Attachment 1

SAIC-91/1264

# TECHNICAL EVALUATION REPORT
# OCONEE NUCLEAR STATION
# STATION BLACKOUT EVALUATION

TAC Nos. 68574, 68575, and 68576

Science Applications International Corporation
An Employee-Owned Company

Final
December 20, 1991

Prepared for:

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

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

9201020371 XA

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# TECHNICAL EVALUATION REPORT

## OCONEE NUCLEAR STATION
## 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 onsite 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 by the NRC staff (9) 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 (10) addressing the NRC's 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. Alternate AC (AAC) power source (Section 3.2),

C. SBO coping capability (Section 3.3),

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

E. Proposed modifications (Section 3.5), and

F. Quality assurance and technical specifications for SBO equipment (Section 3.6).

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 (11), 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, compressed-air capacity, ventilation systems, containment isolation 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.

The licensee's proposed use of an alternate AC power source is reviewed to determine whether it meets the criteria and guidelines of Section 3.3.5 of RG 1.155 and Appendix B of NUMARC 87-00.

This SBO evaluation is based upon the review of the licensee's submittals dated April 17, 1989 (12), and April 5, 1990 (13), the information available in the plant Final Safety Analysis Report (FSAR) (14), a meeting with the licensee in Charlotte, North Carolina, and the information provided by the licensee following the meeting (15).

## 3.0 EVALUATION

### 3.1 Proposed Station Blackout Duration

#### Licensee's Submittal

The licensee, Duke Power Company, calculated (12 and 13) a minimum acceptable station blackout duration of four hours for the Oconee Nuclear Station (ONS) site. The licensee stated (13) that there are no equipment modifications required or planned at Oconee to meet the SBO rule.

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 "1," 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 of the plant is "D." The site is equipped with two shared emergency AC power sources (hydro units). One EAC power supply is necessary to operate safe-shutdown equipment for all three units following a loss of offsite power.

3. **Target Emergency AC Reliability**

The licensee has selected a target EAC reliability of 0.975. The selection of this target reliability is based on having an average EAC reliability greater than 0.975 for the last 100 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 expected frequency of grid-related LOOPs, the estimated frequency of LOOPs due to ESW and SW conditions, the classification of EAC, and the selection of EAC target reliability. The licensee stated that the independence of the plant offsite power system grouping is "I1/2." A review of the available information shows that:

1. Offsite power sources are connected to the plant through two electrically connected switchyards and an independent 100-kV line;

2. During normal operation, power is provided to the safety buses from the main generator;

3. Upon main generator trip, there is an automatic transfer of all of the emergency busses to a 230-kV power source through transformer CT1;

4. Upon loss of power from CT1, there is a manual transfer to the 100-kV offsite source through transformer CT5.

Based on these and the criteria stated in Table 5 of RG 1.155, the plant independence of offsite power system group is "I2."

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., indicates that Oconee did not have any symptomatic grid-related LOOP prior to the calendar year 1984. In the absence of any contradictory information, we agree with the licensee's statement.

Using Table 3-3 of NUMARC 87-00, the expected frequency of LOOPs due to SW conditions places the site in SW Group "1." Using Table 3-2 of NUMARC 87-00, the expected frequency of LOOPs due to ESW conditions places the Oconee site in ESW Group "3." The licensee, using site-specific data, estimated (13) the frequency of SW- and ESW-caused LOOPs to place the site in SW Group "1" and ESW Group "1," respectively. The change in ESW grouping does not affect the classification of the offsite power design characteristic.

The licensee correctly categorized the EAC classification of ONS as "D." The EAC power source for the Oconee site is the Keowee hydro-electric power plant. Keowee has two 83.125-MW hydro power units, with one hydro unit necessary to safely shut down all three Oconee units.

The licensee selected the EAC target reliability of 0.975 based upon the reliability data for the last 100 demands. The licensee added that over the last 100 demands, the Keowee hydro units have demonstrated a 100% reliability.

With regard to maintaining the 0.975 target EAC reliability, the licensee stated (15) that Duke Power Company currently has a program in place which is designed to maintain the reliability of the emergency power sources. This program covers the steps required for maintenance, testing, and surveillance activities, and root-cause investigation. Additionally, Duke Power is closely following the progress of Generic Issue B-56 and, upon resolution of this Generic Issue, Duke Power will review its emergency power source reliability program and make changes as necessary. The licensee, however, did not elaborate on the applicability of Generic Issue B-56 "Emergency Diesel Generator Reliability" to its hydro EAC power sources.

