ATTACHMENT 1

SAIC-90/1056

TECHNICAL EVALUATION REPORT
DAVIS-BESSE NUCLEAR POWER STATION
STATION BLACKOUT EVALUATION

TAC No. 68536

Science Applications International Corporation
An Employee-Owned Company

Final
August 17, 1990

Prepared for:

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

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

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TECHNICAL EVALUATION REPORT

DAVIS-BESSE NUCLEAR POWER 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 (19) 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 (14) 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. 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, 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.

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 on the review of the licensee's submittals dated April 17, 1989 (10), and March 30, 1990 (12), and the information available in the plant Updated Safety Analysis Report (USAR) (11); 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 performad by the NRC staff at some later date

3.0 EVALUATION

3.1 Proposed Station Blackout Duration

Licensee's Submittal

The licensee, Toledo Edison (TE) Company calculated (10 and 12) a minimum acceptable station blackout duration of four hours for the Davis-Besse Nuclear Power Station (DBNPS) site. The licensee stated that no modifications are required to attain this coping 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 "11/2,"

   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 "2."

2. Emergency AC (EAC) Power Configuration Group

   The EAC power configuration of the plant is "C." DBNPS is equipped with two emergency diesel generators. One EAC power supply is necessary to operate safe shutdown equipment following a loss of offsite power.

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 an average EDG reliability of greater than 0.95 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 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 place the DBNPS site in ESW group "2." Using Table 3-3 of NUMARC 87-00, the expected frequency of LOOPs at DBNPS due to SW condition is group "3" for offsite power transmission lines on one right of way, or group "2" for offsite power transmission lines on two or more rights-of-way. The licensee submits an SW group of "2." A review of the plant USAR (11) indicates that the plant has three transmission lines, and the lines can be considered to traverse on two rights-of-way.

The licensee stated that the independence of the plant offsite power system (Figure 1) grouping is "II/2." A review of the DBNPS USAR indicates that:

1. All offsite power sources are connected through a single switchyard;

2. During normal power operation, the essential buses are powered from the unit main generator, through the auxiliary power transformer;

3. Upon loss power from the main generator (preferred power source), there is an automatic transfer of all essential buses to two Start-up Transformers;

4. Each transformer powers one division of essential buses;

5. Each of the Start-up Transformers has sufficient capacity to serve as a complete reserve power source for the station auxiliaries in the event of failure of the Unit Auxiliary Power Transformer supply; and

6. Upon loss of power from one of the Start-up Transformer both 4.16 kV essential buses will be powered from the other Start-up Transformer by a manual transfer.

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

The EAC classification of DBNPS is "C." We are unable to verify the assignment of the EDG target reliability at this time. However, based on the information in the NSAC-108, which gives the EDG reliability data at U. S. nuclear reactors for calendar years 1983 to 1985, the EDGs at DBNPS experience an average reliability of 0.963 per diesel per year. Using this data, it appears that the target EDG reliability (0.95) selected (10) and committed (12) to by the licensee is appropriate. However, an audit may be required to ensure compliance, and to identify whether the DBNPS has any formal EDG reliability program consistent with the guidance of the RG 1.155, Section 1.2, and NUMARC 87-00, Appendix D.

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 U.S., indicates that DBNPS did not have any symptomatic grid-related LOOP prior to the calendar

year 1984. In the absence of any information, we agree with the licensee's statement.

