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

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STATION BLACKOUT EVALUATION

SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1

DOCKET NO. 50-206

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, analysis 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) NUMARC 87-00, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, and (3) NUMARC 87-00 Supplemental Questions/Answers and Major Assumptions dated December 27, 1989 (issued to the industry by NUMARC* January 4, 1990).

To facilitate the NRC staff's (hereafter referred to as staff) review of licensee responses to the SBO rule, the staff endorsed 2 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.

*Nuclear Management and Resources Council, Inc.

The licensee for San Onofre Nuclear Generating Station Unit 1 (SONGS 1) has proposed using an Appendix R dedicated safe shutdown (DSD) diesel generator as an AAC power source and has submitted its response in the applicable generic response format.

The licensee's responses to the SBO rule were provided by letters from M. O. Medford on April 17, 1989; from F. R. Nandy on May 1, 1990 (not signed) and December 5, 1990; and from R. M. Rosenblum on August 6, 1990; all to U. S. Nuclear Regulatory Commission, Document Control Desk. Also, there was a teleconference between representatives of the licensee and the NRC Staff on June 22, 1990. 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 SAIC Technical Evaluation Report (TER) SAIC-90/1378, "SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1, STATION BLACKOUT EVALUATION," dated November 15, 1990, (Attachment 1). The SAIC TER was completed before the licensee's December 5, 1990 submittal and does not reflect the information in that submittal.

2.0 EVALUATION

After reviewing the licensee's submittals and the SAIC TER the, staff concurs with the SAIC 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 "C", and a target Emergency Diesel Generator (EDG) reliability of 0.95. The target EDG reliability was based on SONGS 1 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 "1" 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 coping duration.

2.2 Alternate AC (AAC) Power Source

The licensee has proposed an existing Appendix R DSD diesel generator as an AAC power source to operate systems necessary for the required coping duration of 4 hours and recovery therefrom.

2.2.1 General staff position on AAC power sources

The definition in 10 CFR 50.2, RG 1.155 and NUMARC 87-00 define the 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 are contained in 10 CFR 50.2 (The AAC source should be connectable to but normally not connected to the offsite or onsite emergency AC power systems), 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 AAC power source

The licensee has proposed using the Appendix R DSD diesel generator as the AAC power source for an SBO. The licensee has stated that this power source is available within 20 minutes from the onset of an SBO event, has sufficient capacity and capability to operate all systems necessary for coping with an SBO for a duration of 4 hours and has the capability to bring the plant to a safe shutdown condition (hot standby) and maintain the plant in that condition. The licensee has also stated that the AAC source meets the criteria of NUMARC 87-00, Appendix B and that a timed test will be performed during the next refueling outage to demonstrate that the AAC source can be manually started in 20 minutes and loaded 2 minutes later.

The staff assessment of the capacity and connectability of the proposed AAC source indicates that it falls into the minimally capable category as discussed in Section 2.2.1 above and meets the connectability requirements of Section 2.2.1.1 above. The proposed AAC source does not power any normal safety train related safe shutdown buses. However, in conjunction with extensive manual operator actions outside the control room, it is capable of powering specific loads (Appendix R loads) that are able to shut down the plant (hot standby) during an SBO. The proposed AAC power source does not provide charging to the normal safety batteries. This is discussed further under Section 2.3.2 of this SER.

Recommendation: The licensee, in accordance with their stated intention, should complete the testing of the AAC source to show that it can be started and loaded in less than an hour. The test results should be included with the other documentation that is to be maintained in support of the licensee's response to the SBO rule.

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's Technical Specifications require a minimum condensate storage tank level of 190,000 gallons. Using NUMARC 87-00, the staff has calculated that 29,800 gallons are required to cope with an SBO for four hours. The licensee used a variation of NUMARC 87-00 methodology, and calculated a required condensate of approximately 40,262 gallons. In either case, the available inventory exceeds the required inventory by a significant margin. The staff therefore concludes that there is sufficient condensate water to cope with and recover from an SBO of four hours.

2.3.2 Class 1E battery capacity

As discussed in Section 2.2.2 of this SER above, the proposed AAC source does not power the battery chargers of the station batteries. Following an SBO, the licensee proposes to dispatch operators from the control room to the remote shutdown panel (RSP) to start and load the DSD diesel generator. The licensee in their initial response stated that there is sufficient Class 1E battery capacity to power the SBO loads for one hour. That response suggested that the control room would not be needed after the first hour. Subsequently, following receipt from NUMARC of the NRC staff's position that the control room should be manned and operable during the full duration of an SBO, the licensee stated that a detailed evaluation is being performed and will be submitted to NRC by November 30, 1990. The licensee, in their submittal dated December 5, 1990, stated that completion of the battery calculation will be delayed until the reactor coolant system (RCS) inventory calculation is finished. This will result in a change in the battery calculations by removing the DC thermal barrier pump from the battery loads. The battery capacity and RCS inventory evaluations will be summarized in a submittal within four months after restart from the cycle 11 refueling outage.

