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

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STATION BLACKOUT EVALUATION

OCONEE NUCLEAR STATION

DUKE POWER COMPANY

DOCKET NOs. 50-269/270/287

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 part 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 follow-up 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 licensee provided responses to the SBO Rule regarding the Oconee Nuclear Station (Oconee) by letters from H. B. Tucker on April 17, 1989, and April 4, 1990, to the U.S. Nuclear Regulatory Commission, Document Control Desk. Also, representatives of the licensee and the NRC staff met in Charlotte, North Carolina, for an audit review of the supporting documentation during the week of August 5-9, 1991.

The licensee's responses were reviewed by the staff and by Science Applications International Corporation (SAIC) under contract to the NRC. The results of the SAIC review are documented in the attached SAIC Technical Evaluation Report (TER) SAIC-91/1264, "OCONEE NUCLEAR STATION BLACKOUT EVALUATION," dated December 20, 1991 (Attachment 1 of Enclosure 1).

2.0 EVALUATION

After reviewing the licensee's submittal 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 station blackout (SBO) duration of 4 hours based on a plant AC power design characteristic group "P1," an emergency AC (EAC) power configuration Group "D," and a target EAC reliability of 0.975. The Group "D" EAC configuration is based on two shared EAC power sources (hydro units) normally available to the plant's safe shutdown equipment, of which one EAC power supply is sufficient to operate the safe

shutdown equipment for all three units following a loss of offsite power. The target EAC reliability of 0.975 was based on Oconee having an average EAC (hydro unit) reliability greater than 0.975 for the last 100 demands. The "P1" grouping is based on a severe weather (SW) classification of Group "1," an extremely severe weather (ESW) classification of Group "1," an independence of offsite power classification of Group "I 1/2," and an expected frequency of grid related LOOPs of less than one per 20 years.

After reviewing the available information in the licensee's submittal, RG 1.155, NUMARC 87-00, and SAIC's TER, the staff agrees with the licensee's calculation of a 4-hour SBO coping duration. However, the results using the data from NUMARC 87-00 indicate Oconee belongs to ESW Group "3" rather than ESW Group "1" as determined by the licensee. This discrepancy does not impact the coping duration and therefore is not an issue.

2.2 Alternate AC (AAC) Power Source

The licensee has proposed to use the Standby Shutdown Facility (SSF) diesel generator as an AAC power source to operate systems necessary for the required SBO coping duration and recovery therefrom. The SSF diesel generator will be available within 10 minutes from the recognition of an SBO event.

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 source 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 is provided by the AAC source.

2.2.1.1 Connectabilty 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 EAC power systems) and 10 CFR 50.63 (SBO should not assume a concurrent single failure or design basis accident). Therefore, 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.

2.2.2 Proposed AC (AAC) Power Source

The licensee proposes to use the SSF diesel generator as an AAC power source to operate the systems necessary for the required coping duration of 4 hours and recovery therefrom. The diesel generator cannot be started from the Oconee main control room. However, the licensee stated that testing has demonstrated the ability of plant operations to start the SSF diesel within 10 minutes of the recognition of the SBO event which satisfies the intent of the NUMARC guidance. The licensee added that the SSF diesel generator has sufficient capacity and capability to operate equipment necessary to maintain safe shutdown condition for a 4-hour SBO event. The licensee also states that the SSF was originally designed to provide an alternate means of achieving and maintaining hot standby conditions following a postulated fire or sabotage event.

The licensee states that the AAC power source at Oconee is a 3500 KW diesel generator and is designed to meet the requirements of Appendix R. The SSF at Oconee includes the SSF Auxiliary Service Water (ASW) System. The functioning of the SSF as an AAC power source during an SBO depends on the operability of ASW system both as a condensate supply (see Section 2.3.1) as well as the cooling water for the diesel generator (DG). The ASW system in turn depends on the Unit 2 condensate circulating water (CCW) inlet piping as its suction source. Although we do not assume a failure of these systems during an SBO,

periodic maintenance of these systems affects the availability of the AAC source. In particular, periodic dewatering of the Unit 2 inlet piping is important in assuring the long term reliability of the SSF. Toward this end, the licensee has requested for its Technical Specifications (TS) a special inoperability period of 45 days every third year for the SSF, primarily for the dewatering function. This special inoperability period would be in addition to 7-day inoperable periods allowed for the SSF ASW system, the SSF Portable Pumping System, the SSF Reactor Coolant Makeup System, and the SSF Power System.

