Attachment 1

SAIC-91/6686

TECHNICAL EVALUATION REPORT

VOGTLE ELECTRIC GENERATING PLANT
UNITS 1 & 2
STATION BLACKOUT EVALUATION

TAC No. 68621

Science Applications International Corporation
An Employee-Owned Company

Final
August 22, 1991

Prepared for:

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Contract NRC-03-87-029
Task Order No. 38

1710 Goodridge Drive, P.O. Box 1303, McLean, Virginia 22102 (703) 821-4300
Other SAIC Offices: Albuquerque, Boston, Colorado Springs, Dayton, Huntsville, Las Vegas, Los Angeles, Oak Ridge, Orlando, Palo Alto, San Diego, Seattle, and Tucson

TABLE OF CONTENTS

TECHNICAL EVALUATION REPORT

VOTGLE ELECTRIC GENERATING PLANT UNITS 1 & 2
STATION BLACKOUT EVALUATION

1.0 BACKGROUND

On July 21, 1988, the Nuclear Regulatory Commission (NRC) amended its regulations in 10 CFR Part 50 by adding a new section, 50.63, "Loss of All Alternating Current Power" (1). The objective of this requirement is to assure that all nuclear power plants are capable of withstanding a station blackout (SBO) and maintaining adequate reactor core cooling and appropriate containment integrity for a required duration. This requirement is based on information developed under the commission study of Unresolved Safety Issue A-44, "Station Blackout" (2-6).

The staff issued Regulatory Guide (RG) 1.155, "Station Blackout," to provide guidance for meeting the requirements of 10 CFR 50.63 (7). Concurrent with the development of this regulatory guide, the Nuclear Utility Management and Resource Council (NUMARC) developed a document entitled, "Guidelines and Technical Basis for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," NUMARC 87-00 (8). This document provides detailed guidelines and procedures on how to assess each plant's capabilities to comply with the SBO rule. The NRC staff reviewed the guidelines and analysis methodology in NUMARC 87-00 and concluded that the NUMARC document provides an acceptable guidance for addressing the 10 CFR 50.63 requirements. The application of this method results in selecting a minimum acceptable SBO duration capability from two to sixteen hours depending on the plant's characteristics and vulnerabilities to the risk from station blackout. The plant's characteristics affecting the required coping capability are: the redundancy of the emergency AC power sources, the reliability of onsite emergency power sources, the frequency of loss of offsite power (LOOP), and the probable time to restore offsite power.

In order to achieve a consistent systematic response from licensees to the SBO rule and to expedite the staff review process, NUMARC developed two generic

response documents. These documents were reviewed and endorsed (10) by the NRC staff for the purposes of plant specific submittals. The documents are titled:

1. "Generic Response to Station Blackout Rule for Plants Using Alternate AC Power," and

2. "Generic Response to Station Blackout Rule for Plants Using AC Independent Station Blackout Response Power."

A plant-specific submittal, using one of the above generic formats, provides only a summary of results of the analysis of the plant's station blackout coping capability. Licensees are expected to ensure that the baseline assumptions used in NUMARC 87-00 are applicable to their plants and to verify the accuracy of the stated results. Compliance with the SBO rule requirements is verified by review and evaluation of the licensee's submittal and audit review of the supporting documents as necessary. Follow up NRC inspections assure that the licensee has implemented the necessary changes as required to meet the SBO rule.

In 1989, a joint NRC/SAIC team headed by an NRC staff member performed audit reviews of the methodology and documentation that support the licensees' submittals for several plants. These audits revealed several deficiencies which were not apparent from the review of the licensees' submittals using the agreed upon generic response format. These deficiencies raised a generic question regarding the degree of licensees' conformance to the requirements of the SBO rule. To resolve this question, on January 4, 1990, NUMARC issued additional guidance as NUMARC 87-00 Supplemental Questions/Answers (11) addressing the NRCs concerns regarding the deficiencies. NUMARC requested that the licensees send their supplemental responses to the NRC addressing these concerns by March 30, 1990.

2.0 REVIEW PROCESS

The review of the licensee's submittal is focused on the following areas consistent with the positions of RG 1.155:

A. Minimum acceptable SBO duration (Section 3.1),

B. SBO coping capability (Section 3.2),

C. Procedures and training for SBO (Section 3.4),

D. Proposed modifications (Section 3.3), and

E. Quality assurance and technical specifications for SBO equipment (Section 3.5).

For the determination of the proposed minimum acceptable SBO duration, the following factors in the licensee's submittal are reviewed: a) offsite power design characteristics, b) emergency AC power system configuration, c) determination of the emergency diesel generator (EDG) reliability consistent with NSAC-108 criteria (9), and d) determination of the accepted EDG target reliability. Once these factors are known, Table 3-8 of NUMARC 87-00 or Table 2 of RG 1.155 provides a matrix for determining the required coping duration.

For the SBO coping capability, the licensee's submittal is reviewed to assess the availability, adequacy and capability of the plant systems and components needed to achieve and maintain a safe shutdown condition and recover from an SBO of acceptable duration which is determined above. The review process follows the guidelines given in RG 1.155, Section 3.2, to assure:

a. availability of sufficient condensate inventory for decay heat removal,

b. adequacy of the class-1E battery capacity to support safe shutdown,

c. availability of adequate compressed air for air-operated valves necessary for safe shutdown,

d. adequacy of the ventilation systems in the vital and/or dominant areas that include equipment necessary for safe shutdown of the plant,

e. ability to provide appropriate containment integrity, and

f. ability of the plant to maintain adequate reactor coolant system inventory to ensure core cooling for the required coping duration.

