UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO STATION BLACKOUT, 10 CFR 50.63

ILLINOIS POWER COMPANY, ET AL.

CLINTON POWER STATION, UNIT NO. 1

DOCKET NO. 50-461

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, based on several factors, that each light-water-cooled nuclear power plant be able to withstand and recover from an SBO of a specified duration. The SBO Rule further requires licensees to submit information as defined in 10 CFR 50.63, requires licensees to provide a plan and schedule for conformance to the SBO Rule, and 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) 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 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 capability to cope with an SBO. 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 Clinton Station has proposed using the Division III emergency diesel generator (EDG) as an AAC power source and has submitted its response in the applicable generic response format. The Division III EDG supports a dedicated bus and is not connectable to the emergency buses of the other divisions. The licensee did not proposed any modifications to use the excess capacity of the Division III EDG to cope with an SBO event. Therefore, the Division III EDG is not considered to be an acceptable AAC power source, and Clinton is being analyzed to see whether it can cope with an SBO. See 10 CFR 50.63(a)(2).

The licensee's original response was provided by letters dated April 16, 1989, March 30, and May 17, 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 SAIC's Technical Evaluation Report (TER), SAIC-91/6666, "Clinton Power Station, Station Blackout Evaluation," dated July 31, 1991 (Attachment No. 1).

2.0 EVALUATION

After reviewing the licensee's SBO submittals and the SAIC TER, the staff concurs with the conclusions as identified in the SAIC TER. 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 an offsite power design characteristic Group "P1," an Emergency AC (EAC) configuration Group "C," and an EDG reliability target of 0.95. The target EDG reliability was based on the Clinton EDGs having a reliability greater than 0.90 for the last 20 demands. Although this is an acceptable basis for choosing the 0.95 EDG target reliability, the guidance of RG 1.155 specifies the EDG reliability statistics for the last 50 and 100 demands also be calculated. 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."

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 determination of a minimum required coping duration of 4 hours provided the licensee has an analysis showing the EDG reliability statistics for the last 20, 50, and 100 demands in its SBO submittal supporting documentation (see Attachment 1).

2.2 Alternate AC (AAC) Power Source

The licensee has proposed to use the Division III EDG as an AAC power source to operate systems necessary for the required SBO coping duration and recovery therefrom.

The Division III EDG only supports its dedicated bus and is not connectable to the other divisions of emergency buses. The licensee has not proposed any modifications to use the excess capacity of this EDG to augment its ability to cope with an SBO event. Therefore, the Division III EDG is not considered as an AAC power source, and Clinton is being analyzed to determine if it can cope with an SBO.

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 stated that 121,900 gallons of water are required for the decay heat removal for a 4-hour SBO coping period. The licensee stated that the suppression pool contains a minimum volume of 1,095,000 gallons of water, which is a sufficient amount to cope with a 4-hour SBO event. However, in the fourth hour of an SBO event, the suppression pool temperature will exceed the temperature limit of 175°F established in the Emergency Operating Procedures (EOPs) by approximately 8°F. During the course of its review, the staff's consultant, using the guidance described in NUMARC 87-00 and 102% of the maximum licensed core thermal rating (2894 MWt), performed an independent analysis which shows that 123,300 gallons of water will be needed. Therefore, the staff concludes that the licensee will have a sufficient amount of water to cope with a 4-hour SBO event at the Clinton plant. However, the licensee needs to resolve the discrepancy between the SBO suppression pool temperature and the suppression pool temperature limit established in the EOPs.

The licensee further stated that an additional source of water of 125,000 gallons will be provided from the reactor core isolation cooling (RCIC) storage tank. However, the RCIC storage tank is not safety-grade, and if this water source is not available, suppression pool water will be used. However, if the water in the RCIC storage tank is available, it will be used as the primary source of water. The staff finds the licensee's approach acceptable.

2.3.1.1 Recommendations

2.3.1.1.a The licensee should implement measures to ensure that the suppression pool temperature remains below its limit of 175°F as established in the EOPs.

2.3.1.1.b The licensee should verify that, if the RCIC storage tank water was used, the suppression pool water level would not exceed the maximum allowable level.

2.3.2. Class 1E Battery Capacity

The licensee stated that the Division III EDG which is available during the SBO event energizes its own battery chargers. Division I and Division II batteries have sufficient capacity to meet the SBO loads for 4 hours provided that the loads not necessary to cope with a SBO are stripped.