In view of the special inoperability period request by the licensee for the SSF TS, the staff requested, during an audit of the licensee's supporting data, historical unreliability and unavailability data for the SSF and for the Keowee Hydro Station. Keowee Hydro Unit 1 has experienced 100% reliability and Keowee Hydro Unit 2 a 99% reliability over the last 100 demands. Together, the two Keowee Hydro units (both units unavailable) experienced an average unavailability of 1.93% during the 8 year period from 1980 through 1987, 1.8% in 1989, and 0.85% in 1990.

For the SSF, a review of the data for a 3-year period from August 1988 through July 1991, including a dewatering maintenance period of 30 days in 1989, showed an average unavailability over the 3 years of approximately 7%. The guidance of RG 1.155 and NUMARC 87-00 does not specifically identify the required availability of the AAC source. Both guides do, however, specify a reliability of 0.95 or better. RG 1.155 does discuss unavailability for the emergency diesel generators (EDGs), and states that typical unavailability is about .007. Based on this, RG 1.155 concludes that as long as the unavailability is not excessive, the determination of the EDG reliability based on failure rates alone would result in an acceptable overall reliability. Also, NUMARC 87-00, Appendix B, states that normally online (as contrasted to standby) systems should be available at least 95% of the time that the reactor is operating. Thus, both guides imply that the overall reliability (considering reliability and availability) should be approximately 95%.

The historical data for the SSF system, and the proposed Technical Specifications, indicate that overall reliability (including consideration of unavailability) of the SSF system will be considerably less than 95%. Therefore, the licensee needs to make modifications to improve the overall reliability of the SSF to 95% or better, or provide alternative means for coping with an SBO event. If this reliability improvement were attained, the SSF/AAC could be considered a minimally capable AAC source.

Recommendation: The licensee should make modifications to improve the overall reliability of the SSF system to 95% or better, or provide alternative means for coping with an SBO event.

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

2.3.1 Condensate Inventory for Decay Heat Removal

The licensee stated that 58,116 gallons of water are required to cope with a 4-hour SBO event. The SSF auxiliary service water (ASW) pump which will be utilized to cope with the SBO event takes suction from the Lake Keowee (the plants ultimate heat sink) through the condenser cooling water piping. The plant TS which requires a lake level of at least 775 ft above sea level provide more than the required quantity of water for coping with a 4-hour SBO event. Therefore, no plant modifications or procedure changes are needed to utilize this water source.

Based on its review, the staff finds that Lake Keowee will have sufficient water to cope with a 4-hour SBO event at the Oconee plant. However, the staff also finds that should the condenser cooling water system be out of service for maintenance, the lake water will not be available for coping with an SBO event at the Oconee plant.

Recommendation: The licensee should ensure that the water from Lake Keowee will be available to the SSF ASW pump at all times or provide an alternate source of water for coping with an SBO event.

2.3.2 Class 1E Battery Capacity

Since the plant is a 10-minute AAC plant, the licensee did not address in its submittal the adequacy of the batteries to carry the SBO loads.

The SSF includes its own independent battery system which will be charged by a battery charger powered by the AAC power source. The SSF DC system powers a minimum of instrumentation and control. Some of the plant parameters that could be monitored from the SSF are primary coolant temperature, pressurizer pressure and level, incore thermocouple, steam generator level, and diagnostic capabilities for the mechanical and electrical component performance. The licensee also stated that the design of the SSF is such that it can safely shut down all three Oconee units for a 72-hour period, which exceeds the 4-hour SBO event.