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

3.2 Alternate AC (AAC) Power Source

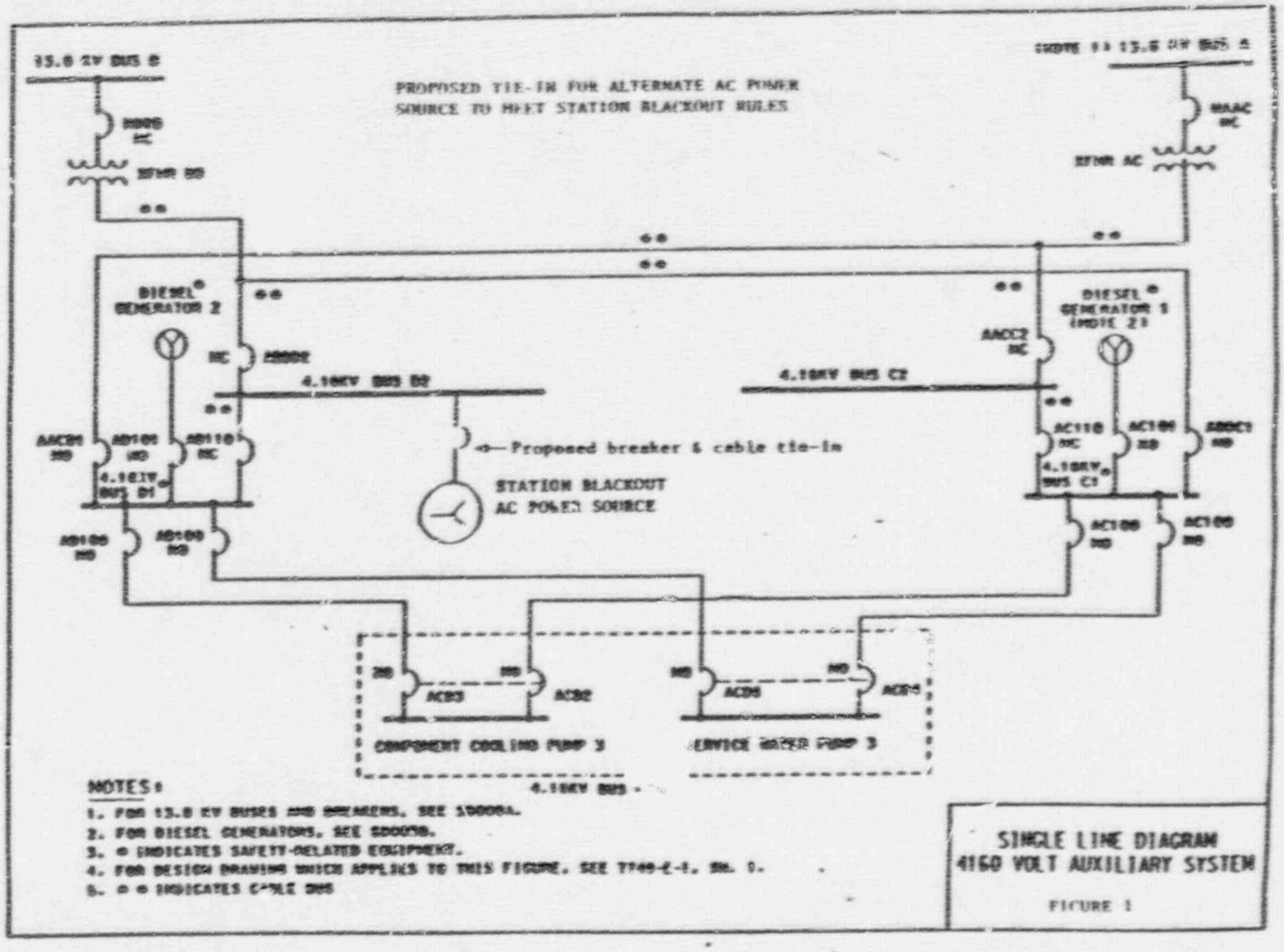
Licensee's Submittal

The licensee proposes to install a diesel generator (DG) as an AAC power source, see Figure 1 (10). The licensee stated that, once the modifications are completed, the AAC power source will meet the criteria specified in Appendix B to NUMARC 87-00. The AAC power source will be available within ten minutes of the onset of an SBO event, and will have sufficient capacity and capability to operate systems necessary for coping with an SBO for a four hour duration.

Review of Licensee's Submittal

Although the licensee is committed to install a non-class 1E diesel which meets the criteria specified in Appendix B of NUMARC 87-00, the licensee did not provide any technical information to evaluate the AAC power source. Since the AAC is available within 10 minutes and no AC-independent coping has been performed, it is assumed that the AAC source will power all the required functions during an SBO event. Our estimate of the SBO loads indicate that the proposed AAC power source should have approximately the same capacity as the present EDGs. If the proposed AAC power source is of less capacity than the present EDGs, then the licensee needs to provide analysis of the required loads for the SBO event. In addition, in the interest of safety it is preferred that the proposed AAC power source be capable of being connected to both essential division buses. The present configuration shows that the proposed AAC is only capable of being connected to one division.

Figure 1


PROPOSED TIE-IN FOR ALTERNATE AC POWER SOURCE TO MEET STATION BLACKOUT RULES
DIESEL GENERATOR 2
DIESEL GENERATOR 1
4.16KV BUS D2
4.16KV BUS C2
Proposed breaker & cable tie-in
STATION BLACKOUT AC POWER SOURCE
COMPONENT COOLING PUMP 3
SERVICE WATER PUMP 3
4.16KV BUS
NOTES:
1. FOR 13.8 KV BUSES AND BREAKERS, SEE 10008A.
2. FOR DIESEL GENERATORS, SEE 20007B.
3. ⊙ INDICATES SAFETY-RELATED EQUIPMENT.
4. FOR DESIGN DRAWING WHICH APPLIES TO THIS FIGURE, SEE 7749-E-1, SH. 9.
5. ⊙ ⊙ INDICATES CABLE BUS
SINGLE LINE DIAGRAM
4160 VOLT AUXILIARY SYSTEM
FIGURE 1