The licensee stated that the load on batteries 1A and 1B following the last minute of the SBO (240 minutes to 241 minutes) is 220 A and 211 A, respectively, for the recovery from a SBO event. The licensee did not state that these loads include the equipment that will be running during the last minute of the SBO. Also, the licensee has not included the RCIC loads in the battery sizing calculations. In addition, according to calculations made by the staff's consultant, SAIC, the expected Division I battery load during the first 10 seconds is 722 A, (573 A transient loads plus 149 A continuous loads) which is different from the licensee's stated loads of 563.8 A for the first minute. Further, the licensee has not provided for the 110% to 115% design margin recommended by IEEE Standard 485 to account for unforeseen additions to the direct current (dc) system or less-than-optimum operating conditions. Also, it

is not clear that the inverter amperage during the end of, and recovery from, the SBO is based on the reduced dc voltage that occurs at the end of the SBO. Finally, the attached TER has identified some instrumentation that is important during an SBO and has not been included as battery loads. Based on the above factors, the Division I battery, and possibly the Division II battery, does not have sufficient capacity to last for 4 hours. Also, the licensee is planning to shed the emergency lighting at 60 minutes into a SBO event. The licensee did not state how lighting will be provided to perform the needed actions.

2.3.2.1 Recommendations

2.3.2.1.a The licensee should ensure that the last minute loading includes the same equipment that will be running before the last minute in addition to the equipment necessary to recover from the SBO event.

2.3.2.1.b The licensee should include RCIC loads in battery sizing calculations.

2.3.2.1.c The licensee should provide information as to how the lighting will be provided to perform the needed actions.

2.3.2.1.d The licensee should verify that both the Division I and Division II battery has sufficient capacity, taking into consideration the staff concerns as identified in Section 2.3.2.

2.3.3 Compressed Air

The licensee has stated that the air-operated valves relied upon to cope with an SBO for 4 hours can either be operated manually or have sufficient back-up sources independent of the preferred and Class 1E power supplies. Based on its review, the staff concludes that Clinton Power Station has sufficient back-up supply of compressed air to cope with a 4-hour SBO event.

2.3.4 Effects of Loss of Ventilation

The licensee has performed analyses to determine the effects of loss of ventilation in the reactor core isolation cooling (RCIC) rooms, steam tunnel, inverter rooms, control room and drywell. The staff's evaluation of the effects of loss of ventilation in each of these areas is provided below.

2.3.4.1 RCIC Room and Steam Tunnel

The calculated peak temperatures in the RCIC pump room, RCIC instrument panel room and steam tunnel room are 146°F, 166°F, and 223°F, respectively. The licensee stated that reasonable assurance of the operability of SBO response equipment in these areas has been assessed in accordance with the guidance described in NUMARC 87-00 and concluded that only procedural changes to disable the automatic trips for RCIC due to high main steam tunnel temperature are required. Based on its review, the staff does not agree with the licensee's conclusion that only the above cited procedure changes are required to cope with an SBO event at the Clinton plant. The staff finds that the licensee also needs to ensure that, at the temperature of 223°F, the RCIC turbine steam supply valve

to ensure that, at the temperature of 223°F, the RCIC turbine steam supply valve will be able to close should containment isolation become necessary.

2.3.4.1.1 Recommendation

2.3.4.1.1.a The licensee should verify that the RCIC turbine steam supply valve will be able to close should the containment isolation become necessary during an SBO event.

2.3.4.2 Inverter Room

There are four inverter rooms. The Division-III inverter room is cooled by the Division-III diesel; therefore, its temperature will not change. For the other three inverter rooms, the licensee assumed an initial temperature of 80°F, and the heat generation rates from normal inverter loads to perform the heat-up calculation. The calculated peak temperatures are 101°F for the Division IV inverter room and 111°F for both the Division I and II inverter rooms. Based on its review, the staff finds that the above cited parameters used by the licensee to perform the heat-up calculation for a SBO event are non-conservative; therefore, the staff has not been able to conclude that the calculated peak temperatures for the inverter rooms are acceptable.