During the site audit review, the licensee stated that the Class 1E station batteries can support the SBO loads for 2 hours with five of the six shared batteries available. The licensee also stated that it will maintain control of the three units from the two main control rooms (one for Units 1 and 2, one for Unit 3) until the Crisis Management Center (CMC) personnel determine that it is necessary to evacuate the control rooms and transfer control of the three units to the SSF. However, the licensee has not demonstrated this capability by an actual shutdown of all three units from the SSF facility under LOOP conditions.

The normal battery-backed plant monitoring and electrical system controls that are an integral part of a control room are considered by the staff to be essential for successfully coping with and recovering from an SBO. Since the

AAC source does provide some of the functions which are required for minimum SBO coping capability, it is considered by the staff to provide an acceptable means to assist in the control of the plant during SBO. However, it is the staff's position (and as stated in Question 7.2 of NUMARC 87-00 Supplemental Question/Answers, dated December 27, 1989,) that the control room should be maintained fully operable and manned in order to provide assurance of plant safety while coping with and recovering from an SBO. Therefore, the staff finds the disablement of the control rooms to be unacceptable.

Recommendation: The licensee should develop and implement the necessary modifications, such as battery charging from an AAC power source or additional battery capacity, which will maintain the main control rooms functional and manned for the full 4-hour SBO duration.

2.3.3 Compressed Air

The licensee stated that the Oconee plant is determined to be a 4-hour coping duration plant with 10-minute ACC capability, therefore, per the guidelines described in NUMARC 87-00, compressed air need not be addressed.

Based on its review, the staff finds that the Oconee plant, besides being a 10-minute AAC plant, does not require compressed air to cope with an SBO event.

2.3.4 Effects of Loss of Ventilation

The licensee stated that the SSF which includes a control room and the equipment required for coping with an SBO event is cooled by the SSF ventilation system. Therefore, no analysis of the loss of ventilation for the SSF equipment room and the SSF control room was performed.

Since the licensee proposes to transfer the main control room function to the SSF control room during an SBO event, the licensee using the guidance described in NUMARC 87-00 concluded that the main control rooms at the Oconee plant are not dominant areas of concern (DACs).

The licensee further stated that the only DAC identified at the Oconee plant is the containment. However, the temperature in the containment will not exceed 250°F during a 4-hour SBO event. The operability of the SBO response equipment in this DAC is assured based upon the original design basis of the SSF systems. Therefore, no modifications or procedure changes are required to provide reasonable assurance for the equipment operability.

Since the staff finds the disablement of the control room to be unacceptable (see Section 2.3.2), the licensee needs to perform heat-up calculations for the areas containing SBO equipment associated with instrumentation and control functions (i.e., for the control rooms, switchgear room, inverter area, etc.).

Recommendation: The licensee should perform and provide for NRC staff review heat-up calculations for the areas containing SBO equipment associated with instrumentation and control functions (i.e., for the control rooms, switchgear room, inverter room, etc.). If reasonable assurance of equipment operability in these areas cannot be assured, the licensee should implement modifications and procedure changes to assure that the main control rooms are habitable, and that instrumentation and control equipment remains operable during an SBO event and recovery therefrom.

2.3.5 Containment Isolation

The licensee stated that the plant list of containment isolation valves had been reviewed in accordance with the guidance described in RG 1.155 and that the closure confirmation for valves which do not meet the exclusion criteria has been incorporated into the SBO procedures.

Based on its review, the staff concludes that the containment isolation valve design and operation at the Oconee plant meets the intent of the guidance described in RG 1.155 and are acceptable.

2.3.6 Reactor Coolant Inventory

The licensee stated that the AAC power source powers the necessary make-up systems to maintain adequate reactor coolant system inventory to ensure that the core is cooled for required coping duration. The SSF powers three make-up pumps, one per unit, each capable of providing 26 gpm. The licensee also stated that the flow is sufficient to cool the pump seals and to make up for the Technical Specification (TS) leak rate. We cannot confirm that the flow is sufficient to cool the pump seals.