3.3 Station Blackout Coping Capability

The licensee stated that since the proposed AAC power source will be available within 10 minutes, the coping evaluations for class 1E battery capacity, compressed air, and containment isolation need not to be addressed in accordance with 10 CFR 50.63(c)(2). We consider the licensee's statement to mean that the functions needed to cope with an SBO are available, and they are adequately powered from the proposed AAC power source for the required duration. The plant coping capability with an SBO event for the required duration of four hours is assessed based on the following results:

1 Condensate Inventory for Decay Heat Removal

Licensee's Submittal

The licensee's submittal stated that ~62,000 gallons of water are required for the decay heat removal during the four hour coping period. The minimum permissible condensate storage tank level per technical specifications provides 250,000 gallons of water, which exceeds the required quantity for coping with a 4-hour SBO event.

Review of Licensee's Submittal

The licensee stated that ~62,000 gallons of water are needed for decay heat removal during a 4-hour SBO event. Using the expression provided in NUMARC 87-00, we have estimated that the water required for removing decay heat would be ~62,600 gallons. This estimate is based on a maximum licensed core thermal rating of 2827 MWt, or 102% of 2772 MWt (Table 15.2.5-1 of the plant USAR).

Based on the above, the site would need a minimum of ~62,600 gallons of condensate water to provide assurance of decay heat removal during an SBO event. The licensee stated that the plant technical specifications require a minimum condensate level of

25[illegible],000 gallons be available in the condensate storage tanks. Therefore, we agree with the licensee that the site has sufficient condensate to cope with an SBO of four hours duration.

2. Class 1E Battery Capacity

Licensee's Submittal

Since the AAC power source will be available within 10 minutes of the onset of an SBO event, no analysis of class 1E battery capacity calculation is provided.

Review of Licensee's Submittal

According to the USAR, DBNPS is equipped with four station batteries which are arranged to form two independent DC systems. Each of the two station battery systems has been sized to supply the anticipated DC and instrument AC supply for one hour after the loss of the battery charger supply. The loads and operating requirements during the worst case accident, (a LOOP, and a LOCA) with no AC power available, require a battery with a one-hour capacity of 600 Ampere Hours (AH) and a one minute rating of 1360 Amperes (the capacity and ampere rating of all four batteries is based on the battery with the largest load). The station batte[illegible]ave a one-hour capacity of 750 AH, and a one minute ratin[illegible] of 1600 Amperes, which appears to have sufficient capacity to satisfy the SBO load for the first 10 minutes prior to the powering of the battery chargers. With the proposed AAC power source available and powering the necessary battery chargers within 10 minutes, the operating station battery will have sufficient capacity to carry the intermediate time for the 4-hour SBO load.

3. Compressed Air

Licensee's Submittal

Since the AAC power source will be available within 10 minutes and power the plant air system, no analysis of the compressed air system is provided.

Review of Licensee's Submittal

A review of the EDG Load Tables (USAR Table 8.3-1) indicates that the emergency instrument air (EIA) compressor will be powered. This means that the compressor is connected to an essential bus and it is, therefore, expected to be powered from the proposed AAC power source during an SBO event. Since the present configuration of the proposed AAC power source is only capable of being connected to one division of emergency buses, the licensee needs to verify that EIA is powered.

4. Effects of Loss of Ventilation

Licensee's Submittal

The licensee stated that the AAC power source provides power to heating, ventilation and air conditioning (HVAC) systems serving the dominant areas of concern. Therefore, consistent with the NUMARC 87-00, Sections 7.2.4 and 7.1.2, the effects of loss of ventilation were not assessed. The licensee added that no modifications and/or procedures are required to provide reasonable assurance for operability of ventilation equipment.

Review of Licensee's Submittal

The licensee's action is consistent with the guidance provided by NUMARC and NRC. We would like to emphasize that the dominant areas of concern should not be limited to those identified in NUMARC 87-00. The licensee needs to ensure that other areas which have heat generation sources, i.e., operating equipment, are provided with appropriate area cooling.

5. Containment Isolation

Licensee's Submittal

The licensee stated that the AAC power source will be available within 10 minutes. Therefore, no analysis of the containment isolation valves (CIVs) is necessary for the SBO.

Review of Licensee's Submittal

The licensee's action is consistent with the guidance of NUMARC 87-00, Section 7.1.2. This is based on the assumption that the proposed AAC power source is available to CIVs requiring closure capability during an SBO event. The single line diagram, see Figure 1, indicates that the proposed AAC power source will be available to power one division of essential buses. The licensee needs to determine if appropriate containment integrity can be assured with the AAC power source available only to one division.

