UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING STATION BLACKOUT RULE (10 CFR 50.63)

SOUTH CAROLINA ELECTRIC & GAS COMPANY

VIRGIL C. SUMMER NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-395

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 the information 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 the staff) review of the licensee's 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 format provides 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's responses to the SBO Rule were provided by letters from O. S. Bradham on April 23, 1990, and from J. L. Skolds on October 4, 1991, to the U.S. Nuclear Regulatory Commission, Document Control Desk. Also, there was a

teleconference between representatives of the licensee and the NRC staff on June 18, 1991. The licensee's responses 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-91/1258, "VIRGIL C. SUMMER STATION BLACKOUT EVALUATION," dated November 19, 1991 (Enclosure 2).

2.0 EVALUATION

After reviewing the licensee's submittals and the SAIC TER, the staff concurs with the SAIC analysis and its conclusions as identified in the SAIC TER (refer to Enclosure 2 for details). The staff's 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 "P1," an emergency AC (EAC) power configuration Group "C," and a target Emergency Diesel Generator (EDG) reliability of 0.950. The Group "C" EAC configuration is based on two EDGs credited as AC 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 Virgil C. Summer Station having an average EDG reliability greater than 0.950 over the last 100 demands. Using these data, the target EDG reliability (0.950) selected by the licensee is appropriate. The licensee also provided the EDG failure statistics for the last 20 and 50 demands, in accordance with the requirements of RG 1.155, which confirms that the target selection is appropriate. The "P1" grouping is based on an independence of offsite power classification of Group "1 1/2," a severe weather (SW) classification of Group "1," and an extremely severe weather (ESW) classification of Group "3."

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 licensee's evaluation of a 4-hour SBO coping duration.

2.2 Station Blackout Coping Capability

The licensee has proposed coping independent of an alternate AC power source for the required 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 61,604 gallons of water are required for decay heat removal during a 4-hour SBO event. The plant Technical Specifications (TS) require a minimum permissible condensate volume of 172,000 gallons to be maintained in the condensate storage tank. The TS required capacity exceeds the amount of water necessary for coping with a 4-hour SBO event.

Based on its review, the staff concludes that there is sufficient condensate inventory to cope with a 4-hour SBO event at Virgil C. Summer Nuclear Station, Unit No. 1 (Summer).

2.2.2 Class 1E Battery Capacity

The licensee initially stated that the Class 1E batteries were determined to have sufficient capacity to meet SBO loads for 4 hours, assuming that loads not needed to cope with the SBO would be stripped. Subsequently, the licensee stated in a submittal dated April 17, 1989, that a review of the Class 1E batteries was conducted and load stripping to extend battery capacity to meet the 4-hour SBO coping duration was not considered a prudent method. The licensee states that three options for consideration were evaluated:

1. Replacement of the existing battery with a higher capacity battery.

2. Addition of a dedicated power source to supply power to the battery chargers.

3. Addition of a dedicated battery to be connected when the existing battery is depleted.

The licensee informed the staff by letter dated October 2, 1989, that it would replace the existing battery with a higher capacity battery (Option 1 above).

Although the licensee did not provide the details of the battery sizing calculations for staff review, the licensee stated that the new batteries are sized larger than required, i.e., each battery contains 60 cells and 58 cells were considered in the sizing calculation. The licensee also stated that the calculations considered all correction factors, including an aging factor of 1.25, a design margin of 1.10, and a temperature factor of 1.11 (based on the lowest anticipated temperature of 60°F), as recommended in Institute of Electrical and Electronics Engineers Standard (IEEE Std)-485. Based on the licensee's statements, the staff agrees that the the batteries will be of sufficient size and capacity to support the SBO loads. The licensee's analyses of the battery sizing should be included in the documentation supporting the SBO submittal that is to be maintained by the licensee.

2.2.3 Compressed Air

The licensee stated that air-operated valves relied upon to cope with a 4-hour SBO event can be manually operated and that valves requiring manual operation are identified in plant procedures.

Based on its review, the staff agrees with the licensee that air-operated valves needed for coping with an SBO event can be manually operated if the areas where these valves are located is habitable during the whole course of an SBO event.

Recommendation: The licensee should provide assurance of the habitability in the areas where the above-cited valves are located for the duration of an SBO event.

