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

ENCLOSURE 2

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE STATION BLACKOUT RULE (10 CFR 50.63)

COMMONWEALTH EDISON COMPANY

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-254 AND 50-265

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 specified duration, requires licensees to submit information as defined in 10 CFR Part 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, analyses 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) 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, which was issued to the industry by NUMARC on 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 licensee for Quad Cities, Units 1 and 2, has proposed using an independent, dedicated non-Class 1E diesel generator as an AAC power source and has submitted its original response in the applicable generic response format. The licensee's original response was provided by letter from M. Richter (Commonwealth Edison) to T. E. Murley (NRC) dated April 17, 1989. Also, the licensee provided a response to the NUMARC 87-00, Supplemental Questions/Answers, by a letter from M. Richter to T. E. Murley dated March 30, 1990. In addition, the licensee provided a transmittal dated September 26, 1989, concerning the SBO calculations for

Dresden and Quad Cities Stations. Meetings were held with the licensee on October 4 and 5, 1989, December 20, 1989, and March 28, 1990, to discuss their initial and revised responses to the SBO rule. The licensee provided their final revised SBO response by letter from M. Richter to T. E. Murley dated May 18, 1990. The licensees' 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-90/1071, "Quad Cities Station Units 1 and 2, Station Blackout Evaluation," dated October 26, 1990 (Attachment 1).

2.0 EVALUATION

After reviewing the licensee's SBO submittal and the SAIC TER, the staff concurs with the conclusions as identified in the SAIC TER (refer to Attachment 1 for details of the 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 station blackout duration of 4 hours based on an offsite power design characteristic group of "P1," an Emergency AC (EAC) configuration group "D," and an emergency diesel generator (EDG) reliability target of 0.95. Although the RG 1.155 requires an EDG reliability target of 0.975 for EAC group "D," the staff has accepted an EDG reliability target of 0.95 (see Section 2.2.2). The target EDG reliability was based on the units having an average EDG reliability greater than 0.95 over the last 100 demands. The P1 grouping is based on an independence of offsite power classification of Group "I 1/2," a severe weather (SW) classification of Group "2" and an extremely severe weather (ESW) classification of Group "1."

The staff review of the licensee's submittal indicates that Quad Cities Station, Units 1 and 2, does not meet one of the criteria for characterization of the independence of the offsite power to be classified as "I 1/2" group. This criteria (see RG 1.155, Table 5) states that, "After loss of the normal ac power source, there is an automatic transfer of all safe shutdown buses to one preferred alternate power source. If this source fails, there may be one or more manual transfers of power source to the remaining preferred or alternate offsite power sources." At the present time, Quad Cities Station has only one manual transfer of <u>one</u> safe shutdown bus to an alternate offsite source (i.e., transfer between buses 24-1 and 14-1) and does not meet the above stated criteria and, therefore, would be classified as "I3" group. In order to achieve the "I 1/2" classification, a second safe shutdown bus transfer capability is required. The second safe shutdown bus transfer capability may be obtained (i.e, between buses 23-1 and 13-1) via the new cable circuits proposed to be installed by the licensee from the proposed AAC power source (non-Class 1E diesel generator) to buses 23-1 and 13-1 (see Figure 1 of Attachment 1). However, in order to credit this cross-connect as a safe shutdown bus transfer, the cable connections from the proposed AAC source to the safety buses in Unit 1 and Unit 2 would have to be safety grade. The licensee did not indicate in their submittal whether or not they intended to use these cross-connects for

meeting the above stated criteria. However, the staff has assumed that this arrangement would allow the safety buses in both units to be fed by either one of two independent sources of off-site power, thus, meeting the criteria for the offsite power to be classified as "I 1/2" group.

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.

2.2 Alternate AC (AAC) Power Source

The licensee has proposed to install an independent AAC power source to operate systems necessary for the required 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 defines 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 partially 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 was provided by the AAC source.