The licensee's submittal is reviewed to verify that required procedures (i.e., revised existing and new) for coping with SBO are identified and that appropriate operator training will be provided.

The licensee's submittal for any proposed modifications to emergency AC sources, battery capacity, condensate capacity, adequacy of the ventilation system for equipment operability, compressed-air capacity, appropriate containment integrity and primary coolant make-up capability is reviewed. Technical specifications and quality assurance set forth by the licensee to ensure high reliability of the equipment, specifically added or assigned to meet the requirements of the SBO rule, are assessed for their adequacy.

This preliminary SBO evaluation is based upon the review of the licensee's submittals dated April 12, 1989 (13), March 28, 1990 (14), the licensee's written response (15) to questions discussed during the May 23, 1991 telephone conference, and the information available in the plant Final Safety Analysis Report Update (FSARU) (12); it does not include a concurrent site audit review of the supporting documentation. Such an audit may be warranted as an additional confirmatory action. This determination would be made and the audit would be scheduled and performed by the NRC staff at some later date.

3.0 EVALUATION

3.1 Proposed Station Blackout Duration

Licensee's Submittal

The licensee, Georgia Power Company, calculated (13 and 14) a minimum acceptable station blackout duration of four hours for the Vogtle Electric Generating Plant Units 1 and 2. The licensee identified three modifications to achieve the four hour coping duration (see Section 3.4), however, none were required to estimate this duration.

The plant factors used to estimate the proposed SBO duration are:

1. Offsite Power Design Characteristics

   The plant AC power design characteristic group is "P1" based on:

   a. Independence of the plant offsite power system characteristics of "I1/2,"

   b. Expected frequency of grid-related LOOPs of less than one per 20 years,

   c. Estimated frequency of LOOPs due to extremely severe weather (ESW) which places the plant in ESW Group "2," and

   d. Estimated frequency of LOOPs due to severe weather (SW) which places the plant in SW Group "1."

2. Emergency AC (EAC) Power Configuration Group

   The EAC power configuration for the plant is "C." Each unit at Vogtle is equipped with two emergency power supplies. Only one emergency AC power supply is necessary to operate safe shutdown equipment following a LOOP.

3. Target Emergency Diesel Generator (EDG) Reliability

The licensee has selected a target EDG reliability of 0.95. The selection of this target reliability is based on having a nuclear unit average EDG reliability greater than 0.90 for the last 20 demands, consistent with NUMARC 87-00, Section 3.2.4.

Review of Licensee's Submittal

Factors which affect the estimation of the SBO coping duration are: the independence of the offsite power system grouping, the estimated frequency of LOOPs due to ESW and SW conditions, the expected frequency of grid-related LOOPs, the classification of EAC, and the selection of EDG target reliability.

Using Table 3-2 of NUMARC 87-00, the expected frequency of LOOPs due to ESW conditions places the Vogtle site in ESW Group "2," which is in agreement with what was stated in the licensee's submittal (13).

Using data from Table 3-3 of NUMARC 87-00, the expected frequency of LOOPs due to SW conditions place the Vogtle site in SW Group "1," which is in agreement with what was stated in the licensee's submittal (13). This calculation was performed with the condition that there are multiple rights of way among the incoming transmission lines, according to FSARU Figure 8-1.1 (12).

The licensee stated that the independence of the plant offsite power system grouping is "I1/2." A review of the Vogtle FSARU shows that, see Figure 1 (12):