The licensee stated (15) that the Keowee hydro units, in addition to serving as the EAC power sources for Oconee, are power generating sources for the Duke system requirements. As power generating units, they are operated frequently, normally on a daily basis at loads equal to or greater than required by Table 8.5 of the FSAR for ESF bus loads. Normal as well as emergency start-up and operation of these units will be from the Oconee Unit 1 and 2 control room. The licensee added that the frequent starting and loading of these units to meet Duke system power requirements assures the continuous availability for emergency power for the Oconee auxiliaries and engineered safety features equipment.

In response to a concern regarding the availability of the Keowee hydro units, the licensee provided a summary of its analysis of the unavailability of the hydro units during the calendar years 1980 through 1987, and 1988 through 1990. Our review of the information for the 1980-1987 calendar years indicates that, on the average, hydro unit #1 was available 96.18% of the time and unit #2 was available 96.29% of the time. The data also shows that with the exception of calendar year 1983 when both hydro units were unavailable for a total of 1042.1 hours, the average availability of unit #1 was 97.53% with a minimum and maximum availability of 94.41% and 98.71%, respectively. The average availability of unit #2 was 97.64% with a minimum and maximum availability of 94.08% and 98.61%, respectively. During the 1983 calendar year, the availability of hydro units #1 and #2 was 86.70% and 86.85%, respectively. The information for 1988 through 1990 was not as detailed as that given for the previous years. This information shows an average hydro unit availability of 98.87%. This data does not provide any information on both hydro units being unavailable simultaneously. Our observation of this data indicates that the recent availability of the hydro units meets the target goal established by the licensee. It should be noted, however, that this conclusion is made solely based upon the summary of the [illegible]mation provided by the licensee. We did not perform a detailed review of the suppo[illegible] documentation (i.e., log book, maintenance procedures, problems, or outages). Based upon the above, it appears that the unit average availability is approximately equal to the target value. In addition, when one EAC power source is out of service for maintenance, technical specification 3.7.4(a) requires that the 4160-volt busses be energized by a gas turbine from the Lee station within 72 hours. Under these conditions, a Lee Station gas turbine and the 100-kV circuit shall be electrically separate from the system grid and offsite non-safety-related loads. In other words, if one of the onsite EAC power sources is out of service, one of the offsite sources must be dedicated to the Oconee safety busses within 72 hours. Operation in this mode is restricted to periods not to exceed 45 days. This approach provides constant back-up emergency AC while one hydro unit is out of service, essentially as if the EAC power were available.

Based on the above, the offsite power design characteristic of the Oconee site is "P1," with a minimum required SBO coping duration of four hours.

## 3.2 Alternate AC (AAC) Power Source

### Licensee's Submittal

The licensee stated (13) that an AAC power source is provided at Oconee which meets the criteria specified in NUMARC 87-00, Appendix B. The AAC power source is the Standby Shutdown Facility (SSF) diesel generator and is available within 10 minutes from the recognition of an SBO event. However, it cannot be started from the Oconee main control room. The licensee stated that testing has demonstrated the ability of plant operators to start the SSF diesel within 10 minutes of the recognition of the SBO event which satisfies the intent of the NUMARC guidance. The licensee added (13) that the SSF diesel generator has sufficient capacity and capability to operate equipment necessary to maintain all three units at hot shutdown conditions for the four-hour SBO event.

The licensee stated (12) that the SSF was originally designed to provide an alternate means of achieving and maintaining hot shutdown conditions. The SSF was designed to resolve the safe-shutdown requirement for fire protection, turbine-building flooding, and physical security. Loss of all normal and emergency station power (AC and DC) is assumed for the postulated fire and sabotage events. The SSF has the capability of maintaining hot shutdown conditions in all three units for approximately three days following a loss of normal AC power, which is well beyond the required coping duration of four hours.

