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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO STATION BLACKOUT RULE

UNION ELECTRIC COMPANY

CALLAWAY NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-483

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 a 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 Initiations 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 on 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's responses to the SBO rule were provided by letters from D. F. Schnell on April 12, 1989, March 29, 1990, May 17, 1991, and May 31, 1991, to the U.S. Nuclear Regulatory Commission, Document Control Desk. Also, there were teleconferences between representatives of the licensee and the NRC staff on May 9, 1991, and June 21, 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 a Technical Evaluation Report (TER) SAIC-91/6684, "CALLAWAY PLANT, STATION BLACKOUT EVALUATION," dated August 30, 1991, (Attachment 1).

2.0 EVALUATION

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

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 "C," and a target Emergency Diesel Generator (EDG) reliability of 0.95. The Group "C" EAC configuration is based on two EDGs which are normally available to the plant's safe shutdown equipment, with one EDG required to operate safe shutdown equipment following a loss of offsite power. The target EDG reliability was based on the Callaway plant having an average EDG reliability of greater than 0.95 for the last 100 demands. The "P1" grouping is based on an independence of offsite power classification of Group "1 1/2," a severe weather (SW) classification of Group "2," and an extremely severe weather (ESW) classification of Group "1."

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 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. The characteristics of the following plant systems and components were reviewed to assure that the system has the availability, adequacy, and capacity to achieve and maintain a safe shutdown and to recover from a SBO for a 4-hour coping duration.

2.2.1 Condensate Inventory for Decay Heat Removal

The licensee stated that based on a plant specific analysis which is more conservative than NUMARC 87-00, 158,000 gallons of water are required for cooldown and decay heat removal during a 4-hour SBO event. The Callaway Technical Specifications (TS) require a minimum condensate storage level of 281,000 gallons which exceeds the required quantity for coping with a 4-hour SBO event. The staff's consultant, used more conservative assumptions (i.e., 102 percent reactor power maximum allowable leakage, etc.), in conducting its independent analysis which indicated that to cope with a 4-hour SBO event, the Callaway plant would required 165,292 gallons of water which is still significantly less than the minimum available condensate for a SBO event.

The staff concludes, based on its review and the consultant's independent analysis, that the licensee will have sufficient condensate inventory to cope with a 4-hour SBO event at the Callaway plant.

2.2.2 Class 1E Battery Capacity

The licensee stated that a battery capacity calculation has been performed in accordance with NUMARC 87-00, Section 7.2.2, to verify that the Class 1E batteries have sufficient capacity to meet the SBO loads for 4 hours.

The Callaway DC power supply system consists of four separate, Class 1E, 125 V subsystems. Each subsystem has a dedicated charger, inverter and battery. Also, Callaway has a centrally located battery charger and inverter that can be connected to any subsystem. According to the plant UFSAR, Section 8.3.2.1.2, the batteries are sized to supply the necessary DC loads for a minimum of 200 minutes (3.3 hours).

The licensee stated that for the Class 1E batteries, no load shedding is required to achieve a 4-hour capability. However, procedural guidance is provided allowing the operators to deenergize the ESF status panels in order to conserve battery capacity.

The nonsafety related batteries, which cannot be assured to last for 4 hours without load shedding, are required to operate the supply breaker to transformer XNB02. Thus, the licensee stated that a non-vital inverter will be shed within 1 hour after the onset of a SBO.

The licensee has revised the plant UFSAR incorporating the changes and additions required by the SBO rule. The licensee has committed to add a footnote to UFSAR Table 8.3-2 to clarify that the batteries have been analyzed for a 240 minutes loading cycle to support the SBO coping analysis.

In response to questions raised during the telephone conversation on May 9, 1991, the licensee stated that the station battery capacity has been assessed using the methodology consistent with IEEE Std. 485. The licensee stated that the battery sizing calculations were performed using a temperature factor of 1.11 (60°F), an aging factor of 1.25, and a design margin of 25 percent. The 25 percent design margin was not explicitly stated in the licensee's response. Based on the conservative temperature and design margin factors used, we consider the batteries to have adequate capacity to support the SBO loads for 4 hours. However, the staff does not have sufficient information as to what plant status indications or control functions will be made unavailable upon load shedding of ESF status panels or the non-vital inverter to conclude that these are acceptable actions.

Recommendation: The licensee should verify and confirm that shedding the ESF status panels from the Class 1E batteries, and the non-vital inverter from the nonsafety related battery will not result in the loss of vital information or control functions needed by the control room operators during a SBO. The verification analysis should be included with the other documentation to be retained by the licensee in support of the SBO submittals.

2.2.3 Compressed Air

The licensee stated that air operated valves relied upon to cope with a SBO for 4 hours can either be operated manually or have sufficient backup sources independent of the preferred and blackout unit's Class 1E power supply.

The turbine driven auxiliary feedwater (AFW) pump steam supply valve, associated bypass valve, and discharge control valves are normally closed air operated valves which have to be operated during an SBO event. Additionally, the steam generator power operated relief valves (PORVs) are air operated valves. The plant compressed air system provides a safety related backup supply of compressed gas (N2) for the PORVs and AFW valves and is designed (normal pressure) for 8 hours of operation without recharging. The licensee stated that the minimum allowed pressure will provide sufficient nitrogen for a 5-hour period with each atmospheric relief valve being stroked every 10 minutes and each Auxiliary Feedwater control valve stoked three times per hour. Therefore, the staff agrees that the compressed air system at the Callaway plant meets the applicable SBO guidance.

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, I&C cabinet room, turbine driven auxiliary feedwater (AFW) pump room, main steam tunnel, and containment during a 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 and I&C Cabinet Room

The licensee stated that the calculated peak temperatures during a SBO event for the control room and I&C cabinet room are 111.5°F and 98.1°F, respectively. Consequently, the licensee concluded that these rooms are not dominant areas of concern.

As part its evaluation, 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, personnel heat load, etc. (see SAIC TER, Section 3.2.4). Based on staff review, it was concluded 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 and that 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 111.5°F and 98.1°F for the control room and I&C cabinet room, respectively, are acceptable.

The licensee stated that the existing Callaway plant procedure OTO-GK-00001, "Loss of Control Room HVAC with High Control Room Temperature," was revised to comply with the guidance of NUMARC 87-00. The staff found this acceptable.

Recommendation: The licensee should reevaluate the temperature rise in the control room and the I&C cabinet room using conservative initial temperatures, corresponding to the TS temperature limits 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 I&C cabinet room temperatures at or below the initial room temperatures used in the heat-up analyses.

2.2.4.2 Inverter Room

The licensee used an initial room temperature of 90°F to perform the heat-up analysis for the inverter room during a SBO event. The calculated peak temperature is 103.9°F. Therefore, the inverter room temperature is not a concern for a SBO event.

Based on staff review, it has been determined that the above calculated peak temperature of 103.9°F, for the inverter room during a SBO event, is acceptable provided that the inverter room temperature be maintained at or below 90°F during normal plant operation.

Recommendation: The licensee should establish an administrative procedure or revise the existing procedure to maintain the inverter room temperature at or below an initial room temperature of the 90°F used in the heat-up analysis.

2.2.4.3 Turbine Driven AFW Pump Room and Battery Rooms

The licensee stated that the calculated peak temperatures for the AFW pump and the battery rooms are 142°F and 93.7°F, respectively. The temperatures of these areas are well below the equipment operability limits described in NUMARC 87-00. 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 a SBO event at the Callaway plant.

2.2.4.4 Main Steam (MS) Line and Main Feedwater (MFW) Line Tunnel

The calculated peak temperature in the MS/MFW tunnel is 202°F. The licensee indicated that no equipment located in the MS/MFW tunnel is required to cope with a SBO event.

Based on its review and pending future audit/verification, the staff finds the above calculated peak temperature acceptable.

2.2.4.5 Containment

The licensee performed plant-specific analyses to evaluate the containment response under SBO conditions. The licensee calculated a maximum temperature of 173°F which is well below the environmental qualification envelope temperature of 384.0°F resulting from a MS line break. Therefore, the licensee concluded that the containment temperature resulting from a SBO event is not a concern.

Based on its review, the staff concludes that the containment temperature resulting from a SBO event is not a concern at the Callaway plant.

2.2.5 Containment Isolation

The licensee stated that the containment isolation valves (CIVs) that must be capable of being closed or 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. Additionally, the licensee stated that procedure ECA-0.0 will be revised to include all actions required to provide appropriate containment integrity during a SBO event.