1. The site has 500 kV and 230 kV switchyards which are electrically connected.

2. Each unit is equipped with two reserve auxiliary transformers (RATs).

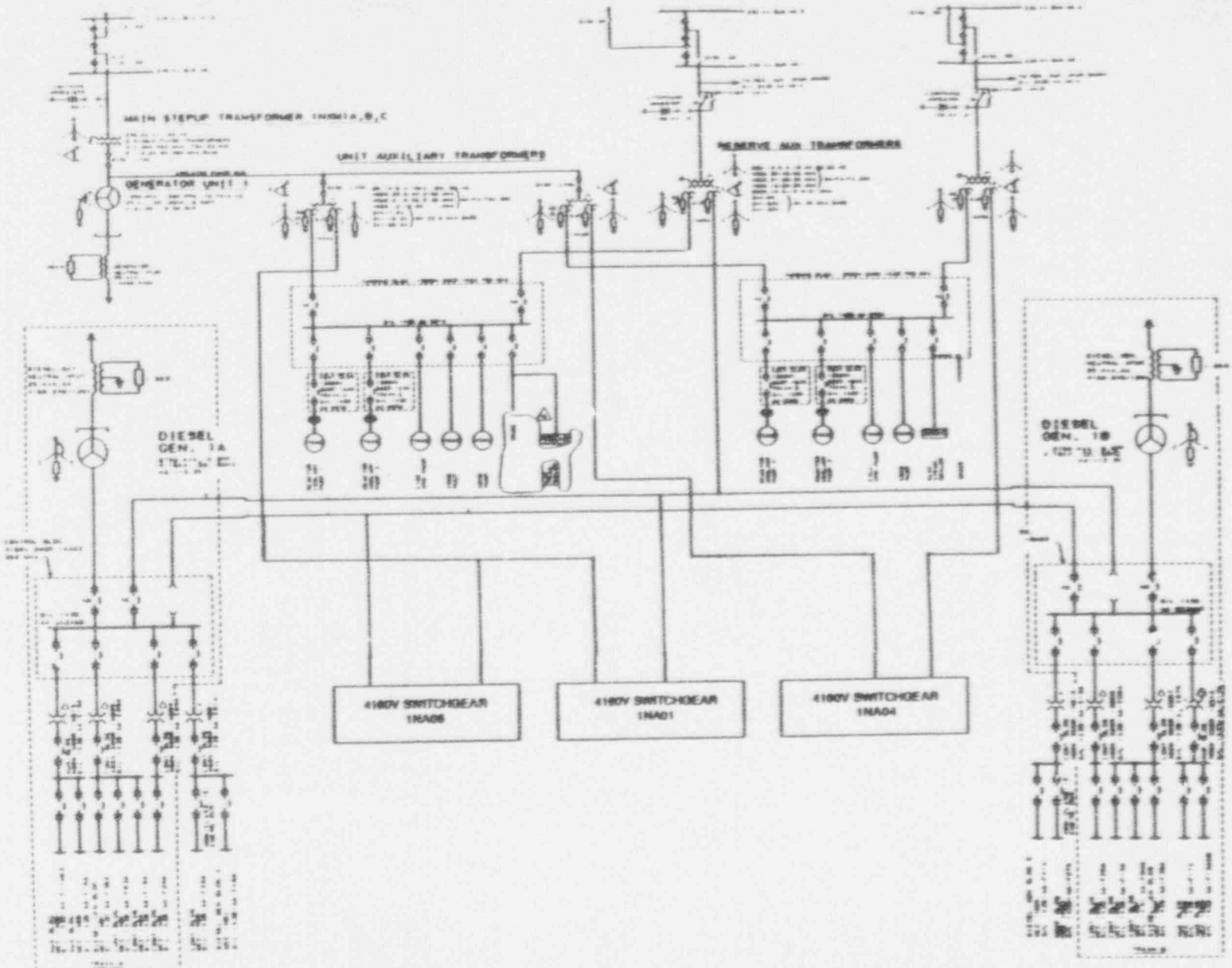

Figure 1: Votgle Electric Generating Plant Unit 1 and Unit 2 Main One Line Diagram (FSAR Figure 8.3.1-1)

3. One RAT from each unit (a total of two RATs) is powered from a separate offsite power source.

4. Each emergency bus is normally connected to one RAT, and each RAT has the capacity to supply both emergency busses.

5. Upon loss of power from one of the RATs, there is a manual transfer to an alternate power source (redundant RAT). The licensee stated (15) that this transfer is proceduralized and involves racking out the breaker in the 4160 V class-1E switchgear and racking it in to an empty cubicle in the same switchgear. This transfer takes approximately 15 minutes.

Based on the above, the plant independence of offsite power system group is "I2." This determination is based on the guidance of Table 5 of RG 1.155, and the NUMARC 87-00 Supplemental Questions and Answers (11) guidance regarding the timing of manual transfer to an alternate required power source.

Establishment of the proper Emergency AC (EAC) Configuration Group is based on the number of available EAC sources and the number of EAC sources required to operate safe shutdown equipment following a LOOP. At Vogtle, each unit has two dedicated EAC sources, one of which is required after a LOOP. We agree with the licensee's assessment which places the plant in EAC Group "C."

The licensee selected (13) an EDG target reliability of 0.95 based upon having a nuclear unit average EDG reliability greater than 0.90 for the last 20 demands. Although this is an acceptable criterion for choosing an EDG target reliability, the guidance of RG 1.155 requires that the EDG statistics for the last 50 and 100 demands also be calculated. The EDG failure statistics are only available on-site as part of the submittal's supporting documents. Without this information, it is difficult to judge how well the EDGs have performed in the past and if there should be any concern. Therefore, we are unable to verify the demonstrated start and load-run reliability of the plant EDGs. Nevertheless, the licensee needs to have an analysis showing the EDG reliability statistics for the last 20, 50 and 100 demands in its SBO submittal

supporting documents. With regard to the EDG reliability program, the licensee stated (14) that the goal is to maintain an average EDG reliability which is better than the target value for each unit. The licensee added that any needed reliability program improvements will be addressed following final resolution of Generic Safety Issue B-56, "Diesel Generator Reliability. However, it did not identify whether the plant has any reliability program which, at a minimum, meets the guidance of R.G. 1.155 Position 1.2.

With regard to the expected frequency of grid-related LOOPs at the site, we can not confirm the stated results. The available information in NUREG/CR-3992 (3), which gives a compendium of information on the loss of offsite power at nuclear power plants in the U.S., only covers these incidents through the calender year 1984. Vogtle did not enter commercial operation until 1987. In the absence of any contradictory information, we agree with the licensee's statement.

Based on the above, we agree with the licensee's claim that the offsite power design characteristic of the Vogtle site is "P1" with a minimum required SBO coping duration of four hours.

3.2 Station Blackout Coping Capability

The plant coping capability with an SBO event for a required duration of four hours is assessed with the following results:

1. Condensate Inventory for Decay Heat Removal

Licensee's Submittal

The licensee's submittal (13 and 15) stated that 203,000 gallons of water are required for the decay heat removal and primary system cooldown during the four-hour coping period. The minimum permissible Condensate Storage Tank (CST) level per Technical Specifications provides 340,000 gallons of water, which exceeds the required quantity for coping with a 4-hour SBO event. The licensee utilized Westinghouse decay heat curve SSE-1515. This curve was originally

used in Vogtle Calculation X4C1302V06, Rev. 0, Condensate Storage Tank Verification. The licensee added that this decay heat model is very similar to the Branch Technical Position ASB 9-2 decay heat curve. The calculation also considers Reactor Coolant System (RCS) cooldown and depressurization of the steam generators to approximately 265 psig over seven hours. The licensee provided (15) a summary of the contributing elements in the calculation of the condensate requirement.