**Review of Licensee's Submittal**

The licensee's proposed AAC power source, the 3500-kW SSF diesel generator, is designed to meet the requirements of Appendix R. The SSF is capable of maintaining all three units in hot standby for a period of up to 72 hours and is completely independent of the normal plant systems. Since the SSF is designed to be able to cope with the loss of the normal plant AC and DC systems, it is therefore designed to meet the conditions of a postulated SBO event. However, since the SSF is susceptible to single failures, the unavailability of the SSF is the sum of the unavailability of the individual equipment. Some of the crucial SSF equipment is the SSF diesel generator, the auxiliary service water (ASW) pump, and the Unit 2 condenser cooling water. If any one of these components is unavailable, then the SSF system as a whole is unavailable. The licensee needs to ensure that the SSF availability will be maintained at a minimum of 0.95. The technical specifications requirements for the availability of the SSF is being addressed under a separate issue.

### 3.3 Station Blackout Coping Capability

The Oconee site has three identical units which share two emergency AC power sources, the two Keowee hydro generators. The postulated SBO includes the loss of these two hydro units and, therefore, all three units are blacked out. Since the three units are identical, the results of our review is applicable to any one of the three units.

The licensee stated (12) that since the AAC power source is available within 10 minutes and has the capability to power the needed SBO functions, the class-1E battery capacity, compressed air, and containment isolation need not be addressed.

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

1. **Condensate Inventory for Decay-Heat Removal**

   **Licensee's Submittal**

   The licensee, using NUMARC 87-00, Section 7.2.1, has determined (12) that 58,116 gallons of water are required for decay-heat removal during the four-hour coping period. Technical specification 3.7.1(i), which requires a lake level of at least 775' above sea level, provides more than the required quantity of water for coping with a four-hour SBO event. The SSF ASW pump takes suction from the condenser cooling water piping, which is continuously provided with water from the lake via an AC-independent siphon. No plant modifications or procedure changes are needed to utilize these water sources.

**Review of Licensee's Submittal**

Using the expression provided in NUMARC 87-00, we have estimated that the water required for removing decay heat during the four-hour SBO would be ~58,000 gallons. This estimate is based on 102% of a maximum licensed core thermal rating of 2568 MWt.

The licensee stated (13) that the source of condensate is the condenser cooling water. The condenser cooling water is siphoned from the lake which has a technical specifications minimum level. Thus the lake provides sufficient water to cope with a four-hour SBO event. The lake water is provided to the SSF ASW pump via the buried condenser circulating water piping for Unit 2. Should this piping be out of service for maintenance, the lake water would not be available. Therefore, the licensee needs to ensure that the lake water is available to the ASW pump with minimal interruptions. This issue is being considered as part of the SSF technical specifications limiting conditions of operation under a separate issue.

Using the lake as the primary water source is not the licensee's first choice. The lake water, a source of raw water, is the back-up condensate supply during an SBO event. The licensee's preferred condensate source during an SBO event is the condenser hot well. During the audit review on August 5-9, 1991, the licensee stated that the plant is capable of circulating the steam from the steam generators, through the turbine bypass valves to the condenser. The combination of the condenser hot well and the upper surge tank (UST) provides 72,000 gallons of water per unit which can be used to remove decay heat. In addition, the steam is condensed in the condenser and returned to the steam generators by the unit emergency feedwater (EFW) system. The condenser cooling water system provides sufficient cooling to the condenser via gravity feed to remove decay heat. The licensee stated that calculation OSC-2155 shows that there is sufficient net positive suction head (NPSH) for the EFW pump to take suction from the condenser hot well under these conditions. However, there is no guarantee that the EFW pump will be able to provide condensate-grade water to the steam generators after two hours when control of the plant is transferred to the SSF, and the licensee may be forced to provide raw water from the lake to the steam generators via the ASW pump.

2. **Class-1E Battery Capacity**

**Licensee's Submittal**

Since the plant is a 10-minute AAC plant, the licensee did not address the adequacy of the batteries to carry the SBO loads in its submittals.

During the audit review, the licensee stated that the batteries can support the SBO loads for two hours with five of the six shared batteries available. It is the licensee's position that it will maintain control of the three units from the two main control rooms (one for Units 1 and 2, one for Unit 3) until the Crisis Management Center (CMC) personnel determine that it is necessary to evacuate the control rooms and transfer control of the three units to the SSF.

The SSF has its own independent battery system which will be charged by a battery charger powered by the AAC power source. Monitoring capability is provided for plant parameters such as primary coolant temperature, pressurizer pressure and level, incore thermocouple, and steam generator level, and diagnostic capabilities for mechanical and electrical component performance.

