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TECHNICAL EVALUATION REPORT
SURRY POWER STATION UNITS 1 AND 2
STATION BLACKOUT EVALUATION

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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 the 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 (15) 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 Regulatory Guide 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 a review of the licensee's submittals dated April 17 and 20, 1989 (11 and 21), March 30, 1990 (12), and August 1, 1990 (16),a telephone conversation on July 3, 1990, and the available information in the plant Updated Final Safety Analysis Report (UFSAR) (13); 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, Virginia Electric and Power Company (VEPCO), calculated (11, 12, and 16) a minimum acceptable station blackout duration of four hours for Surry Power Station Units 1 and 2. The licensee stated that in order to attain this coping duration a new class 1E diesel generator will be added to the site. The licensee also proposes to modify the existing 4.16 kV emergency switchgear to provide two dedicated emergency diesel generators (EDGs) per unit, see Section 3.5.

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

1. **Offsite Power Design Characteristics**

   The plant AC power design characteristic group is "P2*" based on:

   a. Independence of the plant off site 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) places the plant in ESW group "4,"

   d. Estimated frequency of LOOPs due to severe weather (SW) places the plant in SW group "1," and

   e. Implementation of a plant-specific pre-hurricane shutdown requirements and procedures which meet the guidance provided in NUMARC 87-00.

2. **Emergency AC (EAC) Power Configuration Group**

The EAC power configuration of the plant is "C." The Surry power station, after the modification, will have two dedicated EDGs per unit. One EDG per unit is necessary to operate safe shutdown equipment following a LOOP.

3. **Target Emergency Diesel Generator Reliability**

The licensee has selected a target EDG reliability of 0.95 based on having a nuclear unit average EDG reliability of greater than 0.95 for the last 100 demands. The licensee has stated that an EDG reliability program is in place which is consistent with RG 1.155, Section 1.2.

Review Of Licensee's Submittal

The factors which affect the estimation of the required SBO coping duration are: the independence of offsite power system, the estimated frequency of LOOPs due to the severe and extremely severe weather conditions, the estimated grid-related LOOP, the classification of EAC, and the selection of EDG target reliability. The licensee's estimated frequency of LOOPs due to ESW conditions conforms with that given in Table 3-2 of NUMARC 87-00. Using the data provided in Table 3-3 of NUMARC 87-00, the expected frequency of LOOPs due to SW conditions is estimated to be "0.0054" or "0.0028." This is based on the site having offsite power transmission lines on one, or multiple rights-of-way placing the site in SW group "2" or "1," respectively. The licensee stated (16) that offsite power transmission lines are routed through multiple rights-of-way which are separated by at least 1/4 mile at a point one mile from the site. Based on this information, we agree with the licensee that the site SW group is "1."

The licensee stated that the independence of the offsite power system grouping is "I1/2." A review of the Surry power station UFSAR indicates that:

1. All offsite power sources are connected to the plant through two electrically connected switchyards (500 kV and 230 kV).

2. Each circuit feeding an emergency bus through an auto-transformer will automatically switch to another transformer in the event of an auto-transformer becoming inoperable.

3. At each unit, there two divisions of 4.16 kV emergency buses, each division is normally powered from a separate and independent offsite power source through a reserve station service transformer (RSST), see Figure 1 (21).

4. Upon the loss of RSST "A" or "B," power can be transferred through either transfer bus "D" or "E" using a proposed new manual non-safety grade cross-tie which enables the direct connection of emergency bus 1J to emergency bus 2H.

5. Upon the loss of RSST "C," the connected emergency buses (Bus 1H or 2J) can only be powered by backfeeding through either circuit breaker 15H1 or 25H1 from emergency bus 1J or 2H, respectively. This means of providing power does not conform to the operating guidance regarding the independence of the emergency trains in a unit.

We do not agree with the licensee's statement in the August 1, 1990 submittal (16) that the two switchyards are electrically independent. A review of Figure 8.3-1 of the Surry UFSAR indicates that the emergency busses in both units are normally powered from auto-transformers 1 and 2. These auto transformers connect the two switchyards. Therefore, the switchyards are electrically connected and can not be considered as independent.