6. Reactor Coolant Inventory

Licensee's Submittal

The licensee stated that the AAC source powers the necessary make-up systems to maintain adequate reactor coolant system (RCS)

inventory to ensure that the core is cooled for the required coping duration.

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 25 gpm). The make-up, or the charging, system at DBNPS has two centrifugal pumps. Each pump has a design flow capacity of 150 gpm. Therefore, one charging pump would be able to replenish the assumed 125 gpm RCS leakage without loss of inventory, assuming that no shrinkage occurs.

3.4 Proposed Procedures and Training

Licensee's Submittal

The licensee stated that the following plant procedures have been reviewed per guidelines in NUMARC 87-00, Section 4:

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

The licensee listed the name(s) of the plant procedures in each of the above categories in the plant SBO submittal. The licensee stated that these procedures will be revised, if necessary, to meet NUMARC 87-00 guidelines.

Review of Licensee's Submittal

We neither received nor reviewed the affected SBO procedures. We consider these procedures as plant specific actions concerning the

required activities to cope with an SBO. We believe that it is the licensee 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 Modifications

Licensee's Submittal

The licensee has proposed to install an AAC power source consisting of a non-class 1E diesel generator and required support systems with indications and controls to allow remote operation from the control room. The modifications are currently planned to be completed during seventh refueling scheduled to begin September 1, 1991. The licensee stated that, once modifications are completed, this proposed AAC power source will meet the criteria specified in Appendix B to NUMARC 87-00. Procedures for operation, maintenance, surveillance, and testing of the AAC power source will be revised or created as necessary.

Review of Licensee's Submittal

The licensee did not provide technical information on the proposed modifications to review. We believe the proposed modifications enhance the plant ability to cope with an SBO event. We have one concern, however. Although neither NUMARC 87-00 nor RG 1.155 specifies that the AAC power source be connectible to both divisions of essential buses, we believe this connectiblity provides a flexibility that would not be available otherwise. It is true that we should not consider any other equipment failures during an SBO event. However, should one of the required equipment on one division be out for maintenance the redundant equipment can be made operational on the other division only if such connectiblity exists. The present configuration shows that the proposed AAC is only capable of being connected to one division.

3.6 Quality Assurance and Technical Specifications

The licensee did not provide any information on how the plant complies with the requirement of RG 1.155, Appendices A and B.

4.0 CONCLUSIONS

Based on our review of the licensee's submittals and the information available in the USAR for Davis-Besse Nuclear Power Station, we find that the submittal conforms with the requirements of the SBO rules and the guidance of RG 1.155 with the following exceptions:

1. **Emergency Diesel Generator Reliability Program**

   The licensee's submittal does not document the conformance of the plant's EDG reliability program with the guidance of the RG 1.155, Section 1.2 and NUMARC 87-00, Appendix D. However, it is committed to maintain the targeted EDG reliability of 0.95.

2. **AAC Power Source**

   Although the licensee is committed to install a non-class 1E diesel which meets the criteria specified in Appendix B of NUMARC 87-00, the licensee did not provide any technical information to evaluate the AAC power source. Since the AAC is available within 10 minutes and no AC-independent coping has been performed, it is assumed that the AAC source will power all the required functions during an SBO event. Our estimate of the SBO loads indicate that the proposed AAC power source should have approximately the same capacity of the present EDGs. If the proposed AAC power source is of less capacity than the present EDGs, then the licensee needs to provide analysis of the required loads for the SBO event. In addition, in the interest of safety it is preferred that the proposed AAC power source be capable of being connected to both essential division buses. The present configuration shows that the proposed AAC is only capable of being connected to one division.

3. Effects of Loss of Ventilation

The licensee states that the AAC power source will be available within 10 minutes and provides power to HVAC systems serving the dominant areas of concern. We would like to emphasize that the dominant areas of concern should not be limited to those identified in NUMARC 87-00. The licensee needs to ensure that other areas which house operating systems are provided with appropriate cooling.

4. Proposed Modification

The licensee did not provide technical information on the AAC power source, therefore no review can be performed (see also item 2. above).

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. Shelton, D. C., letter to the Document Control Desk of the U.S. Nuclear Regulatory Commission, "Response to Station Blackout Rule," Docket No. 50-346, License No. NPF-3, Serial No. 1651, dated April 17, 1989.

11. Davis-Besse Nuclear Power Station Updated Safety Analysis Report.

12. Shelton, D. C., letter to the Document Control Desk of the U.S. Nuclear Regulatory Commission, "Supplemental Station Blackout Response for Davis-Besse," Docket No. 50-346, License No. NPF-3, Serial No. 1651, dated April 2, 1990.

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

14. 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).