Although the SSF DC system provides a minimum of instrumentation and control, the design of the SSF is such that sufficient control of all three Oconee units is available to safely shut down the units over a 72-hour period, which exceeds the postulated 4-hour SBO event.

**Review of Licensee's Submittal**

Since the batteries at Oconee do not have sufficient capacity to support the SBO loads for four hours, the licensee intends to keep the control room functional as long as the batteries last and then transfer control of the plant to the SSF. The licensee contends that the SSF is designed to maintain all three units in safe shutdown conditions for 72 hours following a total loss of AC and DC power. Based on this, the licensee claims that since the SSF is designed and approved by the staff to mitigate a more serious condition than an SBO event, it should be acceptable for an SBO event. Although the SSF has sufficient instrumentation and control to monitor the state of the primary and secondary systems, it provides minimal information which the NRC staff has considered to be unacceptable from other licensees who had proposed evacuating the control room. NUMARC 87-00 Supplemental Questions/Answers states that the control room should not be evacuated to extend battery capacity. Oconee does not have sufficient battery capacity to keep the control room functional for the four-hour SBO event.

3. **Compressed Air**

**Licensee's Submittal**

The licensee did not address compressed air in its submittals since it is a 10-minute AAC plant. However, during the meeting with the licensee, it provided a list of the sequence of events which indicates that a diesel air compressor will be connected to the instrument air header. The licensee also indicated that the EFW flow control valves have back-up nitrogen supplies designed to last for two hours, so these valves could be controlled from the control room until the batteries are exhausted. The diesel air compressor can also provide air to the turbine bypass valves, allowing steam to be dumped to the condenser.

**Review of Licensee's Submittal**

There is one potential scenario in which compressed air is not required. With control of the three units from the SSF control room and water from the condenser cooling water system (i.e., lake water) being provided to the steam generator by the ASW pump, decay heat can be removed using the main steam safety valves. These valves are spring operated and, therefore, do not require compressed air. Based on this scenario, compressed air is not required to cope with an SBO event. Should the licensee decide to perform a cooldown, the atmospheric dump valves (ADVs) will be necessary. These valves are not air-operated; the ADVs are manually operated locally in the turbine building.

Even though compressed air is not required, the licensee is planning on having a diesel-driven air compressor available. The use of this compressor will enable the licensee to provide condensate-grade water to the steam generators, which is preferable to using raw water from the lake. However, the licensee will not be able to use condensate-grade water for the full four-hour duration of the SBO event (See Condensate Inventory Section). Once the batteries are depleted, the licensee will have to switch control of the plant from the main control room to the SSF control room. Once this is done, condensate-grade water is no longer available.

**4. Effects of Loss of Ventilation**

**Licensee's Submittal**

The licensee stated (13) that since the SSF ASW pump is inside the SSF, it is cooled by the SSF ventilation system which is powered by the SSF diesel generator. Therefore, no analysis of the loss of ventilation for the ASW pump need be performed. The licensee added that the assumption in NUMARC 87-00, Section 2.7.1, that the control room will not exceed 120°F during an SBO event has been assessed. During an SBO event, the control room at Oconee is the SSF control room which is supported by the SSF HVAC system. Therefore, the SSF control room does not exceed 120°F and is not a dominant area of concern (DAC).

The only DAC identified at Oconee is the containment. The temperature following an SBO event will not exceed 250°F in the containment during the four-hour coping duration. The operability of the SBO response equipment in this DAC is assured based upon the original design basis of the SSF systems. No modifications or procedure changes are required to provide reasonable assurance for the equipment operability.

**Review of Licensee's Submittal**

The licensee did not perform heat-up calculations for the steam-driven ASW pump room nor the main control room. With regard to the ASW pump room, we agree with the licensee that no calculation is required for this room. The ASW pump, which is shared by all three units, can provide condensate to all three units' steam generators. This pump is located in the safe shutdown facility and, therefore, will be in an area that will be cooled by the SSF HVAC system during an SBO event.

