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

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO STATION BLACKOUT

(10 CFR 50.63) NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT UNIT NOS. 1 AND 2

1.0 INTRODUCTION

On July 21, 1988, the Code of Federal Regulations 10CFR 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 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, analysis 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) 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, NUMARC 87-00 Major Assumptions (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 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 Prairie Island Nuclear Generating Plant has proposed using an AAC power source and has submitted their response in the applicable generic response format. The licensee's response was provided by letters from Northern States Power Company to the Director of Nuclear Reactor Regulation (NRC) dated April 13, 1989 and March 29, 1990. The licensee 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-89/1641, "Technical Evaluation Report; Prairie Island Nuclear Generating Plant; Station Blackout Evaluation," dated July 18, 1990.

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 No. 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 SBO duration of 4 hours based on a plant AC power design characteristic group "P2", an emergency AC (EAC) power configuration Group "C", and a target emergency diesel generator (EDG) reliability of 0.975. The "P2" group selection 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 Group "3". The EAC power configuration Group C is based on the licensee's proposed modification of the existing 4.16kV station auxiliary system and addition of two Class 1E diesel generators to provide independent and dedicated EDGs for each unit. The target EDG reliability was based on Prairie Island EDGs having a reliability greater than 0.95 for the last 100 demands.

After reviewing the licensee's proposed SBO duration and the available information on the proposed modifications, RG 1.155, NUMARC 87-00 and SAIC 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 using EDGs as an AAC power source to operate systems necessary for SBO coping duration and recovery therefrom.

2.2.1 General staff position on AAC power sources

The definition in 10CFR 50.2, RG 1.155 and NUMARC 87-00 define AAC power source in terms of four attributes: (1) connections to the offsite or the onsite AC power system, (2) minimum potential for common cause failure with offsite power or the onsite emergency AC power sources, (3) timely availability, and (4) required capacity and reliability. More specifically, in regard to the fourth attribute, the SBO rule reads as follows:

> "(4) Has sufficient capacity and reliability for operation of all systems required for coping with station blackout and for the time required to bring and maintain the plant in safe shutdown (non-design basis accident)."

In view of the variety of types, capacities and capabilities of power sources proposed as AAC sources by various licensees, the staff has characterized proposed AAC power sources as being either optimum, fully capable or minimally capable. This characterization, which relates only to the capacity attribute cited above, was necessary in order to facilitate the staff review of licensee responses to the SBO rule. It does not invalidate or revoke any of the requirements or guidance applicable to AAC power sources.

An optimum AAC power source design is one that is capable of powering simultaneously both safety trains of normal safe shutdown systems and equipment. Such a design, following actuation of the AAC source, would provide completely redundant normal safe shutdown capability during an SBO and recovery therefrom from the main control room.

A fully capable AAC power source design is one that is capable of powering at least one complete safety train of normal safe shutdown systems and equipment. This includes decay heat removal, battery charging, HVAC (heating, ventilation and air conditioning), emergency lighting, and the associated controls and instrumentation. Thus, although redundant capability is not available, a fully capable AAC source would enable attainment of safe shutdown during an SBO and recovery therefrom from the main control room.

A minimally capable AAC power source design is one that is not capable of powering all (or any) normal safety train related safe shutdown equipment; but it is capable of powering specific equipment that, in conjunction with extensive manual operator actions both inside and outside of the control room, is critical for attaining safe shutdown during an SBO. Appendix R diesels proposed as an AAC source are examples of minimally capable AAC sources. With this design operability of the main control room could not be assured unless the batteries were sized to operate for the SBO duration, or battery charging capability was provided by the AAC source.

2.2.1.1 EDGs used as AAC power sources

The guidance on the use of existing emergency diesel generators (EDGs) as AAC power sources is documented in the station blackout rule 10 CFR §50.63, RG 1.155 Position C.3.3.5 and NUMARC 87-00 (Section 2.3.1(3)). This guidance is further explained in NUMARC 87-00 Supplemental Questions and Answers dated December 27, 1989, under questions 3.4 and B.3. The station blackout rule states:

> "At multi-unit sites, where the combination of emergency ac power sources exceeds the minimum redundancy requirements for safe shutdown (non-DBA) of all units, the remaining emergency ac power sources may be used as alternate ac power sources provided they meet the applicable requirements."

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.