2.2.4 Effects of Loss of Ventilation

The licensee, using the guidance described in NUMARC 87-00, has performed plant-specific analyses to determine the effects of loss of ventilation during a 4-hour SBO event and has identified the dominant areas of concern (DACs) at the Virgil C. Summer plant (See SAIC TER for the list of DACs and their calculated temperatures). The licensee stated that reasonable assurance of operability of SBO response equipment in these DACs has been assessed in accordance with the guidance described in NUMARC 87-00. The staff's evaluation of the effects of loss of ventilation in each of these DACs is provided below:

2.2.4.1 Control Room and Relay Room

The licensee stated that the calculated peak temperatures during a 4-hour SBO event for the control room and relay room are 120°F and 119°F, respectively. During the course of its review, the staff's consultant reviewed the input parameters used by the licensee for the analyses and found that some non-conservative values were assumed for initial room temperatures, outside temperature, equipment heat loads, etc. (See SAIC TER Section 3.2.4). Based on its review, the staff agrees with its consultant's conclusion that the effect of these non-conservative input parameters on the control room and the I&C cabinet room final calculated peak temperatures would be significant. Therefore, if the licensee were to use more conservative values for the input parameters, the final calculated peak temperatures in these rooms may exceed 120°F. Therefore, the staff has not been able to conclude that the above calculated peak temperatures of 120°F and 119°F for the control room and relay room, respectively, are acceptable.

In addition, the licensee stated that in order to maintain the temperature to assure equipment operability in the relay room, the existing procedure, EOP-6.1, will be revised to require the opening of the doors from the relay room to the cable chase area and to the turbine building. However, the licensee has not provided the procedure which will require the operators to open instrument cabinet doors within 30 minutes of an SBO event under guidance described in NUMARC 87-00.

Recommendation: The licensee should reevaluate the temperature rise in the control room and relay room using conservative initial temperatures, corresponding to the technical specification temperature limit or the maximum values allowed under administrative procedures, and using conservative parameters, as described in the SAIC TER for the heat-up calculations. If the licensee's administrative procedures do not specify an operating temperature limit, the licensee should establish administrative procedures or revise the existing procedures to maintain the control room and relay room temperatures at or below the initial room temperatures used in the heat-up analyses. In addition, the licensee should provide a procedure which will require the operators to open the instrument cabinet doors within 30 minutes following an SBO event in accordance with the guidance described in NUMARC 87-00.

2.2.4.2 Steam Turbine Driven AFW Pump Room

The licensee indicated that the calculated peak temperature during a 4-hour SBO event for the steam turbine driven AFW pump room is 144°F and that reasonable assurance of equipment operability in this room has been provided.

During the review, the staff found that the licensee considered only two high energy lines (steam and AFW coolant) to pass through this room as heat sources. Usually, this room contains more steam lines, e.g., a steam trap and other small steam lines. In addition, the licensee used an insulation surface temperature of 50°C for both high energy lines. The licensee did not provide the basis for this temperature.

Based on its review and providing that the licensee verifies that all the potential heat sources have been considered in its analysis and that the surface temperature of 50°C used in the analysis for high energy lines is consistent with that of an SBO event, the staff agrees with the licensee that there is reasonable assurance of SBO response equipment operability in the steam turbine driven AFW pump room during an SBO event at the Summer plant.

Recommendations: The licensee should (1) verify and confirm that all the potential heat sources have been considered in its analysis, and (2) verify and confirm that the surface temperature of 50°C used in the analysis for high energy lines is consistent with that of an SBO event.

2.2.4.3 Miscellaneous Areas

The licensee identified the reactor building, intermediate building, and east/west penetration access areas as dominant areas of concern and stated that the equipment in these areas has been previously evaluated and qualified for harsh environmental conditions which are also consistent with the guidance described in NUMARC 87-00 for an SBO event. Therefore, the licensee concluded that reasonable assurance of equipment operability in these areas is provided.

Based on its review, the staff agrees with the licensee's conclusion that reasonable assurance of equipment operability during an SBO event in the above cited dominant areas of concern is provided.

2.2.5 Containment Isolation

The licensee stated that the plant list of containment isolation valves had been reviewed to verify that containment isolation valves that must be operated under SBO conditions can be positioned, with indication, independent of the preferred and Class 1E AC power supplies and that no modifications or procedure changes are necessary to ensure containment integrity can be obtained if it is needed under SBO conditions.

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

2.2.6 Reactor Coolant Inventory

The licensee states that the ability to maintain the reactor coolant system (RCS) inventory to ensure that the core is cooled has been assessed for 4 hours. A generic analysis listed in NUMARC 87-00 was used in this assessment. The licensee states that the expected rates of reactor coolant inventory loss under SBO conditions do not result in core uncovery. Therefore, RCS makeup systems under SBO conditions are not required to maintain core cooling under natural circulation (including reflux boiling).