With regard to the main control room, switchgear room, inverter room, etc., we agree that no calculations are necessary if the main control room function is transferred to the SSF. According to the licensee, within ten minutes of the onset of an SBO event, the SSF diesel will be available and HVAC will be provided for the SSF control room. The main control room will not heat up to a point of being uninhabitable (i.e., ≥120°F) in the first ten minutes of an SBO event. At any time beyond the first ten minutes, control of the three units can be transferred to the SSF control room. However, the licensee intends to keep the main control room functional for the first two hours. Therefore, it appears that an analysis of the room heat-up is needed. The licensee claims that since the SSF is available within 10 minutes, any failure resulting from heat-up should not affect the plant coping capability. This will be acceptable if the staff agrees on evacuating the control room. Otherwise, the licensee needs to perform heat-up calculations for the areas containing SBO equipment (i.e., the main control room, relay room, EFW pump room, etc.).

During the audit review, the licensee provided a list of the equipment necessary to cope with an SBO event from the SSF. This list contained the location of the equipment and the justification for the reasonable assurance of the equipment operability. From this list, it is apparent that the only DAC is the containment, which houses, among other equipment, a make-up pump that can be powered from the SSF diesel to provide reactor coolant pump seal cooling within 10 minutes. The licensee provided two heat-up calculations for the containment following a loss of all AC power. One of these calculations used a hand-calculated time-dependent heat-transfer method. This calculation, which did not include the postulated 111 gpm (25 gpm per reactor coolant pump and 11 gpm technical specifications leak rate), indicated a final reactor-building temperature of 225°F, assuming an initial temperature of 120°F. The second calculation was performed using the MAAP computer code and assumed an initial leak rate of 111 gpm. This calculation resulted in a final temperature of ~175°F with an assumed initial temperature of 90°F. If an initial temperature of 120°F were to be used in the MAAP calculation, the final temperature would be less than 205°F. In either case, both of these final calculated temperatures are below the containment equipment operability temperature limit of 286°F. The equipment inside containment consists mostly of valves and the make-up pump, which are qualified for LOCA conditions. Therefore, we concur with the licensee that the containment temperature will not exceed the operability temperature limit for equipment located therein.

5. **Containment Isolation**

**Licensee's Submittal**

The licensee did not address containment isolation in its submittals since it is a ten-minute AAC plant.

**Review of Licensee's Submittal**

During the site audit review, the licensee stated that it used the plant list of CIVs and excluded valves based on the criteria given in RG 1.155. Closure confirmation for the valves which were not excluded by the criteria have been incorporated in the SBO procedures. Based on this, Oconee has the ability to ensure that containment isolation can be provided during an SBO event, should it become necessary.

6. **Reactor Coolant Inventory**

**Licensee's Submittal**

The licensee stated (13) that the AAC power source powers the necessary make-up systems to maintain adequate reactor coolant system inventory to ensure that the core is cooled for the required coping duration. The SSF powers three make-up pumps, one per unit, each capable of providing 26 gpm. During the audit review, the licensee claimed that this flow is sufficient to cool the pump seals and to make up for the technical specifications leak rate. In addition, the licensee provided (15) the results of its MAAP calculations which indicate that the core will not become uncovered during a four-hour SBO event. In this calculation, the licensee assumed that the 26-gpm make-up pump was not available.

**Review of Licensee's Submittal**

Reactor coolant make-up is necessary to replenish the RCS inventory losses due to the reactor coolant pump seal leakage (25 gpm per pump per NUMARC 87-00 guideline), and the technical specifications maximum allowable leakage (estimated to be 11 gpm). According to Table 9-6 of the plant UFSAR, a seal flow to each reactor coolant pump (excluding make-up) of 8 gpm per pump is required. Each unit has four pumps; therefore, a total of 32 gpm is required to maintain the pump seals. Since the SSF make-up pump is only capable of delivering 26 gpm, the SSF make-up pump does not provide sufficient flow to maintain the integrity of the pump seals.

We performed a calculation to determine the adequacy of the reactor coolant inventory. Over four hours with a postulated 111-gpm leak rate, the RCS would lose 26,640 gallons of water, which is ~3600 $ft^3$. The licensee provided information (15) which indicates that the RCS volume is 11,100 $ft^3$. After four hours, the RCS has 7500 $ft^3$ of water remaining. The plant FSAR indicates that each steam generator contains 2030 $ft^3$ of primary coolant (Table 5-20) and the pressurizer contains 800 $ft^3$ of water (Table 5-22). Therefore, after four hours, the pressurizer would be empty and each steam generator would have ~600 $ft^3$ of primary coolant remaining. Therefore, even if the make-up pump is not considered, the core will not become uncovered during an 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 needs to be aware of the potential impact of this resolution on its analyses and actions addressing conformance to the SBO rule.

