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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STATION BLACKOUT EVALUATION

DUKE POWER COMPANY

MCGUIRE NUCLEAR STATION

DOCKET NOS. 50-369/370

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, analyses, and related information be available for NRC review. Guidance for conformance to the SBO Rule is provided by (1) Regulatory Guide (RG) 1.155, Station Blackout, (2) The Nuclear Management and Resources Council, Inc. (NUMARC) 87-00, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, and (3) NUMARC 87-00 Supplemental Questions/Answers and Major Assumptions dated December 27, 1989, (issued to the industry by NUMARC on January 4, 1990).

To facilitate the NRC staff's (hereafter referred to as 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 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 H. B. Tucker on April 17, 1989 and April 4, 1990, to the U.S. Nuclear Regulatory Commission, Document Control Desk. Also, the NRC staff conducted an audit review of the licensee's supporting documentation, during the week of August 5-9, 1991. The licensee's responses were reviewed by the NRC staff and by Science Applications International Corporation (SAIC) under contract to the NRC. The results of the SAIC review are documented by a Technical Evaluation Report (TER) SAIC-91/1265 "MCGUIRE NUCLEAR STATION, STATION BLACKOUT EVALUATION" dated December 10, 1991, (Attachment 1).

2.0 EVALUATION

After reviewing the licensee's submittals and the SAIC TER, the staff concurs with the SAIC analysis and 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 SBO duration of 4 hours based on a plant offsite 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 EAC power configuration Group "C" is based on two EDGs with one EDG required to operate safe shutdown equipment following a loss of offsite power. The target EDG reliability was based on the McGuire Nuclear Station having an average EDG reliability greater than 0.95 for the

last 100 demands. Using this data, the target EDG reliability (0.95) selected by the licensee is appropriate. However, the licensee should also have the EDG reliability data for the last 20 and 50 demands in the documentation to be retained by the licensee in support of the SBO submittals.

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 alternate ac (AAC) power source proposed by the licensee at the McGuire Nuclear Power Station (McGuire) is the Standby Shutdown Facility (SSF) diesel generator. The licensee states that this AAC power source will 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 define an 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 the 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, 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 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 EAC 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 states that an AAC power source is provided at McGuire which meets the criteria specified in NUMARC 87-00, Appendix B. The AAC power source is the Standby Shutdown Facility (SSF) diesel generator which is the power source for the Standby Shutdown System (SSS). The SSF diesel generator cannot be started from the McGuire main control room. However, the licensee stated that testing has demonstrated the ability of plant operations to start the SSF diesel within 10 minutes of the recognition of the SBO event, which satisfies the intent of the NUMARC guidance. The licensee added that the SSF diesel generator has sufficient capacity and capability to operate equipment necessary to maintain safe shutdown conditions for a 4-hour SBO event. The licensee also states that the SSF was originally designed to provide an alternate means of achieving and maintaining hot standby conditions following a postulated fire or sabotage event.

The licensee states that the AAC power source at McGuire is a 600V, 700kW self contained diesel generator and is designed to meet the requirements of Appendix R. The SSF contains its own control room, diesel generator, AC & DC distribution systems, HVAC systems, and lighting system. The SSF diesel generator powers one makeup pump per unit which is located inside containment.

In order to provide water to the steam generator, the normal unit turbine-driven AFW pump is required. The controls for the pump are independent of the normal plant controls.

The staff's 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 is normally in standby and does not power any safety train related safe shutdown buses. However, in conjunction with some manual operator actions outside the control room, it is capable of powering specific loads that are able to shutdown the plant (hot standby) during an SBO event.

The SSF has been approved for Appendix R by the NRC to be capable of maintaining both units in hot standby for a period of up to 72 hours, and, with the exception of the AFW pump, is completely independent of the normal plant systems. Since the SSF diesel generator meets the criteria of NUMARC 87-00, Appendix B, the staff considers it to be an acceptable AAC power source.