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The rule statement requires minimum redundancy. This means in order to qualify as an AAC source, there must be an EDG available in the non-blackout (NBO) unit that is in addition to the number of EDGs required to meet the minimum EDG redundancy requirement for powering a normal safe shutdown for a loss of offsite power (LOOP) event. Thus, the EDG's in a two unit site with two dedicated EDG's per unit would not qualify as AAC sources because the two EDGs per unit just meet the minimum redundancy requirement, i.e., there is no excess EDG.

However, there are some plants at two unit sites which just meet minimum redundancy but where each EDG is of sufficient capacity to fully power all the normal LOOP loads of the NBO unit, and also has sufficient excess capacity for powering the required safe shutdown loads of the SBO unit. In recognition of the existence of this type of situation, the staff has interpreted the excess EDG redundancy requirement of the SBO rule to allow EDGs just meeting the minimum EDG redundancy requirements, to qualify as AAC sources on the basis of excess capacity, provided the other applicable requirements for AAC sources are also met.

The NRC's basic position on the use of EDGs as AAC power sources on the basis of excess capacity is that such excess capacity should not be attained by load shedding in the non-blackout (NBO) unit which results in a degradation of its normally available safe shutdown capability for the loss-of-offsite-power (LOOP) condition. Any actions that would add to the burden of operators that are already in a high stress environment, such as load switching or disablement of information readouts or alarms in the control room, are considered to be a degradation of normal safe shutdown capability for LOOP in the NBO unit. The staff position is therefore that the normal equipment complement should remain available with adequate EDG capacity for use should it become necessary. The NBO unit should have the capability for hot shutdown/hot standby forced cooling, cooldown and depressurization as required. While additional events are not explicitly being postulated, it is not prudent to diminish the capability of the NBO unit to mitigate problems should they arise. It is not in the interest of safety to reduce the capability to handle various eventualities in one unit for the purpose of meeting

the SBO rule in another unit. Each unit must meet the SBO rule on its own merits without reducing another unit's capability to respond to its own potential problems.

Therefore, a multi-unit site with the dedicated EDGs just meeting the minimum redundancy requirement but not having the excess capacity defined above for qualifying as an AAC source does not meet the SBO rule AAC source option requirements. Further measures are required such as a separate AAC source or a coping analysis which shows the plant can cope with and recover from SBO for the required duration.

8.2.1.2 Connectability of AAC power sources

The basic criteria governing the connectability of an AAC power source are contained in 10CFR 50.2 (the AAC source should be connectable to but normally not connected to the offsite or onsite emergency AC power systems), 10CFR 50.63 (SBO should not assume a concurrent single failure or design basis accident), and in Appendix A of 10CFR 50 (the single failure criterion and the independence requirements apply to the NPO unit). Therefore, in a one unit site 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, or whether the AAC source is an excess redundancy EDG or an independent power source.

However, at a two (or more) unit site where the EDGs meet the AAC source excess redundancy criterion, one intertie circuit between units is acceptable provided it is separately connectable to each safety (EDG) bus in both units. This follows from the application of the above criteria and the assumptions that must be taken that an SBO can occur in either unit, and that the single failure in the NPO unit can be on either one of its EDGs or on its respective safety bus.

8.2.2 Proposed AAC power source

The existing EDG configuration for Prairie Island is that of a two unit site with two shared EDGs. However, once the proposed modifications are completed by adding two Class 1E EDGs (resulting in a total of four EDGs, two dedicated per unit), the AAC power source for the blacked out unit will be a crosstied EDG from the non-blacked out unit. Connection of the AAC power source to the blacked out unit, will be through manual bus tie breakers between buses of the same train on opposite units. The licensee has stated that the AAC source is available within 10 minutes of the onset of the SBO event and will have sufficient capacity and capability to operate systems necessary for coping with an SBO for the required SBO duration of 4 hours. Furthermore, the licensee has stated that the AAC source will have sufficient capacity and capability to bring and maintain the plant in safe shutdown.

On January 4, 1990, NUMARC issued to the industry, a supplemental Question/Answer guidance for SBO. The supplemental guidance was endorsed by the staff and reflected the staff's position regarding various aspects of SBO. In particular, question B.3 of that guidance, stated that the crosstied AAC source must be capable of carrying the loss of offsite power safe shutdown loads of the non-blacked out unit and the SBO loads of the blacked out unit for the required SBO duration. The supplemental guidance continues by stating that the AAC source for the blacked out unit can only be the excess capacity above the loss of offsite power loads of the non-blacked out unit.