The licensee stated in answer to questions raised during the telephone conversation on June 18, 1991, that it used the results of a generic analysis performed by Westinghouse Owner's Group, WCAP-10541, "Reactor Coolant Pump Seal Performance Following a Loss of all AC Power." The licensee states that even though this report shows a seal leakage of 150 gpm/pump, the time to core uncovery is greater than 4 hours. The licensee concludes that this analysis is applicable to the Summer plant.

As discussed in the attached TER, an independent RCS inventory calculation was done by the staff's consultant (SAIC) using the information available in the plant Updated Final Safety Analysis Report (UFSAR) and that provided in the licensee's submittals. The plant UFSAR states that at the maximum guaranteed power the total RCS water volume is 8,850 ft^3. During a 4-hour SBO event, the RCS is assumed to lose 88 gpm, corresponding to leakage of 25 gpm per pump seal and 13 gpm for the Technical Specification allowed leakage, resulting in a total loss of 21,120 gpm, or about 2,823 ft^3. In addition, RCS level will be lost due to water volume shrinkage caused by primary system cooldown. Even if we were to assume that the RCS will be cooled down to a saturation temperature of 420°F, the SAIC analysis concludes that the RCS inventory will be sufficient to cover the core and maintain natural circulation to keep the core cooled. The staff agrees with the licensee that the core will remain covered during a 4-hour SBO event.

The reactor coolant inventory evaluation, as described above, was based on the guidance provided in NUMARC 87-00 of 25 gpm per reactor coolant pump (RCP) seal leakage for pressurized water reactors. The 25 gpm value was agreed to between NUMARC and the staff pending resolution of Generic Issue (GI) 23. If the final resolution of GI-23 defines higher RCP leakage rates than assumed for this evaluation, the licensee should be aware of the potential impact of this resolution on their analysis and actions addressing conformance to the SBO rule.

2.3 Proposed Procedures and Training

The licensee states that the plant procedures have been reviewed and verified to meet the guidelines in NUMARC 87-00, Section 4, in the following areas:

a. Severe weather per NUMARC 87-00, Section 4.2.3;

   - EPP-015, "National Emergency (Earthquake, Tornado)"

b. AC Power Restoration per NUMARC 87-00, Section 4.2.2;

- EOP-6.0, "Loss of All AC Power"
- EOP-6.1, "Loss of All AC Power Recovery Without SI Required"
- EOP-6.2, "Loss of All AC Power Recovery with SI Required"

The licensee further states that the following SBO response plant procedures have been reviewed and procedure changes will be implemented:

a. SBO response per NUMARC 87-00, Section 4.2.1

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

The staff did not review the procedures or proposed procedure modifications. These procedures are plant-specific actions concerning the activities required to cope with an SBO event. The staff expects the licensee to implement and maintain 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 event.

2.4 Proposed Modifications

The licensee stated that no plant modification would be required to cope with a 4-hour SBO. If any modification requirements are subsequently identified, it is the licensee's responsibility to ensure that the modifications comply with the SBO guidance.

2.5 Quality Assurance And Technical Specifications

The licensee did not specifically address Quality Assurance (QA) programs or Technical Specifications for the SBO equipment. 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 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 Technical Specifications regarding the SBO equipment are warranted, the licensee will be notified of the implementation requirements.

Recommendation: The licensee should verify and confirm that the SBO equipment is or will be covered by an appropriate QA program consistent with the guidance of RG 1.155, Appendix A. Verification that such a program is in place should be included as part of the documentation supporting the SBO Rule response.

2.6 EDG Reliability Program

The licensee stated that it will maintain the target reliability of 0.950.

Recommendation: It is the staff's position that an EDG reliability program should be implemented which meets, as a minimum, 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, Section 1.2.

2.7 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 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's 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 procedure,

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 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 confirmations and commitments need to be made as described in the recommendations itemized herein. These include verification and confirmation of habitability in the areas where the air-operated valves are located and which need to be manually operated during an SBO event, reevaluation of the heat-up analyses in the control room and relay room using more conservative initial temperatures, implementing a procedure that will require operators to

open instrument cabinet doors, verification of the parameters used for the heat-up evaluation for the steam turbine driven AFW pump room, confirmation that the SBO equipment is covered by an appropriate QA program consistent with RG . 155, and implementation of an EDG reliability program in accordance with the guidelines 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 submittals, and maintain this documentation for further inspection and assessment by the NRC to further verify conformance with the SBO Rule.

Based on our review of the submittals, the staff finds 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 identified within this SE will be implemented. The schedule for implementation should also be provided in accordance with 10 CFR 50.63(c)(4).

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