2.2.1.1 Connectability of AAC Power Sources

The basic criteria governing the connectability of an AAC power source is contained in 10 CFR 50.2 (AAC source should be connectable to but normally not connected to the offsite or onsite emergency AC power systems) and 10 CFR 50.63 (SBO should not assume a concurrent single failure or design basis accident). Therefore, in a one unit site (or in multi-unit sites where an independent AAC (non-EDG) power source is proposed for only one unit), as a minimum, an AAC source need only be connectable to one set of safe shutdown equipment, regardless of whether or not that equipment is part of a safety train.

2.2.2 Proposed AAC Power Source

The licensee for Quad Cities had originally proposed using existing EDGs as AAC power sources for meeting the SBO rule. But Quad Cities EDGs do not meet the minimum redundancy requirements in order to qualify as AAC power sources in accordance with 10 CFR 50.2, RG 1.155 and NUMARC 87-00. Subsequently, the licensee proposed an independent non-safety related diesel generator as an AAC power source sized for SBO loads of one unit only. However, during further discussions with the staff, the licensee proposed to install a diesel generator of larger capacity (sized for SBO loads for both units) provided the staff would accept a lower reliability target of existing EDGs, that is from 0.975 to 0.95. Since Quad Cities is a two unit site with only three EDGs (one EDG dedicated to each unit and one EDG shared between both units), it was the staff's judgement that an additional large independent diesel generator would be beneficial and provide added safety margin. Therefore, the staff agreed with the licensee's proposal for providing a larger diesel generator for Quad Cities in order to select a lower reliability target than that required by RG 1.155. The staff's acceptance of a lower EDG reliability target than that required by the RG 1.155 is limited to EDG configurations similar to Quad Cities and is contingent upon the following:

1. The AAC power source is sized to power the complete contingent of safety related and non-safety related loads associated with one safety division of each unit simultaneously that are normally expected to be available for the loss of offsite power (LOOP) condition.

2. The AAC power source is connectable to all EDG buses of all the units.

3. The AAC source should be diverse from existing EDGs. Lack of diversity must be justified by addressing how common mode failures are minimized.

By letter dated May 18, 1990, the licensee proposed an AAC power source which will have the capacity (5,700kW, 2,000 hours rating) for supplying all loads necessary to achieve and maintain safe shutdown for both units simultaneously for the loss of offsite power (LOOP) condition. The proposed AAC power source will be connectable to all EDG buses of both units (23-1, 24-1, 13-1 and 14-1).

The proposed AAC power source for Quad Cities, Units 1 and 2, is an independent non-Class 1E diesel generator which can provide power to any of the four safety buses of Units 1 and 2. The licensee has stated that this power source will be available within 1 hour from the onset of an SBO event and has sufficient capacity and capability to power one division of the shutdown loads of each unit simultaneously. The licensee also stated that the AAC power source will meet the criteria in Appendix B of NUMARC 87-00. Therefore, based on the licensee's statement, the proposed AAC power source has sufficient capacity for supplying the full complement of safe shutdown loads, including heating, ventilating and air conditioning (HVAC), of at least one safety division; that is, the AAC source has sufficient capacity and capability to power the LOOP loads for one safety division. Under this basis the proposed AAC source would be in the fully capable category cited in Section 2.2.1.

As discussed in Section 2.1, the proposed cable circuits for connecting the AAC source to the safe shutdown buses may be credited as the cross-tie between safety buses 23-1 and 13-1. However, all the connections from safety buses 23-1, 24-1, 13-1 and 14-1 to AAC power source output circuit breaker would have to be safety grade since all these circuits are directly connected to the AAC source output breaker.

Recommendation: All the connections from safety buses 23-1, 24-1, 13-1 and 14-1 to, but not including, the AAC power source output circuit breaker should be installed as safety grade (Class 1E). The licensee should provide a full description including the nature and objective of this modification and AAC power source evaluation to conform to Appendix B of NUMARC 87-00 and include this description in the SBO documentation that is to be maintained by the licensee.

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 has determined that 78,000 gallons of water are required for decay heat removal for 4 hours. The condensate storage tank (CST) maintains a minimum volume of 90,000 gallons in reserve for the reactor core isolation

cooling (RCIC) system. In addition, RCIC suction can be switched to the suppression pool, which contains approximately 800,000 gallons of water. Each water source exceeds the required quantity for coping with a 4-hour SBO.