Review of Licensee's Submittal

Using the expression provided in NUMARC 87-00 (assuming no cooldown), we estimated that 75,451 gallons of water per unit would be required to remove decay heat during a four-hour SBO event. This estimate is based on the licensed core thermal rating of 3411 MWt per unit listed in the Vogtle FSARU (12). The licensee indicated that the primary system will be cooled down to 350°F. We reviewed the information provided by the licensee and found it to be conservative with regard to the condensate requirement for a four hour SBO event. Although we did not repeat the licensee's calculations, we concur with the licensee that, based on a minimum CST volume of 340,000 gallons, the site has sufficient condensate for both decay heat removal and cooldown during a four hour SBO event.

2. Class-1E Battery Capacity

Licensee's Submittal

The licensee stated (13 and 15) that a battery capacity calculation has been performed pursuant to NUMARC 87-00 which verifies that the class-1E batteries have sufficient capacity to meet SBO loads for four hours. The licensee noted, however, that lighting in the main control rooms will require augmentation to assure sufficient light after the initial 90 minutes of lighting provided by self-contained, gel-cell battery packs.

In its response to questions raised at the telephone conversation on May 23, 1991, the licensee stated (15) that the adequacy of the class-1E batteries have been verified for four hour of SBO operation without a need for load shedding. The licensee added, although no load shedding is required, the plant emergency operating procedure, 19100-C, "Response to Loss of All AC Power," makes provisions for load stripping. This action would take place in one-half to one hour after the procedure is initiated. Further, the licensee stated that a permanent modification to augment control room lighting is expected to be completed by the end of 1992. Meanwhile, additional lighting is available from hand-held lights. The licensee provided (16) the class-1E battery sizing calculation for review.

Review of Licensee's Submittal

We reviewed the battery sizing calculation provided by the licensee. We found the licensee to have properly identified and clearly stated all of the assumptions and limitations associated with the analysis. The calculations were performed using IEEE-Std 485 methodology by considering an aging factor of 1.25, a temperature factor of 1.04 (or 70°F electrolyte temperature) and a design margin of 1.0. The analysis is based on the actual connected load values and as such does not allow for any future load growth. There are four 125 VDC battery banks in each unit. The licensee's calculations show that all batteries marginally meet the four hour SBO loads.

We found the assumption of zero percent design margin to be inconsistent with IEEE-Std 485 guidance. In addition, the 70°F electrolyte temperature is non-conservative.

We also reviewed and compared the battery loads identified in the calculation with those given in the FSARU (12). Our comparison of the loads indicates that for the Train A and Train B batteries, the sizing calculations have used smaller inverter loads than the FSARU values. This reduction in loads (18.9 Amperes) appears to be due to the licensee's use of the actual load instead of the rated load on inverters

IAD1I11 and IAD1I12. The FSARU uses a design margin of 10%, compared to zero design margin in the calculation, and states that the batteries can support the loads for 165 minutes. The combination of reduction in the inverter load estimate and the assumption of zero percent design margin allow the batteries to be qualified for 240 minutes.

For the Train C and Train D sizing calculations, we found the total loads to be consistent with that given in the FSARU. However, our review identifies the following anomalies. First, there is a 25 kVA inverter on both the train C and train D batteries which appears to be connected without any load. The licensee assumed an inverter loss of 1800 W requiring 17.2 Amperes. This load loss appears to be low, representing only a 9% loss. On the other hand, if this inverter is not needed, it would appear to be better to shed it from the battery load. If this load cannot be shed, a higher loss needs to be considered (≈20%). Second, the licensee states that the load on inverter 1DD1I4, which is rated at 7.5 kVA, is limited to 80% of rated capacity. However, in its calculation it uses an efficiency (0.745) which results in smaller current. If the licensee were to use a lower efficiency, i.e. 71.5%, consistent with the data provided, the Train D battery will not meet the four hour calculation.

Based on the above discussion, the following summarizes our findings:

1) The licensee's assumption of zero design margin is not consistent with the recommended 10-15% values in IEEE-Std 485.

2) The efficiency on inverter 1DD1I4 needs to be changed to 71.5%, consistent with the data provided by the licensee.

3) The heat load assumption on 25 kVA inverter 1DD1I6, and/or 1CD1I5 is low. If these inverters are not providing any support they could be shed, otherwise, higher loads need to be considered on batteries C and D.

4) The 70°F electrolyte temperature is non-conservative. The licensee needs to have a procedure which ensures that the room temperature would not go below this temperature under any circumstances.

3. Compressed Air

Licensee's Submittal

The licensee stated (13) that no air operated valves are relied upon to cope with an SBO for four hours. In its later submittal, the licensee stated (15) that steam release to the atmosphere will be accomplished under SBO conditions by the local, manual hydraulic operation of the steam generator atmospheric relief valves (ARVs). This local, manual operation of each ARV can be accomplished from a ground-level hand-pump station located in the main steam isolation valve area, approximately eight feet below the main steam piping and atmospheric relief valves. The MSIV area is a large room with openings to the outside on the side and roof which allows for natural circulation during an SBO. The licensee further stated that the pump stations are readily accessible from the entrance of the MSIV areas, and as the adjustments of the ARVs are intermittent operations, the operator can remain at the entrance to the MSIV areas and enter only when valve position adjustments are necessary. Sound powered communication with the control room is available from these areas.