### 3.4 Proposed Procedure and Training

**Licensee's Submittal**

The licensee stated that the following procedures have been reviewed and the changes necessary to meet NUMARC 87-00 guidelines will be implemented:

1. Station response,
2. AC power restoration, and
3. Severe weather guidelines.

**Review of Licensee's Submittal**

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.

### 3.5 Proposed Modification

**Licensee's Submittal**

The licensee stated that no modifications or associated procedure changes are required in order for Oconee to be able to cope with an SBO event for four hours.

### Review of Licensee's Submittal

The licensee proposes to evacuate the control room prior to the depletion of the batteries. If this action is deemed unacceptable by the staff, then modifications are needed. Otherwise, we did not identify the need for any modifications.

## 3.6 Quality Assurance and Technical Specifications

The licensee stated (15) that the SBO response equipment is classified into three Quality Assurance (QA) categories. The three categories are 10 CFR 50, Appendix B, which covers safety-related equipment; 10 CFR 50, Appendix R, which covers fire and security-related equipment; and RG 1.155, Appendix A, which would cover the SBO equipment not covered in other categories. The licensee added that equipment covered by Appendices B and R meet the QA requirements of RG 1.155. Duke power is in the process of establishing a program which meets the requirement of RG 1.155, Appendix A. The technical specifications requirements for the SSF are under review by the staff under a separate topic.

## 4.0 CONCLUSIONS

Based on our review of the licensee's submittals and the information available in the FSAR for Oconee Nuclear Station, 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. **EAC Reliability Program**

   The licensee stated that it is following the progress of Generic Issue B-56 and, upon resolution of this Generic Issue, the licensee will modify its reliability programs. This Generic Issue, however, pertains to diesel generators; Oconee's EAC power sources are two hydro power units. The licensee did not provide information on the applicability of the Generic Issue to its reliability program for its hydro units.

2. **AAC Power Source**

   The licensee proposes to use the SSF in order to be able to cope with an SBO event. The SSF was designed to be able to cope for 72 hours with a fire or a security event concurrent with the loss of all normal AC and DC power. Therefore the SSF facility was designed for conditions which bound an SBO event. However, the licensee needs to ensure that the availability of the SSF system as a whole, not just the SSF diesel generator, is maintained at 0.95.

3. **Condensate Inventory**

   Lake water is provided to all three units' steam generators by the SSF ASW pump via the buried condenser circulating water piping for Unit 2. The licensee needs to ensure that lake water is available to the SSF ASW pump with minimal interruptions. This issue is being considered as part of the SSF technical specifications limiting conditions of operation under a separate issue.

4. **Class-1E Battery Capacity**

The batteries at Oconee do not have sufficient capacity to keep the control room functional for the required four-hour SBO coping duration. The licensee proposed evacuating the control room once the batteries run low approximately two hours into the SBO event. The licensee's evacuation of the control room is contrary to the guidance provided in NUMARC 87-00 Supplemental Questions/Answers.

5. **Loss of Ventilation**

The licensee proposes to evacuate the main control room when the batteries are depleted. If this evacuation of the main control room is not accepted, the licensee needs to perform heat-up calculations for the areas which contain SBO equipment (i.e., main control room, switchgear room, AFW pump room, etc.).

6. **Proposed Modifications**

The licensee proposes to evacuate the control room prior to the depletion of the batteries. If this action is deemed unacceptable by the staff, then modifications are needed. Otherwise, we did not identify the need for any modifications.

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

10. 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).

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

12. Tucker, H. B., letter to U.S. Nuclear Regulatory Commission Document Control Desk, "Requirements for Station Blackout," dated April 17, 1989.

13. Tucker, H. B., letter to U.S. Nuclear Regulatory Commission Document Control Desk, "Requirements for Station Blackout (SBO)," dated April 4, 1990.

14. Oconee Nuclear Station Final Safety Analysis Report, Revision dated December 31, 1990.

15. Supplemental information provided by the licensee following the site audit review in Charlotte, NC, from August 5-9, 1991.