A leakage rate of 18 gpm was assumed for each recirculation pump plus the 25 gpm system leakage allowed per plant technical specifications was considered as part of a total maximum primary system leakage of 61 gpm. The staff, therefore, concludes that there is sufficient condensate water supply available for decay heat removal during a 4-hour SBO coping duration.

2.3.2 Class 1E Battery Capacity

The licensee has determined that there is sufficient battery capacity for 1 hour at which time the AAC power source will energize a battery charger on each unit.

The staff agrees with the licensee's assessment that the battery can support the safe shutdown loads for 1 hour.

2.3.3 Compressed Air

The licensee has stated that no air operated valves are relied upon to cope with an SBO for 1 hour. The relief valves needed for depressurization and decay heat removal are dc powered and do not depend on compressed air for operation. Compressed air can be restored once the AAC power source becomes available after 1 hour.

After reviewing the licensee's submittals and SAIC's TER, the staff agrees with the SAIC assessment that no air operated valves are relied upon during the first hour of an SBO event.

2.3.4 Effects of Loss of Ventilation

The licensee has stated that the AAC power source will supply power to the HVAC system within 1 hour. During the first hour, no HVAC will be available to areas containing SBO equipment. The licensee's analyses show that reasonable assurance of operability is established for the containment and all dominant areas of concern during the first hour. Procedure revisions are required for use of a portable fan to provide air circulation in the control room and for opening access and panel doors in the control room and the auxiliary electrical equipment rooms (AEERs). The licensee's calculations for the RCIC room indicate a steady state temperature of 163°F with no ventilation. The licensee's submittal claims the 1-hour temperature for the RCIC room to be less than 120°F, but, it has not provided any information supporting this claim. Since the steady state value and the 1-hour value are quite different, the large temperature variation for RCIC room temperature needs to be justified. In addition, it appears from the information provided in the licensee's submittals that all SBO equipment may not have been evaluated for the effects of loss of ventilation. Also, the licensee's submittal does not provide information regarding whether the control room and AEERs heat-up calculations were made using initial temperatures corresponding to the maximum bounding design temperatures of these rooms, including maximum technical specification temperatures.

Recommendations: (1) The licensee should justify the discrepancy between the 1-hour temperature given in the submittal and the calculated steady state temperature for the RCIC room, (2) the licensee should address SBO equipment that may not have been evaluated for the effects of loss of ventilation, and (3) the licensee should verify whether the control room and AEERs heat-up calculations were performed using the pertinent initial maximum bounding design temperatures for these rooms in lieu of normal room temperatures. These evaluations and verifications and any resulting modifications should be included in the documentation supporting the SBO submittal that is to be maintained by the licensee.

2.3.5 Containment Isolation

The licensee has stated that the station's list of containment isolation valves (CIVs) was reviewed to ensure that containment integrity can be provided during SBO conditions. In addition to the valves meeting the exclusion criteria listed in NUMARC 87-00, Section 7.2.5, the licensee excluded the valves that are always procedurally closed during power operation or valves that are upstream or downstream of CIVs. The licensee further states that the valves that may require manual actuation to ensure containment integrity under SBO conditions will be incorporated into the appropriate station procedure.

The licensee's criteria for excluding CIVs that are always procedurally closed during full power operation is not in accordance with NUMARC 87-00, Section 7.2.5. The licensee did not state whether these valves are normally locked closed during power operation or if they will fail closed on loss of ac power or air. In addition, the licensee did not provide information on valve position indication (e.g., local mechanical, dc powered, or AAC) for these valves and manual operated valves.

Recommendation: The licensee should indicate whether the CIVs that are procedurally closed during power operation are normally locked closed or they will fail closed on loss of ac power or air. In addition, the licensee should ensure that these air or ac operated CIVs remain properly positioned during an SBO event by providing capability for valve position indication independent of preferred and Class 1E power supplies. This information and verification should be included in the documentation supporting the SBO submittals that is to be maintained by the licensee.