To determine if the existing EDG capacities were consistent with the staff's position (as stated above), the staff referred to the Prairie Island UFSAR, Chapter 8, page 8.4-2, stated that each EDG is capable of supplying the power requirement of one complete set of engineered safety features for one reactor unit while providing sufficient power to allow the second unit to be placed in a safe shutdown condition. The review of the loads given in Table 8.4-1 of the UFSAR indicates that each of the existing EDGs has sufficient capacity to supply the SBO loads in the blacked-out and the required LOOP loads in the non-blacked out unit. The licensee's submittal stated that vital loads will be loaded onto the EDG of the non-blacked out unit following a loss of offsite power. Therefore, based on the FSAR and the licensee's submittal the staff has concluded that there is sufficient capacity and capability in the existing EDGs to comply with the staff's position on crosstied AAC power source capacities. In addition the proposed new EDGs will have a capacity that is almost twice the existing EDG capacity. Based on the above review, the staff assessment of the proposed AAC power source, both existing and proposed (after implementation of the modifications), indicates that it falls into the fully capable AAC power source category cited in section 2.2.1 of this safety evaluation report (SER). As part of the fully capable classification and based on the licensee submittal, the battery capacity and/or charging is adequate to power the normal battery-backed plant monitoring and electrical system controls that are an integral part of the control room and are considered essential for successfully coping with and recovering from an SBO.

Based on the above review, the staff has determined that the proposed AAC source does meet the requirements of RG 1.155 and NUMARC 87-00. However, the licensee's submittal did not specifically address the testing requirements of 10CFR 50.63(c)(2) and NUMARC 87-00, Appendix B, item B.12. The rule and NUMARC 87-00 guidance requires that the AAC source be demonstrated by an initial test, to be available to power the shutdown buses within 10 minutes of the onset of the SBO event. In order to ensure compliance with the SBO rule, the AAC test will need to be performed.

Recommendation: After the licensee has completed the proposed modifications, the licensee is required to perform the appropriate tests as required by 10CFR 50.63. In addition, the test procedures and test results should be documented and this supporting documentation should be available for NRC review or audit for verifying conformance with 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 recover from an SBO for a 4-hour coping duration.

2.3.1 Condensate inventory for decay heat removal

The licensee has performed calculations and shown that sufficient water is available in the condensate storage tank (CST) to provide decay heat removal for a 4 hour SBO duration.

After reviewing the licensee's submittal and the SAIC TER, the staff agrees with the licensee's assessment that the plant has adequate condensate inventory for a 4 hour SBO duration. In addition, the excess inventory in the CST is available for SBO recovery.

2.3.2 Class 1E battery capacity

RG 1.155 and NUMARC 87-00 do not require the licensee to submit a battery capacity assessment if (1) the AAC power source is available within 10 minutes of the onset of an SBO event, and (2) the AAC power source will power the one division of Class 1E battery chargers. Based on the licensee's submittal, the licensee has met the above mentioned conditions; and therefore, no battery capacity coping analysis is required.

2.3.3 Compressed air

RG 1.155 and NUMARC 87-00 do not require the licensee to submit a coping analysis for compressed air if (1) the AAC power source is available within 10 minutes of the onset of an SBO event, and (2) the AAC power source will power the necessary air compressors. Based on the licensee's submittal, the licensee has met the above mentioned conditions; and therefore, no coping analysis for compressed air is required.

2.3.4 Effects of loss of ventilation

The licensee stated in their SBO submittal, that the AAC power source will power the HVAC systems that serve the dominant areas of concern (DAC) including the control room. As a result, the licensee did not submit a loss of ventilation assessment. The licensee also stated no modifications and/or procedures are required to provide reasonable assurance for operability of ventilation equipment. NUMARC 87-00 and NUMARC supplemental questions and answers (issued by NUMARC on January 4, 1990) provide guidance to the licensee for the determination of DACs. The licensee has referenced the NUMARC 87-00 guidance and has stated that the HVAC systems that serve the DACs will be powered by the AAC source. Consistent with the RG 1.155 and NUMARC 87-00 guidance, if the DACs are provided with HVAC systems during an SBO event, then a reasonable assurance of SBO equipment operability has been provided and the licensee is not required to provide an assessment of the loss of ventilation effects. Therefore, the staff finds the licensee's response regarding the effects of loss of ventilation to be consistent with the regulatory guidance. However, the licensee should ensure that other areas which have equipment needed for an SBO have appropriate cooling or have been analyzed to show that they are not DACs.