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 stated that 75,452 gallons of water are required for decay-heat removal during the 4-hour coping period and that the turbine-driven auxiliary feedwater pumps would be aligned to the following sources of condensate-grade water:

1. Auxiliary feedwater condensate storage tank - 45,000 gallons (This tank is shared between units)

2. Upper Surge Tanks - 85,000 gallons

3. Condenser Hotwell - 170,000 gallons

In addition to the condensate sources listed above, the SSF also has the ability to align to the condenser circulating water system (CCWS), which has the capability to maintain the plant at hot standby conditions for approximately 72 hours, to remove the decay heat during an SBO event. Therefore, the licensee concluded that there is sufficient water available to cope with a 4-hour SBO event and that no plant modifications or procedure changes are necessary to use these water sources.

Based on its review, the staff agrees with the licensee that there is sufficient water to cope with a 4-hour SBO event at the McGuire plant.

2.3.2 Class 1E Battery Capacity

The licensee stated that a plant-specific battery capacity calculation is not required because the design of the vital batteries allows cross-tieing the non-blacked-out (NBO) unit battery charger to the blacked-out unit's batteries.

The licensee further states that the Standby Shutdown Facility (SSF) is provided with its own 250/125 VDC power system which is independent from the normal plant 125 VDC and 120 VAC vital I & C power systems. The SSF batteries are charged by th· *AC power source and are available to power the SSF instruments and controls necessary to achieve and maintain hot standby conditions from the SSF control room following an SBO event.

A review of the licensee's submittal and the plant FSAR indicates that McGuire has four Class 1E batteries labelled A, B, C, and D, which are shared between

units. Batteries A and C make up one division for each unit, as do batteries B and D. There are five battery chargers for the site, one for each battery and one spare charger, each of which have the ability to be powered from either unit. Each battery charger has the capacity and connectability to power a complete division of batteries (either batteries A and C or B and D). The licensee further states that each EDG is able to power two of the normal battery chargers as well as the spare charger. Since one EDG will be available in the NBO unit, two of the normal battery chargers and hence one division in each unit will be powered. Therefore, we conclude that, McGuire has sufficient battery capacity to cope with a 4-hour SBO event.

2.3.3 Compressed Air

The licensee stated that no air-operated valves are relied upon to maintain hot standby from the SSF. However, the licensee is planning to remove decay heat during an SBO event by using the steam generator safety valves (SVs) instead of the atmospheric dump valves (ADVs). Should cooldown become necessary pursuant to procedure ECA 0.0, the licensee can manually operate the ADVs. In addition to the ADVs, the AFW flow control valves which are also air operated during normal operation will be manually operated in order to control the steam-generator water level during an SBO event.

Based on its review, the staff concludes that compressed air is not relied upon to cope with an SBO event at the McGuire plant. However, the licensee should ensure the accessibility to the above cited valves and the habitability in the areas where the above cited valves are located during an SBO event.

Recommendation: The licensee should ensure and confirm the accessibility to the above cited valves and the habitability in the areas where these valves are located during an SBO event.

2.3.4 Effects of Loss of Ventilation

The licensee, using the guidance described in NUMARC 87-00, identified the containment, annulus, AFW pump room, turbine-driven AFW pump pit, mechanical penetration rooms, and inboard doghouses as the dominant areas of concern (DACs) and performed analyses to determine the effects of loss of ventilation in these DACs during an SBO event (see SAIC TER for the list of the DACs and their associated calculated temperatures). It was also determined that the control room and switchgear room are not DACs. The staff's evaluation of the effects of loss of ventilation in each of these areas is provided below:

2.3.4.1 Containment

The licensee performed plant-specific analyses to evaluate the containment response under SBO conditions. The licensee calculated a maximum temperature of 205°F which is well below the calculated peak temperature of 326°F resulting from a main steam line break. Therefore, the licensee concluded that the containment temperature resulting from an SBO event is not a concern.

Based on its review, the staff agrees with the licensee that the containment temperature resulting from an SBO event is not a concern at the McGuire plant.

2.3.4.2 AFW Pump Room and Turbine-Driven AFW Pump Pit

The licensee stated that the calculated peak temperatures during an SBO event for the AFW pump room and the turbine-driven AFW pump pit are 127°F and 143°F, respectively. These calculated peak temperatures are well below the guidance of temperature limits described in NUMARC 87-00 for equipment operability. Therefore, the licensee concludes 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 operability of SBO response equipment in these areas.

Recommendation: The licensee should ensure the accessibility and habitability in these areas for the manual operation of AFW flow control valves during an SBO event.