2.3.4.2.1 Recommendation

2.3.4.2.1.a For the temperature of 80°F used as initial temperature in the heat-up calculation to be acceptable, the licensee should have or establish an administrative procedure to ensure that this temperature would not be exceeded during normal power operation or use the maximum allowable temperature for these rooms.

2.3.4.2.1.b For the heat load in the room due to the inverters, the licensee should verify that it has used an inverter efficiency loss consistent with the expected inverter load, or use a constant efficiency loss based on the rated capacity of the inverter.

2.3.4.3 Control Room

Based on the results of its preliminary analyses, the licensee determined that additional cooling would be required in order to maintain the control room temperature below 120°F. Consequently, the licensee developed a fan-flow model which induces outside ambient air with an assumed temperature of 96°F into the control room and exhausts air from the control room using a gasoline-powered fan. The model established that a flow rate of 5200 cubic feet per minute (cfm) of 96°F outside air, initiated at 30 minutes into the SBO event, would prevent the control room temperature from exceeding 120°F. The licensee stated that this modification to add the gasoline-powered fan for control room ventilation is scheduled to be designed and implemented in 1992.

In addition, the licensee stated that procedures will be revised to ensure the opening of cabinet doors to electrical cabinets in the control room within 30 minutes after the onset of a SBO event.

During the course of its review, the staff's consultant found the values of numerous input parameters (see Section 3.3.4.3 in SAIC TER) used by the licensee to perform the above cited fan-flow model analysis non-conservative. Based on its review, the staff agrees with its consultant that the licensee should reevaluate its control room heat-up analysis, taking into account the non-conservatism as identified in the SAIC TER.

2.3.4.3.1 Recommendation

2.3.4.3.1.a The licensee should re-perform its control room heat-up analysis taking into account the non-conservatisms as identified in the attached TER and verify the prior conclusion that the control room temperature would not exceed 120°F.

2.3.4.4 Drywell

The licensee stated that, with regard to the loss of heat/ventilaing/air conditioning (HVAC) capability in the drywell, it has confirmed that the temperature peak in the containment/drywell as a result of a SBO event is enveloped by the LOCA/HELB analyzed peak temperature of 250°F. The staff finds this statement from the licensee to be acceptable.

2.3.5 Containment Isolation

The licensee stated that the plant list of containment isolation valves (CIVs) was reviewed and it was determined that all of the valves which must be capable of being closed or operated (cycled) under SBO conditions can be positioned with indication independent of the preferred and blacked-out unit's Class-1E power supplies. The licensee also said that, although no modifications are necessary to ensure that appropriate containment integrity can be provided under SBO conditions, a minor procedure change is required and will be completed within one year after receipt of this SE.

Upon review of the list of CIVs (USAR Table 6.2-47), the staff's consultant found that there are several valves (i.e., RHR shutdown cooling, LPCS suppression pool suction, etc.) which do not meet the exclusion criteria outlined in RG 1.155. Therefore, the staff has not been able to conclude that containment integrity can be provided during a SBO event at the Clinton plant.

2.3.5.1 Recommendation

2.3.5.1.a The licensee should establish an appropriate procedure to list the CIVs which are either normally closed or normally open, fail as-is upon loss of ac power and cannot be excluded by the criteria given in RG 1.155, and identify the actions necessary to ensure that these valves are fully closed, if needed. The valve closure should be confirmed by position indication.

2.3.6 Reactor Coolant Inventory

The licensee has stated that the AAC power source from the Division III EDG will power the necessary makeup systems to maintain adequate reactor coolant system (RCS) inventory to ensure that the core is cooled for the required SBO coping

duration. Reactor coolant makeup is necessary to remove decay heat, to cool down the primary system, and to replenish the RCS inventory losses due to the 61 gpm leak rate (18 gpm per recirculation pump and 25 gpm for the TS maximum allowable leakage). Since the Division III EDG only supports its dedicated bus and is not connectable to the emergency buses of the other divisions, the Division III EDG is not classified by the NRC staff as an AAC power source and Clinton is being evaluated as a coping plant. The HPCS pump which is directly powered from the Division III EDG has the capability to inject CST water at a rate of 5010 gpm to remove the decay heat. In addition, the steam turbine driven RCIC pump is also available for RCS makeup.

Based on the licensee's submittal and after reviewing the SAIC TER, the staff agrees with the licensee's assessment that adequate RCS inventory will be maintained to ensure core cooling during a SBO event.

The 18 gpm recirculation pump seal leak rate for boiling water reactors was agreed to between NUMARC and the NRC staff pending resolution of Generic Issue (GI) 23. If the final resolution of GI-23 defines higher recirculation pump seal leak rates than assumed for the RCS inventory evaluation, the licensee should be aware of the potential impact of this resolution on its analyses and actions addressing conformance to the SBO Rule.

2.4 Procedures and Training

The licensee has stated that the appropriate procedures have been reviewed per guidance in NUMARC 87-00, Section 4, and will be revised as required.

The proposed procedure modifications indicated above were not reviewed, but the staff expects the licensee to maintain and implement these procedures including any others to ensure an appropriate response to a SBO event. Although personnel training requirements for a SBO event are not specifically addressed by the licensee's submittal, the staff expects the licensee to implement the appropriate training to assure an effective response to the SBO.

2.5 Proposed Modifications

The licensee initially stated that no plant modifications were required to meet the requirements of the SBO Rule. Later, the licensee determined that a modification to add a 5200 cfm gasoline-powered fan is necessary for the ventilation of the control room. The modification is scheduled to be designed and implemented in 1992. Based on the staff's concerns regarding the ventilation analysis made by the licensee for the control room, the staff finds that the capacity of the 5200 cfm fan may not be adequate.

2.5.1 Recommendation

2.5.1.a The licensee should reevaluate the adequacy of the proposed fan after taking into consideration the staff concerns discussed in Section 2.3.4.3 pertaining to the effects of loss of ventilation in the control room. The licensee should include a full description of the fan installation and how it meets the guidelines of Appendix B of NUMARC 87-00 in the documentation that is to be maintained by the licensee in support of the SBO submittals.

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

The licensee has not stated that the plant complies with the QA and TS programs of RG 1.155, Appendices A & B.

The TS for the SBO equipment are currently being considered generically by the staff 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.

2.6.1 Recommendation

2.6.1.a The licensee should verify that the SBO equipment is covered by an appropriate QA program consistent with the guidance of RG 1.155.

2.7. EDG Reliability Program

The licensee's SBO submittal did not specifically address a commitment to implement an EDG reliability program that conforms to the guidance of RG 1.155, Position 1.2, or NUMARC 87-00, Appendix D.

2.7.1 Recommendation

2.7.1.a The licensee should implement, for its Division I, II and III EDGs, 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 SBO Rule (10 CFR 50.63) requires licensees to submit a response containing specifically defined information. It also requires utilities to have baseline assumptions, analyses, and related information used in their coping evaluation available to NRC. The staff and its contractor did not perform a detailed review of the proposed equipment or procedure modifications which are scheduled for later implementation. However, based on the staff's review of the licensee's SBO submittals and FSAR, the following areas have been identified for focus in any follow-up inspection or assessment that may be undertaken by the staff 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 which meets, as a minimum, the guidelines of RG 1.155;

e. equipment and components required to cope with an SBO which are incorporated in a QA program that meets the guidance of RG 1.155, Appendix A; and, but not limited to,

f. actions taken pertaining to the specific recommendations noted in this SE.

Additional areas may be identified following staff review of licensee's revised response to the SBO rule.

3.0 SUMMARY AND CONCLUSION

The staff has reviewed the licensee's response to the SBO rule (10 CFR 50.63) and the TER prepared by the staff's consultant. Based on the staff's review, additional analyses and confirmations described in the recommendations provided in this SE need to be completed. These include the condensate inventory for decay heat removal; adequacy of the Class 1E battery capacity; effects of loss of ventilation in RCIC system/main steam tunnel, inverter rooms, and control room; identification of and procedures for those valves that were not listed and are needed to ensure containment integrity; verification that the SBO equipment is covered by an appropriate QA program; and confirmation that an EDG reliability program has been or will be implemented in accordance with the guidance of RG 1.155. The licensee should maintain the availability of these verifications, confirmations, and analyses in the documentation supporting the SBO submittal for further inspection and assessment as may be undertaken by the NRC to audit conformance with the SBO Rule.

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

4.0 ATTACHMENT

1. SAIC-91/6666, Technical Evaluation Report, Clinton Power Station, Station Blackout Evaluation, July 31, 1991.

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