation supporting the SBO submittals that is to be maintained by the licensee.

2.6 Quality Assurance and Technical Specifications

The licensee has stated that all SBO related equipment is covered by a QA program except the dc powered reactor water level indicator which measures the level from 150" to 200". The licensee has committed to place this component (or an equivalent) under a QA program. The staff finds the licensee's response is in accordance with RG 1.155 and is, therefore, acceptable.

The Technical Specifications 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 understands 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.

2.7 EDG Reliability Program

The licensee's submittal on SBO did not specifically address a commitment to implement an EDG reliability program to conform to the guidance of RG 1.155, Position 1.2. However, in the submittal of March 30, 1990, the licensee has committed to establish a reliability program in accordance with the final resolution of GI B-56. Although the licensee has committed to a reliability program pending resolution of GI B-56, they are required to implement a program that meets the guidance of RG 1.155, Position 1.2.

Recommendation: The licensee should provide confirmation and include in the documentation supporting the SBO submittals that is to be maintained by the licensee that such a program meeting the guidance of RG 1.155, Position 1.2, is in place or will be implemented.

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 procedure modifications which are scheduled for later implementation. However, based on our review of the licensee's supporting documentation and our SBO audit, we have identified the following areas for focus in any follow-up inspection or assessment that may be undertaken by the NRC to verify conformance with the SBO rule.

a. Hardware and procedural modifications,

b. SBO procedures, in accordance with RG 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 meets, 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 this SER.

3.0 SUMMARY AND CONCLUSIONS

The staff has reviewed the licensee's response to the SBO rule (10 CFR 50.63) and the TER prepared by the staff's consultant, SAIC. The staff and SAIC also jointly conducted a site audit review of the supporting documentation for the SBO response. Based on our review, additional analyses and confirmations described in the recommendations provided in this Safety Evaluation (SE) need to be completed. These include demonstrating the operability of the AAC crosstie circuits by test, verifying that the assumptions in the LOCA analysis are consistent with those of the SBO scenario for containment areas, establishing procedural control to monitor the control room and switchgear room temperatures and opening cabinet doors within 30 minutes, verifying that the rise in suppression pool level will not affect the operation of the HPCI and RCIC systems, and confirming that an EDG reliability program meeting the guidance of RG 1.155 will be implemented. The licensee should maintain these analyses and other documentation supporting the SBO submittal available for inspection and assessment that may be undertaken by the NRC to further verify conformance with the SBO Rule. Based on our review of the submittal and site audit, we find the licensee's design 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 identified in this SE will be implemented. The schedule for implementation should also be provided in accordance with 10 CFR 50.63(c)(4).

Dated: October 4, 1990

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