2.3.4.3 Control Room

The licensee stated that the main control room is shared between the units, and is served by a shared heating, ventilation, and air conditioning (HVAC) system. The HVAC system, which will be powered from the non-blacked out (NBO) unit's available EDG, will be available approximately 45 minutes after the onset of an SBO event. The licensee stated that the control-room temperature will be maintained at approximately 75°F with a possible short-duration excursion above 75°F (but not exceeding 120°F) for the period required to realign the HVAC to the operable EDG. The licensee, therefore, concluded that the control room is not a DAC.

Based on its review, the staff agrees with the licensee that the control room at the McGuire plant is not a DAC.

Recommendation: The licensee should provide a procedure which will require the operators to open instrument cabinet doors within 30 minutes following an SBO in accordance with the guidance described in NUMARC 87-00.

2.3.4.4 Switchgear Room

The control complex HVAC system also provides ventilation for the switchgear rooms. Therefore, the switchgear rooms will have HVAC available within 45 minutes of the onset of an SBO event and will not exceed 120°F during an SBO event. Consequently, the licensee concluded that the switchgear rooms are not DACs.

Based on its review, the staff agrees with the licensee that the switchgear rooms at the McGuire plant are not DACs.

2.3.4.5 Annulus, Mechanical Penetration Rooms and Doghouses (Inboard/Outboard)

The licensee stated that plant-specific calculations and assumptions were used to determine the temperature in these DACs and that reasonable assurance of the operability of SBO response equipment in these DACs has been provided in accordance with the guidance described in NUMARC 87-00. Therefore, the licensee concluded that no modifications or procedure changes are required to provide reasonable assurance of equipment operability.

Based on its review, the staff agrees with the licensee that there is reasonable assurance of SBO response equipment operability in the above DACs during an SBO event at the McGuire plant. However, with regard to the doghouses where the SVs are located the licensee should ensure (as indicated in the above Section 2.3.3) the accessibility and habitability for the manual operation of the SVs. In addition, the licensee should verify that no manual operation of SBO response equipment in the annulus and mechanical penetration rooms is required during an SBO event.

Recommendation: The licensee should verify that no manual operation of SBO response equipment in the annulus and mechanical penetration rooms is required during an SBO event.

2.3.5 Containment Isolation

The licensee stated that the plant List of containment isolation valves (CIVs) has been reviewed to verify that valves which must be capable of being closed or that must be operated (cycled) under SBO conditions can be positioned with indication independent of the blacked-out unit's Class-1E power supplies. The licensee concluded that no modifications or associated procedure changes are required to ensure that appropriate containment integrity can be provided under SBO conditions.

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

2.3.6 Reactor Coolant Inventory

The licensee stated that the AAC source (the SSF diesel generator) provides power to the necessary makeup system to maintain adequate reactor coolant system inventory to ensure that the core is cooled for the required coping duration of 4 hours. A standby makeup pump powered from the SSF diesel generator is located in the annulus of each unit to supply makeup to the RCS. The licensee stated that the pump is sized to accommodate normal system leakage, reactor coolant pump (RCP) seal leakage, and additional flow for system makeup. The standby make-up pump delivers borated water from the spent fuel pool to the RCS at a rate of 26 gpm. Approximately 18 gpm is required for seal leakage, leaving 8 gpm available for RCS makeup and boration.

The licensee provided the results of its calculations which indicate that the core will not become uncovered during a 4-hour SBO event. For this calculation, the licensee assumed an initial leak rate of about 110 gpm which decreased to about 30 gpm after 4 hours. Reactor coolant makeup is necessary to replenish the RCS inventory losses due to the reactor coolant pump seal leakage (25 gpm per pump per NUMARC 87-00 guideline), and the Technical Specifications maximum allowable leakage of 11 gpm.

The staff's consultant, SAIC, performed a calculation to determine the adequacy of the reactor coolant inventory and concluded that there is sufficient volume to maintain natural circulation and to keep the core covered and cooled during an SBO event. The staff agrees that the core will remain covered during a 4-hour SBO event.

The reactor coolant inventory evaluation as discussed above was based on the guidance provided in NUMARC 87-00 of 25 gpm per reactor coolant pump (RCP) seal leakage for pressurized water reactors. The 25 gpm value was agreed to between NUMARC and the staff pending resolution of Generic Issue (GI) 23. If the final resolution of GI-23 defines higher RCP leakage rates than assumed for

this evaluation, the licensee should be aware of the potential impact of this resolution on their analyses and actions addressing conformance to the SBO rule.

2.4 Procedures and Training

The licensee stated that plant procedures have been reviewed and, where necessary, will be modified to meet the guidelines of NUMARC 87-00, Section 4, in the following areas:

- Station blackout response,
- AC power restoration, and
- Severe weather guidelines.

The licensee identified the procedures that have been reviewed as well as those that have been modified to cope with an SBO event. The staff did not review the procedures or proposed procedure modifications. The staff expects the licensee to implement and maintain these procedures including any others that may be required to ensure appropriate response to an SBO event. Although personnel training requirements for an SBO response were not specifically addressed by the licensee's submittal, the staff expects the licensee to implement the appropriate training to ensure an effective response to an SBO event.

2.5 Proposed Modifications

The licensee has not identified any potential design changes or modifications which will be required for the plant to cope with an SBO event.

2.6 Quality Assurance and Technical Specifications

The licensee states that the SBO response equipment is classified into three Quality Assurance (QA) categories. The three categories are 10 CFR 50, Appendix B, which covers safety-related equipment; 10 CFR 50, Appendix R,

which covers fire and security-related equipment; and RG 1.155, Appendix A, which would cover the SBO equipment not covered in these categories. The licensee added that equipment covered by Appendices B and R meet the QA requirements of RG 1.155. Additionally, the licensee states that it is in the process of establishing a QA program which meets the requirements of RG 1.155, Appendix A. The staff accepts the licensee's commitment to establish a QA program which meets the guidelines of RG 1.155 and concludes that all equipment required during an SBO is, or will be covered under an appropriate QA program.

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's submittals on SBO did not specifically address the commitment to implement an EDG reliability program to conform to the guidance of RG 1.155, Position 1.2.

Recommendation: The licensee should provide confirmation and include in the documentation supporting the SBO submittals that a program meeting as a minimum the guidance of RG 1.155, Position 1.2, is in place or will be implemented.

2.8 Scope of Staff Review

The SBO Rule (10 CFR 50.63) requires licensees to submit a response containing specifically defined information. It also requires utilities "...to have baseline assumptions, analyses, and related information used in their coping

evaluations available for NRC review." The staff and its contractor (SAIC) did not perform a detailed review of any proposed procedural modifications which are scheduled for later implementation. However, based on our review of the licensee's supporting documentation, we have identified the following areas for focus in any follow-up inspection or assessment that may be undertaken by the NRC to verify conformance with the SBO Rule. Additional items may be added as a result of the staff review of the actions taken by the licensee in response to this SE.

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 the SE.

3.0 Summary and Conclusion

The staff has reviewed the licensee's responses to the SBO Rule (10 CFR 50.63) and the TER prepared by the staff's consultant, SAIC. Based on our review, some confirmations and commitments need to be made as described in the recommendations itemized herein. These include verification of the

accessibility for the SVs and AFW flow control valves and verification of operator habitability under SBO conditions, confirmation of procedures to open the control room cabinet doors within 30 minutes of an SBO, verification that no manual operation of SBO equipment in the annulus and mechanical penetration rooms is required during an SBO event, and implementation of an EDG Reliability Program in accordance with the guidelines of RG 1.155, Section 1.2. The licensee should include the documentation associated with the above actions and verifications with the other documentation supporting the SBO submittal, and maintain this documentation for further inspection and assessment as may be undertaken by the NRC to further verify confirmation with the SBO Rule.

Based on our review of the submittals, we find the licensee's responses and proposed method of dealing with an SBO to be in conformance with the SBO Rule contingent upon receipt of confirmation from the licensee within 30 days that the recommendations identified within this SE will be implemented. The schedule for implementation should also be provided in accordance with 10 CFR 50.63 (c)(4).

4.0 Attachments

SAIC-91/1265, Technical Evaluation Report, McGuire Nuclear Station, Station Blackout Evaluation, December 10, 1991.

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Date: February 19, 1992