2.3.5 Containment isolation

RG 1.155 and NUMARC 87-00 do not require the licensee to submit a coping analysis for containment isolation if: (1) the AAC power source is available within 10 minutes of the onset of an SBO event, and (2) the AAC power source has sufficient capacity and the capability to power the appropriate containment isolation valves. Since power is available to one division of safe shutdown equipment, it is assumed that the AAC source provides power to the appropriate isolation valves to assure containment integrity during an SBO.

2.3.6 Reactor coolant inventory

The licensee has stated that the AAC power source will power the necessary make-up systems to maintain adequate reactor coolant system (RCS) inventory to ensure that the core is covered for the required SBO coping duration.

Based on the licensee's submittal and after reviewing the SAIC TER, the staff agrees with the licensee's assessment that there will be adequate RCS inventory to ensure core cooling for the 4 hour SBO duration.

2.4 Procedures and Training

The licensee has stated that the appropriate procedures (including a procedure for use of two non-safeguard diesel generators in the interim until the new Class 1E EDGs are installed) will be modified to reflect the necessary changes for an SBO event. Furthermore, the licensee has stated that the changes will meet the guidelines of NUMARC 87-00 and will be implemented prior to the startup of Cycle 15 for Unit 2 (early 1992). The licensee has also stated that the interim contingency procedure which utilizes non-safeguard diesel generators to supply the safeguard buses does not meet the 1-hour time response required for AAC sources, however it is intended to provide preplanned contingency actions pending completion of the Class 1E EDGs addition project.

The proposed procedure modifications were not reviewed but the staff expects the licensee to maintain and implement these procedures 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.

2.5 Proposed Modifications

As discussed in Paragraph 2.2.2 above, the licensee is modifying the 4.16kV station auxiliary system to accommodate two new EDGs so that either one of the two EDGs of each unit can be used as an AAC source for an SBO of the other unit. This modification will include modifying the interlocks of the bus-tie and EDG output circuit breakers. The procedures pertaining to operation, maintenance, surveillance and testing of the modified 4.16kV station auxiliary system will be revised or created as needed. The staff finds that the proposed modification serves as a part of the AAC power source and meets the applicable guidelines of RG 1.155 and NUMARC 87-00, Appendix B.

2.6 Quality Assurance (QA) and Technical Specifications (TS)

The licensee did not provide any information regarding QA programs and TS for SBO equipment. Since much of the SBO equipment is safety related or will be safety related, and some of the equipment is covered by TS, the staff assumes that the licensee has a QA program already in place. However, for equipment not already covered by an existing QA program, RG 1.155 provides QA program guidelines that the staff considers acceptable for SBO purposes.

Furthermore, 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 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 identify SBO equipment that will require a QA program. The QA program should then be reviewed (or developed if nonexistent) to ensure that it is consistent with the guidance of RG 1.155. Further this evaluation should be documented as part of the package supporting the SBO rule response.

2.7 EDG Reliability Program

The licensee did not provide any information or documentation on an EDG reliability program. An EDG reliability program should be developed in accordance with the guidance of RG 1.155, Section 1.2.

Recommendation: The licensee should implement an EDG reliability program which meets 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.

2.8 Scope of Staff Review

The station blackout rule (10CFR 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. Therefore, based on our review of the licensee SBO submittal and UFSAR, 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,

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 this SER.

3.0 SUMMARY AND CONCLUSIONS

The staff has reviewed the licensee's response to the station blackout (SBO) rule (10 CFR 50.63) and the TER prepared by SAIC. Based on our review of the licensee's submittal, we find the proposed design and method of dealing with an SBO to be in conformance with the SBO rule. However, the staff's concerns that are identified in this SER should be addressed by the licensee. The licensee is expected to ensure that the baseline assumptions of NUMARC-8700 are applicable to the Prairie Island Nuclear Generating Plant. Also, the licensee is expected to document all analyses and related information and verify that these are available for NRC review.

Additional, the schedule for implementation of required hardware and associated procedure modifications should be provided to the NRC within 30 days of the receipt of this SER, in accordance with 10 CFR 50.63(c)(2).

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