The normal battery-backed plant monitoring and electrical system controls that are an integral part of the control room are considered by the staff to be essential for successfully coping with and recovering from an SBO. Since the AAC source and the ASP do provide some of the functions which are required for minimum SBO coping capability (Fig. 1 of Attachment 1), they are considered by the staff to provide an acceptable means to assist in the control of the plant during an 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 an recovering from an SBO.

Recommendation: The licensee should develop and implement the necessary modifications, such as battery charging from the AAC power source or additional battery capacity, which will maintain the main control room fully functional and manned for the full 4 hour SBO duration. The supporting analysis should be submitted for staff review and included in the documentation supporting the SBO submittals to be maintained by the licensee.

2.3.3 Compressed air

The licensee stated in their initial submittal that the air operated valves needed to cope with an SBO for one hour can either be operated manually or have sufficient backup sources independent of the Class 1E AC power supply. In their August 6, 1990 submittal, the licensee stated that the nitrogen system allows for operation of required components for up to 16 hours before replacing any bottles. The backup nitrogen is automatically available to the valves when the instrument air pressure gets below 80 psig. Also, the nitrogen header pressure is routinely checked.

Based on the above, we find that there is reasonable assurance of sufficient compressed air for the operation of the air-operated valves during a 4-hour SBO event.

2.3.4 Effects of loss of ventilation

The licensee in his initial submittal referenced the Systematic Evaluation Program (SEP) Topic IX.5, "Ventilation Systems" calculations as bounding heat-up evaluations for the DC Switchgear Room, Charging Pump Room, and 480V Switch-gear Room. Subsequently, the licensee has decided to use the NUMARC methodology for assessing the effects of loss of ventilation for the above areas. In their August 6, 1990 submittal, the licensee stated that these calculations have been completed for the charging pump room and the 480V switchgear room, and that the calculations show that these rooms will be able to survive an SBO without excessive heatup. The licensee, in their revised response dated December 5, 1990, stated that the calculation for the DC switchgear room has been completed; however, a deviation from the NUMARC 87-00 guidance was necessary for this room and other plant areas in order to predict acceptable temperatures after loss of HVAC. The licensee stated that a submittal explaining the HVAC deviation and results will be provided by December 21, 1990.

The licensee stated that calculations using NUMARC methodology showed that the control room would reach a temperature of approximately 117°F after a 4-hour SBO event assuming an ambient control room temperature of 75°F on onset of an SBO. However, the licensee's response to the SBO rule does not provide information regarding whether the control room heating calculations were performed using an initial temperature corresponding to the maximum bounding design temperature of the control room, including technical specification temperature limits. The licensee has committed to open the doors of the cabinets in the control room within 30 minutes of the onset of an SBO event in accordance with NUMARC 87-00 guidance.

Recommendation: The licensee should (1) complete the calculation of the ambient temperature in the DC switchgear room resulting from a four hour SBO event, and verify that the equipment in this room will remain operable under such temperature conditions and (2) verify whether the control room temperature used in heatup calculations is the maximum bounding design temperature. If not, an initial maximum bounding temperature should be used to re-evaluate the loss of

ventilation effects inside the control room, including SBO equipment operability for the required SBO duration. The results of these evaluations, justification for each assumption used and a description of any resulting modifications should be submitted to the NRC for review. The complete evaluations and details of the modifications should be included in the documentation supporting the SBO submittals that is to be maintained by the licensee.

2.3.5 Containment isolation

The licensee stated in his initial SBO response that the containment isolation valves (CIVs) that must be capable of being closed or that must be operated (cycled) under SBO conditions are being verified to assure that they can be positioned (with indication) independent of the preferred and SBO unit's Class 1E power supplies. Also, the licensee in his revised SBO response, excluded those CIVs which are "always" or "normally" closed but not "locked closed" and those CIVs evaluated under the SONGS 1 systematic Evaluation Program (SEP) Topic VI-4, "Containment Isolation Systems."

The licensee has revised the procedures to include "normally closed" CIVs for ensuring that the CIVs remain closed during an SBO event. However, the licensee needs to ensure that these valves can be closed independent of the preferred and Class 1E AC power supplies and have valve position indication (e.g. local mechanical, DC powered, or alternate AC powered) that is independent of the preferred and blacked-out unit's Class 1E power supplies.