The licensee provided a list of containment penetrations and justifications for exclusion per the guidance described in RG 1.155 for each penetration. These penetrations and the staff's evaluations are:

(a) Residual Heat Removal (RHR) System Suction Lines From The Hot Legs

The licensee stated that although the CIVs for these penetrations do not meet the exclusion criteria of NUMARC 87-00, they could not be open at the onset of a SBO because of their control circuit design (interlocks) which prevent them from being opened when RCS pressure is above 425 psig.

Based on staff review, it has been determined 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 a SBO event. However, these isolation valves and their associated RHR system could not be operated during a SBO event when AC power is not available. Therefore, these isolation valves would remain in their pre-existing (closed) positions during a SBO event. The pre-existing positions are specified by the system operating procedures with proper valve position indications in the control room prior to a 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 CIV design and operation for these penetrations have met the intent of the guidance described in RG 1.155 and are acceptable.

(b) RHR and Containment Spray System Suction (Recirculation) Lines From The Containment Sumps

The CIVs for these penetrations are maintained closed during all power operations, and opening the valves would result in entry into TS action statements. These valves are required to open during the safety injection recirculation phase following a LOCA.

Based on its review and the rationale similar to those described above for the RHR system suction lines from the hot legs, the staff concludes that the CIV design and operation for the RHR and containment spray system recirculation lines have met the intent of the guidance described in RG 1.155 and are acceptable.

2.2.6 Reactor Coolant Inventory

The licensee stated that the ability to maintain adequate reactor coolant inventory was assessed using a plant-specific analysis. The analysis shows that expected rates of reactor coolant inventory loss under SBO conditions do not result in core uncovery for a SBO of 4 hours. The licensee concluded that no make-up systems are required to cope with a SBO with a duration of 4 hours.

In response to the questions raised during the telephone conversation on May 9, 1991, the licensee stated that the RCS inventory calculation is based on the following assumptions and data:

- 25 gpm per recirculation pump seal leak,
- 11 gpm maximum technical specification allowed leakage,
- 125 gpm for 10 minutes leakage until letdown is isolated, and
- an estimated 2390 ft^3 RCS shrinkage.

As discussed in the attached TER, the RCS water volume at 100 percent power is 11,393 ft^3. Using the licensee's assumed leakage and a final RCS pressure of 280 psia and temperature of 410°F, 5242.43 ft^3 of water will remain in the RCS at the end of 4 hours. This exceeds the RCS inventory required to keep the core covered since the reactor vessel water volume is 3700 ft^3. Therefore, the staff concludes no additional makeup capabilities are necessary to cope with a SBO of 4 hours duration.

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

2.3 Procedures and Training

The licensee stated that plant procedures have been reviewed to ensure compliance with the guidelines in NUMARC 87-00, Section 4.

The proposed procedures were not reviewed, but the staff expects the licensee to maintain and implement these procedures including any others to ensure and appropriate response to a SBO event. Although personnel training requirements for a 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 the SBO.

2.4 Proposed Modifications

The licensee stated that no hardware 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 (QA) and Technical Specifications (TS)

The licensee did not provide any information regarding QA programs and TS for 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 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 a TS regarding the SBO equipment is 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. Further, this verification should be included with the documentation that is to be maintained by the licensee in support of the SBO submittals.

2.6 EDG Reliability Program

The licensee stated that Callaway will comply with NUMARC SBO Initiative 5A.

Recommendation: It is the staff's position that an EDG reliability program should meet 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 evaluation available to NRC. 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 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 procedure;

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

e. Equipment and components required to cope with a 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.

Additional items may be added as a result of the staff review of the actions taken by the licensee in response to this 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 our review, some actions and verifications need to be completed as described in the recommendations itemized herein. These recommendations include: (1) verification that vital information will not be lost due to shedding of the ESF status panels or inverters from the station batteries; (2) revised heat-up calculations for the control room and instrumentation and control (I&C) cabinet rooms; (3) provision for administrative procedure to maintain the inverter room temperature at or below the initial room temperature used in the heat-up calculations; (4) confirmation that the plant complies with the QA requirements of RG 1.155, Appendix A; and (5) confirmation of an Emergency Diesel Reliability program consistent with 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 a SBO event 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).

4.0 ATTACHMENT

SAIC-91/6684, Technical Evaluation Report, Callaway Plant, Station Blackout Evaluation, August 30, 1991.

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Date: June 9, 1992