Review of Licensee's Submittal

Our review confirms that no air operated valves will be relied upon to cope with an SBO of four hours duration. Our examination of the plant FSARU Section Section 10.4.9 (12) reveals that the Auxiliary Feedwater (AFW) flow is controlled by four dc-powered flow control valves to each of the four steam generators. The power to these valves is provided by 125 VDC battery C, and the licensee has properly considered the required load. Thus, it appears that the Auxiliary

Feedwater flow control valves can be adequately controlled during a SBO.

With respect to steam relief to the atmosphere, it will be accomplished by local, manual hydraulic operation of the steam generator atmospheric relief valves (ARVs). The SBO temperature calculated by the licensee for the MSIV area is 126°F. The licensee considers this to be a conservative temperature for the hydraulic hand-pump area, as no consideration for natural cooling effects or other air circulation was assumed. The licensee also stated that sound powered communication with the control room will be available from these areas. Based on these facts, we agree with the licensee's assertion that the ARV hand-pump area will be habitable during an SBO event.

4. Effects of Loss of Ventilation

Licensee's Submittal

The licensee stated (15) that all components required to function during an SBO event and maintain safe shutdown were identified. Based on NUMARC 87-00 criteria and supplemental guidelines, the licensee stated that only the turbine-driven auxiliary feedwater pump room (by definition) was considered to be a dominant area of concern (DAC). However, to assess the reasonable assurance of operability (RAO) of all SBO components, all areas (outside containment) housing SBO components were evaluated to determine their steady-state temperature during the SBO coping duration.

The licensee stated (15) that the control rooms for the two units are open to each other. The two rooms share a common ductwork system served by four 100-percent capacity, independent, safety-related HVAC systems. Any of the four systems is capable of providing the necessary cooling to maintain the normal ambient conditions for both control rooms. Therefore, during an SBO, the control room of the affected unit will receive HVAC cooling powered from the unaffected unit's emergency diesel generators.

In accordance with the NUMARC 87-00 guidelines, transmission loads were excluded and residual loads were considered on a case-by-case basis. All AC lighting was excluded from the room heat loads.

The licensee stated (15) that SBO maximum average ambient temperatures were calculated in accordance with the guidelines of NUMARC 87-00, including the NUMARC 87-00 supplemental guidelines. The only exception was the MSIV areas, whose SBO temperature was enveloped by Vogtle Design Criteria DC-1007, "Environment." The determination of the DC-1007 abnormal temperature of 126°F was based on the loss of all normal ventilation in the MSIV areas for 24 hours with all normal heat sources operating, which envelops SBO conditions.

With respect to the class-1E 125 VDC/120 VAC equipment rooms, the licensee stated (13) that the elevated ambient temperatures experienced during a SBO would result in the derating of the trip setpoint of five molded case circuit breakers (each unit) below their potential current loading. In order to provide reasonable assurance of operability, the licensee stated that these breakers would be replaced with larger size breakers to avoid the potential for spurious tripping. In its supplemental response (14), the licensee revised this proposed modification to include the replacement of six circuit breakers in Unit 1 and seven circuit breakers in Unit 2. The Unit 2 circuit breakers have been replaced; the Unit 1 circuit breakers will be replaced in the Fall of 1991.

The licensee used the normal ambient room temperature as the initial temperature in its temperature rise calculations. The normal ambient room temperature is defined (15) by the licensee as "that temperature for which equipment is expected to perform its safety-related function, as required, on a continuous basis without impairment of its safety-related functional capability." As a result of the supplemental guidelines, the calculations were revised, where necessary, to use a

higher initial room temperature to account for average wall temperatures. For several rooms credit was taken for the opening of doors to enhance cooling, consistent with the NUMARC 87-00 methodology. Table 1 summarizes (15) the areas containing SBO equipment that were considered by the licensee, along with the normal ambient temperature and SBO maximum ambient temperature for each area.

The licensee stated (13) that NUMARC 87-00 Appendix F Revision 1 and/or the October 1988 NUMARC 87-00 Topical Report, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors" were used to assess the operability of SBO equipment. The licensee concluded (15) that the calculated temperatures are within the acceptance limits for the equipment in the rooms as given in NUMARC 87-00.

Review of Licensee's Submittal

The licensee's temperature rise calculations were neither received nor reviewed. Therefore, this review is based on summaries provided by the licensee in its submittals. As such, the review only covers the assumptions and methods identified by the licensee, and assumes the calculated temperatures to be accurate, pending future verification.

The licensee stated (15) that the control rooms for the two units are open to each other and are served by four 100-percent capacity, independent, safety-related HVAC systems. We agree with the licensee that during an SBO, the control room of the affected unit will receive HVAC cooling powered from the unaffected unit's emergency diesel generators.