2.3.6 Reactor Coolant Inventory

The licensee has performed an analysis and has stated that 78,000 gallons of water are required for reactor make-up water for 4 hours. The condensate storage tank (CST) maintains a minimum volume of 90,000 gallons in reserve for the RCIC system which exceeds the required quantity for coping with a 4-hour SBO event. The licensee did not provide any information concerning cooldown in their analysis for reactor coolant inventory. However, the staff finds the licensee's assessment that adequate RCS inventory will be maintained to be reasonable and finds it acceptable (refer to Attachment 1 for details).

Recommendation: The licensee should provide information to address the required make up to compensate for RCS shrinkage as a result of the limited cooldown to assure the availability of proper reactor coolant inventory. This information should be included in the documentation supporting the SBO submittals that are to be maintained by the licensee.

2.4 Procedures and Training

The licensee has stated that procedure revisions not associated with modifications will be completed one year after the issuance of this SER. Procedure revisions associated with the AAC power source will be completed by December 1995. The proposed procedure modifications indicated above were not reviewed, but the staff expects the licensee to maintain and implement these procedures including any others (fire protection initiation) 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 the SBO. In addition, adequate emergency lighting should be provided to carry out the needed operator actions during an SBO.

2.5 Proposed Modifications

The installation of an independent non-Class 1E AAC diesel generator comprises a major hardware modification (see Section 2.2.2). The AAC power source will be connected to all 4kV safety buses. The new cable circuits to be installed from the proposed AAC source to the safety buses may be credited as a cross-tie between safety buses 23-1 and 13-1 in order to classify the independence of the offsite power as "I 1/2" group. However, these connections from the AAC source output breaker to the safety buses (23-1, 24-1, 13-1 and 14-1) would have to be Class 1E circuits for taking credit for the cross-tie between buses 23-1 and 13-1.

In addition, the licensee has proposed to make changes in the logic circuits for the shared EDG (EDG 1/2) to allow it to be connectable to safety buses 23-1 and 13-1 simultaneously. The staff has not evaluated this modification since it does not have any bearing on the SBO issue. However, the licensee may submit this modification under separate review if desired.

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 (QA) and Technical Specifications (TS)

The licensee has stated that all SBO equipment is either currently covered by the QA program or will be covered by a QA program in accordance with the guidance of RG 1.155. The staff finds the proposed licensee actions in this area to be acceptable.

The Technical Specifications (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 expects plant procedures to 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 is warranted, the licensee will be notified of the implementation requirements.

2.7 EDG Reliability Program

The licensee 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, it is required to implement a program that meets the guidance of RG 1.155, Position 1.2, Items 2 through 5.

Recommendation: The licensee should provide confirmation and include it in the documentation supporting the SBO submittals that are to be maintained by the licensee, that such a program meeting the guidance of RG 1.155, Position 1.2, Items 2 through 5, is in place or will be implemented.

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 evaluation available to NRC." The staff and its contractor (SAIC) did not perform a detailed review of the proposed procedure modifications which are scheduled for later implementation after the modifications that could result from the staff recommendations in this SER. However, based on our review of the licensee supporting documentation, we have identified the following areas for focus in any followup inspection or assessment that may be undertaken by the NRC to further 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, Position 1.2, Items 2 through 5,

e. equipment and components required to cope with an SBO are incorporated in a QA program that meet 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 Technical Evaluation Report prepared by the staff's consultant, SAIC. Based on our review, additional analyses and confirmations described in the recommendations provided in this SER need to be completed. These include confirmation of the installation of Class 1E circuits from the AAC source output circuit breaker to the safety buses of both units, verification of control room and AEERs heat-up calculations using maximum bounding initial design temperatures, justification of the discrepancy between the 1-hour and steady state temperature for the RCIC room, and the justification for excluding CIVs that are procedurally closed. The licensee should maintain these analyses and confirmations in the documentation supporting the SBO submittal available for further inspection and assessment as may be undertaken by the NRC to audit conformance with the SBO Rule.

Based on our review of the submittal, we find the licensee's design and proposed method of dealing with an SBO to be in conformance with the SBO rule. However, the schedule for implementation of the proposed hardware and associated procedure modifications, including those resulting from the recommendations documented in this Safety Evaluation (SE), should be provided to the NRC staff within 30 days of receipt of this SE, in accordance with 10 CFR 50.63(c)(4).

Principal Contributor: N. K. Trehan

Dated: