UNITED STATES
NUCLEAR REGULATORY COMMISSION
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ENCLOSURE

SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STATION BLACKOUT RULE (10 CFR 50.63)

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-390 AND 50-391

1.0 INTRODUCTION

On July 21, 1988, the Code of Federal Regulations, Title 10 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 Regulatory Guide (RG) 1.155, SBO, and NUMARC 87-00, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors.

The Tennessee Valley Authority (TVA), a prospective licensee for Watts Bar Nuclear Plant, provided a response to the SBO rule by letter, dated August 31, 1992, from William J. Museler to the U.S. Nuclear Regulatory Commission. In response to a staff request, TVA provided additional information by letter dated January 27, 1993.

2.0 EVALUATION

Based on a review of TVA's submittals, the staff findings and recommendations are summarized as follows.

2.1 Station Blackout Duration

TVA has calculated a minimum acceptable SBO duration of 4 hours based on a plant ac power design characteristic Group "P1," an emergency ac (EAC) power configuration Group "D," and a target emergency diesel generator (EDG) reliability of 0.975. The target EDG reliability was based on the NUMARC 87-00, Section 3.2.4, minimum target reliability for plants in EAC Group D. The "P1" grouping is based on an independence of offsite power classification of Group "I2," a severe weather (SW) classification of Group "2," and an extremely severe weather (ESW) classification of Group "1."

If the expected frequency of grid-related loss of offsite power (LOOP) events, based on prior experience, exceeds once per 20 years, the ac power design characteristic group (P) should be classified as P3. TVA states that the frequency of such events at Watts Bar, based on NUREG-1032, does not exceed once per 20 years. However, TVA should not rely on NUREG-1032 alone, and should confirm, based on TVA's experience, that the expected frequency of such events does not exceed once in 20 years.

Other factors which affect the "P" classification are the "SW", "ESW", and "I" classifications for the site. The "SW" classification is based on the frequency of LOOP due to severe weather. For sites not vulnerable to the effects of salt spray, this frequency depends on four factors. These are:

h_1 Annual expectation of snowfall for the site in inches.

h_2 Events per square mile of tornadoes of severity f_2 or greater.

h_3 Storms per year with wind velocities between 75 and 124 mph.

b Factor based on the separation of the transmission lines from the plant.

TVA used values for the above factors obtained from NUMARC 87-00, Paragraph 3.2.1, and calculated a frequency of LOOP due to severe weather of 4.2775E-3, using the equation of Paragraph 3.2.1, Part 1C. This results in a SW classification of "2". The staff agrees with TVA's determination.

The ESW classification is based on the expectancy of storms with winds greater than 125 mph. TVA used the value of 1E-4 which was obtained directly from Table 3-2 of NUMARC 87-00. This results in an ESW classification of "1". The staff agrees with TVA's determination.

The "I" classification depends on the capability of the plant for automatic and manual switching of power supply to the safety buses that occur upon loss of the normal power source and the back-up source(s). For Watts Bar, the normal source of power is from one of the two common station service transformers (CSSTs) C and D. On the loss of power from one of the CSSTs, capability exists for the manual transfer of the safety buses from the affected CSST (C or D) to the other CSST. Based on the guidance of NUMARC 87-00, or RG 1.155, TVA determined that the "I" classification for the plant is I1/2 ("1" or "2"). Based on the above described transfer scheme, the staff agrees with TVA's determination.

TVA states that there are four EDGs available at the plant for the two units. TVA has determined, using NUMARC 87-00, Table 3-7, an EAC classification of "D" based on two specific EDGs (1A and 2A or 1B and 2B) is necessary (out of the four available) to operate safe-shutdown equipment (on a unit or plant basis) following a LOOP. TVA notes, and the staff agrees, that any three of the four EDGs will satisfy the requirement of two specific EDGs. Based on this, the staff agrees with TVA's EAC classification of "D."

Plants with an emergency ac (EAC) power configuration of "D" must select an EDG target reliability of 0.975 for the plant. TVA has selected an EDG target reliability of 0.975 consistent with this criteria.

The required coping duration for an SBO event is based on (NUMARC 87-00, Table 3-8) the "P" classification, the EAC classification, and the EDG target reliability. The staff agrees with TVA's determination of a 4-hour coping duration based on a P classification of P1, an EAC classification of D, and an EDG target reliability of 0.975.

Recommendation: TVA should not rely on NUREG-1032 alone, and should confirm, based on its experience, that the expected frequency of a grid-related loss of offsite power (LOOP) does not exceed once in 20 years.

2.2 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 with a 4-hour coping duration.

2.2.1 Condensate Inventory For Decay Heat Removal

TVA indicated that based on the guidance described in NUMARC 87-00, 75,451 gallons of water per unit are required for decay heat removal during an SBO with a 4-hour coping duration. The minimum permissible condensate storage tank (CST) level per the plant draft technical specifications (TS) will provide 210,000 gallons of water per unit, which exceeds the required quantity for coping with a 4-hour SBO event.

Based on its review of similar Westinghouse plants (e.g., Sequoyah, Units 1 & 2) and provided that the final TS for the amount of water stored in the CST will not deviate significantly from the above draft TS, the staff concludes that TVA will have sufficient condensate inventory to cope with a 4-hour SBO event at the Watts Bar plant.

2.2.2 Class 1E Battery Capacity

For the Class 1E 125V vital batteries, TVA takes credit for non-essential load shedding at 30 minutes into the SBO event. TVA's submittal includes a list of the loads to be shed and the loads that will remain. TVA stated that no loads will be shed that are necessary for the SBO safe shutdown path, and at least three separate circuits (equivalent to one train) of dc-powered emergency lighting is assured available in the control room. In response to staff questions regarding the load shedding, TVA stated that the load shedding would begin immediately once the SBO event is identified and would involve approximately 121 individual breakers to open for shedding miscellaneous loads. These loads are grouped in various panels located in the battery board rooms. In addition, there are four lighting panels located in the shutdown board rooms that require breaker manipulations for load shedding. These rooms are easily accessible and in close proximity to the main control room. Operations personnel estimate that the load shedding can be completed in

approximately 20 minutes. TVA stated that the operating procedures will be structured such that if one of the breakers fails to open, the load shedding of the remaining breakers would continue.

TVA stated that with load stripping, the final battery voltage at the end of the 4-hour SBO event is greater than 105 volts, and that this battery voltage is above the minimum required for successful operation of the equipment. The IEEE Standard 485 methodology was used in evaluating the battery adequacy. An aging factor of 1.25 and a temperature correction factor of 1.11 based on a worst-case minimum battery room temperature of 60 °F were used. In response to a staff question regarding the margin remaining on the battery at the end of the 4-hour SBO event, TVA stated that additional margin above that provided by the temperature correction and aging factor was not specifically addressed in the battery calculation. However, a conservative load profile was used in the calculation. In particular, a three-step load profile was used for the calculation, and the ampere loads for the third step were based on a minimum battery voltage of 105 volts.

In order to provide assurance that additional margin was available, TVA made a calculation with the third step of the load profile separated into three steps using the expected voltages for these load segments. The calculation indicated that a margin of approximately 6.9 percent would be available. TVA also noted that any future load growth could be accommodated by revisiting the load shedding list.

For EDG field flashing, Watts Bar has separate 125V dc batteries from those discussed above. The licensee proposes to attempt two EDG starts (field flashings) at the beginning of the SBO event (to identify that the event has occurred) and to reserve one start attempt (field flashing) for the end of the 4-hour period. The licensee stated that the adequacy of these batteries have been analyzed using the IEEE Standard 485 methodology and that the results demonstrate sufficient battery voltage after the 4-hour event to flash the generator field.

In its August 31, 1992 submittal, TVA stated that no credit is taken for the 250V non-Class 1E batteries (e.g., for closure or control of the breakers in the switchyard) for restoration of ac power from the offsite power sources at the end of the SBO event. Instead, the restoration of ac power was to be accomplished by the EDGs. The staff, in its request for additional information (RAI), stated that this assumption is not acceptable, and that the battery capability must be sufficient for restoration of power by each power source (i.e., one cannot choose which power source will become available). In its response to the staff's RAI, TVA stated that the ac power restoration procedures will allow the operators to attempt to restore power from either the EDGs or the switchyard/offsite power sources. Further, TVA is currently in the process of replacing the 250V batteries and has made an analysis which confirms that the replacement batteries have sufficient capacity, with implementation of load shedding procedures, to perform any needed control functions for restoration of offsite power after 4 hours.

Based on the above, the staff finds that there is reasonable assurance that the 125V vital batteries, the 125V EDG batteries, and the 250V switchyard batteries will have sufficient capacity to cope with and recover from an SBO of 4 hours.

2.2.3 Compressed Air

TVA indicated that the following modifications and procedure changes are necessary to ensure that air-operated valves required for decay heat removal during a 4-hour SBO event have sufficient backup sources for operation or can be manually operated.

The air-operated valves that will require modifications and associated procedure changes for the SBO event are the air-operated turbine-driven auxiliary feedwater pump (TDAFWP) level control valves. The amount of air available to operate these valves will be supplemented by the addition of nitrogen bottles. These modifications together with the associated procedure changes will provide sufficient compressed gas for the control of these valves during the 4-hour duration of an SBO event.

Based on its review, and provided that the modifications and procedures discussed above will be implemented, the staff concludes that TVA will have sufficient compressed air to cope with a 4-hour SBO event at the Watts Bar plant.

2.2.4 Effects of Loss of Ventilation

TVA performed a steady state heat-up analyses in accordance with NUMARC 87-00 guidelines to determine the effects of loss of ventilation in main control room complex without heating, ventilation, and air conditioning (HVAC), TDAFWP room, north and south main steam valve rooms, 125V vital battery rooms, 125V vital battery board rooms, cable spreading room, pipe chase, 480V board rooms, and 6.9kV and 480V shutdown board room. The calculated peak temperatures in each of these areas are as follows:

Rooms	Peak Temp. (F_o)
Main Control Room Complex (without HVAC)	104
TDAFW Pump Room	122
North Main Steam Valve Room	162
South Main Steam Valve Room	177
125V Vital Battery Rooms	95
125V Vital Battery Board Rooms	103
Cable Spreading Room	104
Pipe Chase	122
480V Board Rooms	104
6.9kV and 480V Shutdown Board Room	103

The calculated steady state temperatures for the above rooms with the exception of the north and south main steam valve rooms are well below the temperature limits described in NUMARC 87-00, Section 2.7. TVA indicated that there is no SBO equipment located in the north main steam valve room; therefore, the south main steam valve room which contains the TDAFWP level control valves is the only dominant area of concern (DAC). TVA further indicated that reasonable assurance of the operability of SBO response equipment in the above DAC had been assessed and that no system modifications or associated procedures would be required. TVA has also committed to revise the procedure for opening the control room cabinet doors within 30 minutes following an SBO event in accordance with the guidance described in NUMARC 87-00.

Based on its review, subject to future audits of TVA's detailed heat-up calculations, the staff finds TVA's evaluation of the effects of loss of ventilation during an SBO event at Watts Bar plant acceptable.

2.2.5 Containment Isolation

TVA has reviewed the plant list of containment isolation valves (CIVs) to ensure that valves which must be capable of being closed or operated (cycled) during an SBO event can be positioned (with indication) independent of the blacked-out unit's power supplies. TVA stated that no plant modifications are necessary to insure containment integrity during an SBO event.

Based on its review, the staff concludes that CIV design and operation at the Watts Bar plant have met the intent of the guidance described in RG 1.155 and are, therefore, acceptable.

2.2.6 Reactor Coolant Inventory

For the inventory analysis, TVA used a reactor coolant pump (RCP) seal leakage of 25 gallons per minute (gpm) for each of four pumps, and an allowable identified RCS leakage of 10 gpm, resulting in a total leakage of 26,400 gallons during the 4-hour coping duration. The 26,400 gallons is equivalent to about 3,530 ft^3.

TVA stated that the letdown isolation valve closes when the air supply is lost subsequent to the loss of ac power. In the unlikely event that cooldown is required, TVA estimates a shrinkage of 3,653 ft^3. The total volume of the RCS is about 12,145 ft^3. TVA concludes that with the leakage plus the shrinkage, there would be sufficient RCS inventory remaining to keep the core covered.

TVA stated that it understands that if the final resolution of Generic Issue (GI) 23 defines higher RCP seal leakage rates than the 25 gpm assumed, it could potentially affect its analysis and actions addressing conformance to the SBO Rule.

Based on the above, the staff concludes that there is reasonable assurance that there is sufficient RCS inventory to keep the core covered during a 4-hour SBO event.

2.3 Procedures and Training

TVA stated that in accordance with NUMARC Initiative 2, Watts Bar will implement site-specific procedures for:

a. coping with a 4-hour SBO event,

b. restoration of ac power following a 4-hour SBO event, and

c. preparing the plant for severe weather conditions to reduce the likelihood and consequences of LOOP and to reduce the overall risk of an SBO event.

TVA's August 31, 1992 submittal briefly describes its plans to modify the operating procedures or instructions applying to loss of ac power, ac power restoration, response to severe weather, and response to a tornado watch or warning.

TVA stated that the schedule for the procedure-related actions including reviewing, revising, and implementing the procedures, and including verification of adequate staffing and training, is 2 years following the NRC issuance of a final safety evaluation, in accordance with 10 CFR 50.63(c)(4).

The staff did not review the procedures or proposed procedure modifications or associated training. The staff expects TVA to maintain and implement these procedures including any others that may be required to ensure an appropriate response to an SBO event.

2.4 Proposed Modifications

TVA stated that successful operation of the auxiliary feedwater (AFW) system depends on the CST inventory, the flowpath from the CST to the turbine-driven auxiliary feedwater (TDAFWP), the 125V vital battery system, and the auxiliary compressed air (ACA) system supply to open, keep open, and position as required, the level control valves. The TDAFWP level control valves are the only air-operated devices that require an air supply from the ACA system. TVA stated that the only equipment modification required is to provide nitrogen bottles which contain sufficient capacity for the duty cycle of the level control valves during the 4-hour SBO event. TVA stated that the schedule for the equipment-related modifications is 2 years following the NRC issuance of a final safety evaluation, in accordance with 10 CFR 50.63(c)(4).

2.5 Quality Assurance And Technical Specifications

With respect to quality assurance (QA), TVA stated that for any non-safety-related equipment used to meet the requirements of 10 CFR 50.63 that are not already covered by QA requirements of 10 CFR Part 50, Appendix B or 10 CFR Part 50, Appendix R, Watts Bar will apply the guidance and specifications of RG 1.155, Appendices A and B, respectively. The staff finds this commitment to be acceptable.

With respect to Technical Specifications (TS), TVA stated that the equipment used for an SBO event is already part of the plant's draft proposed TS, or the equipment (e.g., the condensate components) is in continuous use during normal plant operation.

The 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 TS regarding the SBO equipment is warranted, TVA will be notified of the implementation requirements.

2.6 EDG Reliability Program

TVA states that Watts Bar will utilize the target reliability of 0.975 in the reliability program that is to be established to conform to RG 1.155, Section 1.2, and NUMARC 87-00, Revision 1, Appendix D. TVA states that it understands that the resolution of Generic Issue (GI) B-56 could potentially impact the above guidance provided for the reliability program.

The staff accepts TVA's commitment. However, until GI B-56 is resolved, TVA should follow the guidelines of RG 1.155, Section 1.2, or NUMARC 87-00, Revision 1, Appendix E. The staff has not accepted Appendix D of NUMARC 87-00, Revision 1, in its entirety.

2.7 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 did not perform a detailed review of the proposed hardware and procedural modifications which are scheduled for later implementation. However, based on the staff's review of TVA's submittals, the staff has 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 any additional SBO responses from the licensee.

a. Hardware, if necessary, 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 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 recommendation noted in this SE.

3.0 SUMMARY AND CONCLUSIONS

The staff has reviewed TVA's responses to the SBO Rule (10 CFR 50.63), and finds TVA's responses and proposed method of dealing with an SBO to be generally acceptable. However, TVA should confirm, based on its experience, that the expected frequency of a grid-related LOOP does not exceed once in 20 years (see Section 2.1).

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