The licensee used the normal ambient room temperature as the initial temperature in its temperature rise calculations. The use of normal ambient room temperature is defined (15) by the licensee as "that temperature for which equipment is expected to perform its safety-related function, as required, on a continuous basis without

Table 1: Summary of Areas Containing Components Required to Operate During an SBO, Vogtle Units 1 and 2

Areas[a]:	Normal Ambient Temp.[b] (°F)	SBO Max. Avg. Ambient Temp. (°F)
• MSIV Areas	115	126
• Turbine Drive. AFW Pump Rm	104	121
• Main Control Rm	85	85
• Aux Building - SG Steam Line Pressure Transmitter Rms	114 [c]	133
• Aux Building - AFW to SG Flow Transmitter Rms	120	120
• Aux Building - Inverter/AC Panel Rms 116, 118, 147, 149	85	107
• Control Building - Neutron Flux Monitoring Rms	100	103
• Control Building Switchgear Rms B29, B36, B48, B55 (Switchgear, MCC, AC panel, DC panel & Inverter)	85	119 [d]
• Control Building Switchgear Rms B26, B31, B47, B52 (Switchgear, AC panel, DC panel & Inverter)	100	119 [d]
• Control Building Rm B84 (DC MCC)	85	100
• Control Building Battery Rms	75	e
• CST Tank 1 - Level Transmitters	Ambient	Ambient

Notes:

a This Table summarizes information provided by the licensee in its June 7, 1991 submittal (15). For rooms which contain similar types of equipment, results are only reported for the room which experienced the highest calculated SBO maximum ambient temperature.

b These represent Design Manual DC-1007 normal temperatures. Initial room temperatures used in calculating the "SBO maximum average ambient temperature" reflect the NUMARC "average" ambient temperatures and therefore may be higher.

c Based on Unit 1 operating temperature survey.

d Assumes the opening of doors.

e Due to the absence of significant heat loads, the resultant ambient temperatures were not calculated.

impairment of its safety-related functional capability." The use of normal temperature is reasonable if the temperatures assumed are equal to or greater than the maximum allowed technical specification temperatures for each area. The licensee needs to make a commitment to establish an appropriate procedure to ensure that these assumed initial temperatures will not be exceeded under any circumstances. The definition of normal temperature seems to imply that the ability of equipment to perform its function cannot be assured at temperatures above the normal ambient room temperature.

The licensee evaluated the RAO for the inverter/switchgear rooms at 119°F and concluded that, except for certain circuit breakers, all other equipment would be operational at these temperatures. The licensee's initial temperature assumption of 85°F for these rooms is non-conservative. For this initial temperature to be acceptable, the licensee needs to ensure that under no circumstances will this temperature be exceeded during normal operation. Verification needs to be in the form of administrative or technical specification cited temperatures. Otherwise, if a higher temperature of 104°F consistent with the guidance were to be used, the maximum temperature in the inverter/switchgear rooms is expected to reach 138°F. If this is the case case, the licensee will need to verify that the equipment in these rooms is qualified to operate at this higher temperature.

For several rooms, the licensee took credit for the opening of doors to lower the expected temperature. The licensee needs to modify the Station Blackout Procedure to provide guidance for opening these doors within 30 minutes of an SBO, consistent with the guidance in NUMARC 87-00.

Based on the NUMARC guidance, the licensee needs to provide a statement verifying that the containment temperature profile during an SBO is bounded by that of the LOCA/High Energy Line break temperature profile. The licensee needs to provide such verification.

5. Containment Isolation

Licensee's Submittal

In its initial submittal (13), 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 station blackout conditions can be positioned (with indication) independent of the preferred and the unit class-1E power supplies. The licensee stated that no plant modifications and/or associated procedure changes were determined to be required to ensure that appropriate containment integrity can be provided under SBO conditions.

In response to discussion during the May 23, 1991 telephone conference, the licensee provided (15) a list of all CIVs that are normally open or closed, fail as-is, and cannot be excluded by the five criteria given in RG 1.155 to be included in a procedure.

Review of Licensee's Submittal

We reviewed FSARU Table 6.2.4-1 and Figure 6.2.4-1 (12) and the list of CIVs provided by the licensee in its June 7, 1991 submittal (15). The licensee's response for valves which were normally open or closed and fail as-is, were reviewed and found to be reasonable and consistent with the intent of RG 1.155 guidance with one exception. The excess letdown and seal water leakoff line (X-49) contains normally open AC motor-operated globe valves which fail as-is inside and outside containment. The licensee needs to identify the actions necessary to ensure that these valves are fully closed, if needed, upon the loss of AC power. The staff's position is that the valve closure needs to be confirmed by position indication (local, mechanical, remote, process information, etc.).

6. Reactor Coolant Inventory

Licensee's Submittal

The licensee stated (13) that the ability to maintain adequate reactor coolant system inventory to ensure that the core is cooled has been assessed for four hours using the generic analyses listed in Section 2.5.2 of NUMARC 87-00. The licensee used an assumed seal leakage rate of 25 gpm per Reactor Coolant Pump, consistent with the NUMARC 87-00 guidance, and concluded that make-up systems beyond those currently available under SBO conditions are not required to maintain core cooling under natural circulation. The licensee added that if the resolution of Generic Issue 23 indicates that modifications are necessary to maintain RCS leakage below a value, they will be implemented.

In response to discussions at the May 23, 1991 telephone conference, the licensee stated (15) that it used the results of a Westinghouse Owners Group Report on Reactor Coolant Pump Seal Performance Following a Loss of All AC Power, WCAP-10541, Section 8.2, Rev 2, which were determined by Westinghouse to be applicable to Vogtle. The results of this report were not provided by the licensee for review. Assuming 21 gpm seal leakage per RCP and a primary system cooldown to 417°F, it was determined that there was sufficient inventory to maintain the core covered for 18.7 hours. The licensee concluded that the assumption of additional RCS leakage, (i.e. 110 gpm compared to 84 gpm considered in the Westinghouse analysis), will reduce the 18.7 hour time, but will remain well within the four hour coping duration.