The staff's consultant, SAIC (see attached TER), calculated an inventory loss based on the information in the FSAR and the submittal. Over 4 hours with a postulated 111-gpm (25 gpm/pump x 4 pumps + 11 gpm TS) leak rate, the RCS would lose 26,640 gallons of water, which is 3600 ft^3. The licensee provided information (15) which indicates that the RCS volume is 11,100 ft^3. After four hours, the RCS has 7500 ft^3 of water remaining. The plant FSAR indicates that each steam generator contains 2030 ft^3 of primary coolant (Table 5-20) and the pressurizer contains 800 ft^3 of water (Table 5-22). Therefore, after four hours, the pressurizer would be empty and each steam generator would have 600 ft^3 of primary coolant remaining. After reviewing the supporting documentation and SAIC's TER, the staff agrees with the licensee's assessment that there will be sufficient coolant in the reactor and that the core will remaine covered during an SBO event of 4 hours.

The reactor coolant inventory evaluation was based on the guidance of NUMARC 87-00 of 25 gpm per recirculation pump seal leakage 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.

2.4 Procedures and Training

The licensee stated that the plant procedures, station blackout response guidelines, AC power restoration, and severe weather guidelines have been reviewed and modified to meet NUMARC 87-00, Section 4, guidelines.

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 the appropriate training to ensure an effective response to an SBO.

2.5 Proposed Modifications

The licensee stated that no modification would be required to cope with an SBO with a duration of 4 hours. The staff's review has several recommendations which may require modifications for their resolutions. It is the licensee's responsibility to ensure that any modifications comply with the SBO guidance.

2.6 Quality Assurance And Technical Specifications

The licensee stated that the SBO response equipment is classified into three Quality Assurance (QA) categories. The three categories are 10 CFR 50, Appendix B, which covers the safety-related equipment; 10 CFR 50, Appendix R, which covers fire and security-related equipment; and RG 1.155, Appendix A, which would cover the SBO equipment not covered in other categories. The licensee also stated that equipment covered by appendices B and R meet the QA requirements of RG 1.155. The licensee is in process of establishing a program which meets the requirement of RG 1.155, Appendix A. The staff finds this to be acceptable commitment. However, this evaluation should be documented as part of the documentation supporting the SBO Rule response.

The TS for the SBO equipment are currently being considered generically by the NRC in the context of the Technical Specification Improvement Program and remains 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.

2.7 EDG Reliability Program (Hydro Units)

The Oconee Nuclear Station on-site emergency AC power system consists of two hydro-units (Keowee Hydro Station, Unit 1 and 2) in lieu of emergency diesel generators. The licensee's submittal did not specifically address the commitment to implement reliability program for the hydro units to conform to the guidance of RG 1.155, Position 1.2.

Recommendation: It is staff's position that reliability program for the onsite emergency a systems (hydro units) should be developed in accordance with the guidance of RG 1.55, Section 1.2. If the 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 station blackout 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 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 follow-up 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 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 the SE.

3.0 Summary and Conclusions

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 staff's review of the licensee's submittal and the SAIC TER, the staff finds that Oconee does not conform with the SBO Rule and the guidance of RG 1.155, and therefore recommends that the licensee reevaluate the areas of concern that have been identified in this SE. Guidance for the licensee to review and implement the staff's recommendations is provided in RG 1.155, NUMARC 87-00 and the

supplementary guidance (NUMARC 87-00 Supplement Questions/Answers; NUMARC 87-00 Major Assumptions) dated December 27, 1989, which was issued to the industry by NUMARC on January 4, 1990. The staff's concerns that are identified in this SE should be addressed by the licensee, and a revised response submitted to NRC within 60 days. In particular, the staff finds that abandonment of the main control rooms during an SBO is unacceptable, and has recommended that the licensee provide modifications to maintain the control rooms fully functional and manned for the full 4-hour SBO duration.

The licensee is expected to ensure that the baseline assumptions of NUMARC 87-00 are applicable to Oconee. Also, the licensee should maintain all analyses and related information in the documentation for further inspection and assessment as may be undertaken by the NRC to further verify conformance with the SBO rule.

4.0 Attachment

SAIC-91/1264, Technical Evaluation Report, Oconee Nuclear Station, Station Blackout Evaluation, December 20, 1991.

5520 Document Name: OCSBO