Recommendation:

For those CIVs that are not "locked closed" the licensee should verify that these valves can be closed independent of the preferred and Class 1E AC power supplies and have valve position indication (e.g. local mechanical, DC powered, or alternate AC powered) that is independent of the preferred and blacked-out unit's Class 1E AC power supplies. This 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 stated in his initial submittal 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 the required coping duration. In their revised submittal, the licensee stated that the reactor coolant pump (RCP) seals are cooled via a DC powered thermal barrier pump during the first hour and by an AAC powered charging pump during the remaining three hours of an SBO event. No additional RCP seal leakage was assumed in the reactor coolant inventory loss analysis. Subsequently, the staff requested the licensee to provide additional information and analysis pertaining to the ability of the DC thermal barrier pump and the component cooling water system to keep the RCP seals cool during an SBO. The licensee, by a letter dated December 5, 1990, stated that it has decided to

eliminate the use of the DC thermal barrier pump from the method of compliance with the station blackout rule. The licensee has now committed to perform a RCS inventory assessment based on the guidance in NUMARC 87-00 to satisfy the station blackout rule.

The licensee needs to demonstrate by an appropriate analysis that an adequate reactor coolant inventory will be maintained, considering the assumed reactor coolant leakage of 87 gpm (25 gmp/RCP plus maximum allowed technical specification leakage of 12 gpm).

The reactor coolant inventory evaluation as discussed above was based on the guidance provided in NUMARC 87-00 of 25 gpm per reactor coolant pumps (RCP) seal leakage for pressurized water reactor. 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 analyses and actions addressing conformance to the SBO rule.

Recommendation: The licensee should provide the analysis for staff review to support their assumption that no RCP seal degradation will occur during an SBO event or demonstrate adequate reactor coolant inventory is maintained considering the assumed reactor coolant leakage of 87 gpm for SONGS 1. These evaluations should also be included in the documentation supporting the SBO submittals to be maintained by the licensee.

2.4 Procedures and Training

The licensee stated that the AC power restoration, severe weather, and station blackout response procedures would be reviewed and modified to meet the guidelines of NUMARC 87-00, Section 4. Also, minor changes will be made to the coping procedures to ensure all the provisions of NUMARC 87-00, Section 7, are included.

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 assure an effective response to an SBO.

2.5 Proposed Modifications

The licensee stated that minor changes will be made as necessary to the Appendix R DSD system to ensure operation of the system under the conditions of an SBO event.

Recommendation: The licensee should include a full description including the nature and objective of all modifications required for compliance with the SBO rule in the documentation supporting the SBO submittals that is to be maintained by the licensee.

2.6 Quality Assurance And Technical Specifications

During the telephone conversation of June 22, 1990 , the licensee stated that all the SBO equipment is covered by NRC-approved QA programs (10 CFR 50, Appendix B or Appendix R).

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 expects 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 is warranted, the licensee will be notified of the implementation requirements.

2.7 EDG Reliability Program

The licensee stated that they will establish a reliability program for their EDGs consistent with NUMARC 87-00, Appendix D, as clarified. The licensee also stated that since the DSD diesel is not designed to safety-related standards, a separate reliability program would be developed for it. The submittal did not specifically address a commitment to implement an EDG reliability program to conform to the guidance of RG 1.155, Position 1.2.

Recommendation: It is the staff's position that an EDG reliability program should be developed in accordance with the guidance of RG 1.155 Section 1.2. Confirmation that such a program is in place or will be implemented should be included in the documentation supporting the SBO submittals that is to be maintained by the licensee.

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 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. Additional items may be added as a result of the staff review of the actions taken by the licensee in response to this SER.

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 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 in the SER.

3.0 CONCLUSIONS:

The staff has reviewed the licensee's responses to the SBO rule (10 CFR 50.63) and the Technical Evaluation Report prepared by the staff's consultant, SAIC.

Based on the staff's review of the licensee's submittals and the SAIC TER, the staff finds that San Onofre Nuclear Generating Station, Unit 1 does not conform with the SBO rule and the guidance of R.G. 1.155, and therefore recommends that the licensee reevaluate the areas of concern that have been identified in this SER. 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 Supplementary 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 concerns that are identified in this SER should be addressed by the licensee, and a revised response submitted to the NRC within 60 days. The licensee is expected to ensure that the baseline assumptions of NUMARC 87-00 are applicable to the SONGS 1 plant. Also, the licensee is expected to document all analyses and related information, and verify that these are available for NRC review. Subject to an acceptable resolution of the identified non-conformances and the staff recommendations, the issue of conformance to the SBO rule remains open at the SONGS 1 plant.

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