Review of Licensee's Submittal

Table 5.1.2-1 of the FSARU (12) reports a total liquid volume for the primary system of 11720 ft^3, a nominal operating pressure of 2250 psia and a average core temperature of 591.8°F. Assuming RCS leakage of 25 gpm/pump, 10 gpm technical specification leakage and 1 gpm unknown leakage and a RCS cooldown to 350°F, we calculated the volume of water remaining in the core to be 5274 ft^3. This is in excess of the volume which the licensee reported to be required to cover the

core (2550 ft^3). Thus, we agree with the licensee's conclusion that the core will not be uncovered during a four hour SBO event.

NOTE:

The 25-gpm RCP seal leak rate 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 RCP seal leak rates than assumed for the RCS inventory evaluation, the licensee is aware of the potential impact of this resolution on its analyses and actions addressing conformance to the SBO rule.

3.3 Proposed Procedure and Training

Licensee's Submittal

The licensee stated in its submittal (13) that plant procedures have been reviewed by GPC. For offsite actions by those personnel charged with responsibility for control of the transmission system, grid restoration procedures have been updated to meet the requirements of the SBO rule. Specifically, the following two documents are being added to the procedures:

- Black Start Procedure for Plant Vogtle; and
- Restoration of Offsite AC Power for the Shutdown of Plant Vogtle

Onsite actions are addressed principally by three procedures:

- Loss of All AC;
- Severe Weather; and
- System Operating Procedures for Diesel Generator Operation.

These procedures are being evaluated against the criteria of NUMARC 87-00 for SBO considerations. If necessary, changes to the procedures will be made to support the SBO response. The SBO related procedure review and update are scheduled to be implemented within one year of receipt of NRC approval of the Vogtle Station Blackout submittal.

Review of Licensee's Submittal

We neither received nor reviewed the affected procedures, although several procedure changes have been identified as being required to maintain containment integrity under SBO conditions. We consider these procedures to be plant-specific actions concerning the required activities to cope with an SBO. It is the licensee's responsibility to revise and implement these procedures, as needed, to mitigate an SBO event and to assure that these procedures are complete and correct, and that the associated training needs are carried out accordingly.

3.4 Proposed Modification

Licensee's Submittal

The licensee identified (14) the following modifications which will be required to attain the proposed four hour coping capability:

- Lighting in the common main control room will be augmented to assure sufficient lighting after 90 minutes of initial lighting provided by self-contained, gel-cell battery packs.

- Six circuit breakers in Unit 1 and seven circuit breakers in Unit 2 will be replaced with larger size circuit breakers to avoid the potential of spurious tripping due to a temperature induced shift in tripping characteristics at elevated ambient temperatures. The Unit 2 circuit breakers have been replaced; the Unit 1 circuit breakers will be replaced in the Fall of 1991.

- If the resolution of Generic Issue 23 indicates that modifications to RCP seals are required, they will be implemented according to the current RCP maintenance schedule after the appropriate modifications are available.

Review of Licensee's Submittal

The circuit breaker replacement proposed by the licensee is based on expected switchgear room temperatures which are calculated using a non-conservative initial room temperature of 85°F. The licensee needs to establish a procedural requirement to ensure that these room temperatures would not exceed 85°F under any circumstances or verify that these circuit breakers are also functional at the conditions resulting from the use of a higher initial temperature.

Control room lighting augmentation is needed to ease operator actions within the control room area. It is unclear, however, what lighting is available in the non-blacked out unit portion of the control room. If only hand-held lights are available after 90 minutes, it is prudent that the licensee analyzes this condition to ensure that control room operation will not be hampered by hand-held flash lights.

Further, our review has identified several concerns which the licensee needs to address and may result in additional modifications.

3.5 Quality Assurance and Technical Specifications

The licensee's submittal does not document the conformance of the plant's SBO equipment with the guidance of RG 1.155, Appendices A, and B.

4.0 CONCLUSIONS

Based on our review of the licensee's submittals (13, 14, 15) and the information available in the FSARU for Vogtle Electric Generating Plant Units 1 and 2 (12), we find that the submittal conforms with the requirements of the SBO rule and the guidance of RG 1.155 with the following exceptions:

1. Class-1E Battery Capacity

Based on our review of the licensee's battery capacity calculations and the discussion in Section 3.2, the following summarizes our findings:

1) The licensee's assumption of zero design margin is not consistent with the recommended 10-15% values in IEEE-Std 485.

2) The efficiency on inverter 1DD1I4 needs to be changed to 71.5%, consistent with the data provided by the licensee.

3) The heat load assumption on 25 kVA inverter 1DD1I6, and/or 1CD1I5 is low. If these inverters are not providing any support they could be shed, otherwise, higher loads need to be considered on batteries C and D.

4) The 70°F electrolyte temperature is non-conservative. The licensee needs to have a procedure which ensures that the room temperature would not go below this temperature under any circumstances.

2. Effects of Loss of Ventilation

Based on our review of the licensee's temperature rise calculations and the discussion in Section 3.2, the following summarizes our findings:

1) The licensee used the normal ambient room temperature as the initial temperature in its temperature rise calculations. The use of normal temperature is reasonable if the temperatures assumed are

equal to or greater than the maximum allowed technical specification temperatures for each area. The licensee needs to make a commitment to establish an appropriate procedure to ensure that these assumed initial temperatures will not be exceeded under any circumstances.

2) The licensee evaluated the RAO for the inverter/switchgear rooms at 119°F and concluded that, except for certain circuit breakers, all other equipment would be operational at these temperatures. However, the final room temperature calculated by the licensee was based on a non-conservative initial room temperature of 85°F. If a higher temperature of 104°F consistent with the guidance were to be used, the maximum temperature in the inverter/switchgear rooms is expected to reach 138°F. If this is the case case, the licensee will need to verify that the equipment in these rooms is qualified to operate at this higher temperature.

3) For several rooms, the licensee took credit for the opening of doors to lower the expected temperature. The licensee needs to modify the Station Blackout Procedure to provide guidance for opening these doors within 30 minutes of an SBO, consistent with the guidance in NUMARC 87-00.

4) Based on the NUMARC guidance, the licensee needs to provide a statement verifying that the containment temperature profile during an SBO is bounded by that of the LOCA/High Energy Line break temperature profile. The licensee needs to provide such verification.

3. **Containment Isolation**

The excess letdown and seal water leakoff line (X-49) contains normally open AC motor-operated globe valves which fail as-is inside and outside containment. The licensee needs to identify the actions necessary to ensure that these valves are fully closed, if needed, upon the loss of AC power. The staff's position is that the valve closure

needs to be confirmed by position indication (local, mechanical, remote, process information, etc.).

4. Modifications

The circuit breaker replacement proposed by the licensee is based on expected switchgear room temperatures which are calculated using a non-conservative initial room temperature of 85°F. The licensee needs to establish a procedural requirement to ensure that these room temperatures would not exceed 85°F under any circumstance and verify that these circuit breakers are also functional at the condition resulting from the use of a higher initial temperature.

Control room lighting augmentation is needed to ease operator actions within the control room area. It is unclear, however, what lighting is available in the non-blacked out unit portion of the control room. If only hand-held lights are available after 90 minutes, it is prudent that the licensee analyzes this condition to ensure that control room operation will not be hampered by hand-held flash lights.

5. Quality Assurance and Technical Specifications

The licensee's submittal does not document the conformance of the plant's SBO equipment with the guidance of RG 1.155, Appendices A, and B.

5.0 REFERENCES

1. The Office of Federal Register, "Code of Federal Regulations Title 10 Part 50.63," 10 CFR 50.63, January 1, 1989.

2. U.S. Nuclear Regulatory Commission, "Evaluation of Station Blackout Accidents at Nuclear Power Plants - Technical Findings Related to Unresolved Safety Issue A-44," NUREG-1032, Baranowsky, P.W., June 1988.

3. U.S. Nuclear Regulatory Commission, "Collection and Evaluation of Complete and Partial Losses of Offsite Power at Nuclear Power Plants," NUREG/CR-3992, February 1985.

4. U.S. Nuclear Regulatory Commission, "Reliability of Emergency AC Power System at Nuclear Power Plants," NUREG/CR-2989, July 1983.

5. U.S. Nuclear Regulatory Commission, "Emergency Diesel Generator Operating Experience, 1981-1983," NUREG/CR-4347, December 1985.

6. U.S. Nuclear Regulatory Commission, "Station Blackout Accident Analyses (Part of NRC Task Action Plan A-44)," NUREG/CR-3226, May 1983.

7. U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory Research, "Regulatory Guide 1.155 Station Blackout," August 1988.

8. Nuclear Management and Resources Council, Inc., "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," NUMARC 87-00, November 1987.

9. Nuclear Safety Analysis Center, "The Reliability of Emergency Diesel Generators at U.S. Nuclear Power Plants," NSAC-108, Wyckoff, H., September 1986.

10. Thadani, A. C., Letter to W. H. Rasin of NUMARC, "Approval of NUMARC Documents on Station Blackout (TAC-40577)," dated October 7, 1988.

11. Thadani, A. C., letter to A. Marion of NUMARC, "Publicly-Noticed Meeting December 27, 1989," dated January 3, 1990, (Confirming "NUMARC 87-00 Supplemental Questions/Answers," December 27, 1989).

12. Vogtle Electric Generating Plant Units 1 & 2, Final Safety Analysis Report Update (FSARU).

13. Hairston, W. G., III, letter to the Document Control Desk of the US Nuclear Regulatory Regulation, W. R. Butler, Project Director, "Plant Vogtle - Units 1 and 2, NRC Docket 50-424, 50-425. Operating Licenses NPF-68, NPF-81, Response to Station Blackout Rule," Docket No's. 50-424, 50-425, dated April 12, 1989.

14. Hairston, W. G., III, letter to the Document Control Desk of the Nuclear Regulatory Regulation, W. R. Butler, Project Director, "Vogtle Electric Generating Plant, Supplemental Response to Station Blackout Rule," Docket No's. 50-424, 50-425, dated March 28, 1990.

15. McCoy, C.K., letter to the Document Control Desk of the US Nuclear Regulatory Commission, "Vogtle Electric Generating Plant, Response to Station Blackout Questions," Docket No's. 50-424, 50-425, dated June 7, 1991.

16. Calculation No. NX3AD01-1, "Vogtle Electric Generating Plant Unit 1, 4 Hour Station Battery Capacity During Station Blackout," dated March 5, 1990.