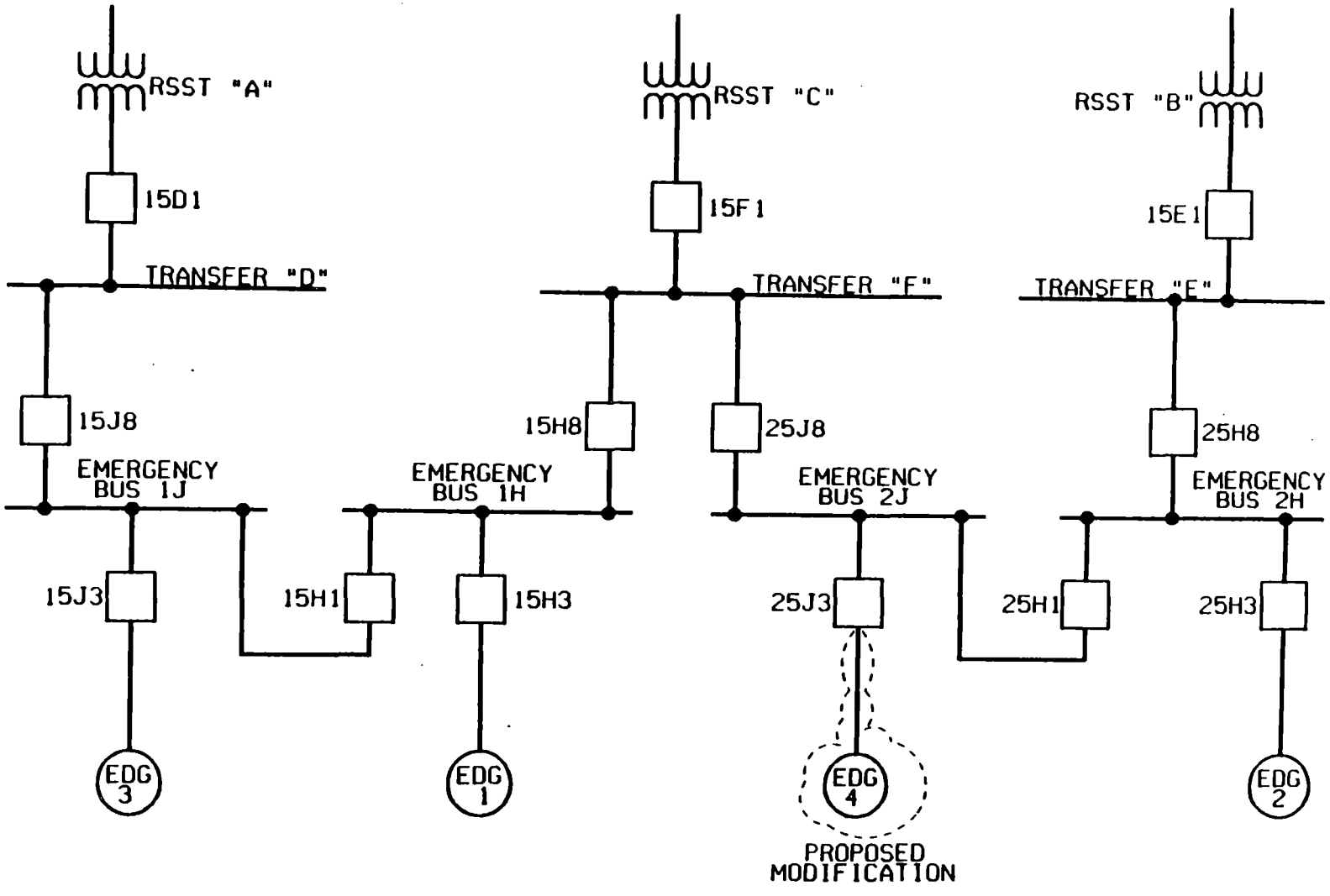

FIGURE 1

SURRY POWER STATION

Using the guidance provided in Table 5 of RG 1.155 the independence of the offsite power system grouping is "I3." This conclusion is driven by the configuration discussed in item 5 above.

The licensee stated that, after the addition of a new class 1E diesel generator, each unit at the Surry Power Station will be equipped with two EDGs where only one is required to power the safe shutdown equipment for each unit after a LOOP. Therefore, we agree with the licensee's EAC classification of "C" for each unit.

The licensee's statement of nuclear unit average EDG reliability of greater than 0.95 for the last 100 demands as a justification for selecting a target EDG reliability of 0.95 is in conformance with both NUMARC 87-00 and RG 1.155. The licensee stated (16) a reliability program consistent with the position C.1.2 of RG 1.155 is in place to maintain the targeted EDG reliability. Since the information supporting the above claims is only available onsite for review, an audit may be required to confirm compliance.

With regard to the expected frequency of grid-related LOOPs at the site, we cannot 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 the Surry station did not have any grid-related LOOPs prior to the calendar year 1984. This time period does not include the last six years of operation of the Surry Power Station. However, in the absence of any contradicting information, we agree with the licensee's statement.

Based on the above, the offsite power design characteristics of the site is "P2." The licensee stated that plant specific pre-hurricane shutdown requirements and procedures will be implemented consistent with the guidelines of Section 4.2.3 of NUMARC 87-00. This implementation, however, will not change the classification to "P2*" per NUMARC 87-00 Table 3-6b due to the "I3" classification of independence of offsite

power grouping. Therefore, the Surry power station needs to cope with an 8-hour SBO event with a selected target EDG reliability of 0.95.

3.2 Alternate Ac (AAC) Power Source

Licensee's Submittal

The licensee stated that the AAC power source at Surry will be from one of the four EDGs at the site. This AAC power source will be available to the blacked out unit within one hour of an SBO event and has sufficient capacity and capability for coping with an SBO for four hours while maintaining and bringing both units to safe shutdown conditions. The proposed AAC power configuration is shown in Figure 1.

Review of Licensee Submittal

The licensee's proposed AAC power source configuration, see Figure 1, conforms to a variation of an acceptable configuration provided in NUMARC 87-00, and NUMARC 87-00 Supplemental Questions/Answers under Question C.1 (15). The AAC power source, one of the site EDGs, meets all the required criteria in Appendix B of NUMARC 87-00 except for the following cases:

- Paragraph B.9 of Appendix B states, "the AAC power source shall be ... **capable of maintaining voltage and frequency within limits consistent with established industry standard that will not degrade the performance of any shutdown system or component. At a multi-unit site, except for 1/2 Shared or 2/3 emergency AC power configuration, an adjacent unit's Class 1E power source may be used as an AAC power source for the blacked-out unit if it is capable of powering the required loads at both units."**

- Paragraph B.12 of Appendix B states, " ... **the AAC system shall be demonstrated by initial test to be capable of powering required shutdown equipment within one hour of a station blackout event."**

The guidance on the use of existing EDGs as AAC power sources at multi-unit sites is documented in RG 1.155, Section 3.3.5, NUMARC 87-00, Section 2.3.1(3), NUMARC 87-00 Supplemental Questions/Answers, Question 3.4 and B.3, and further detailed in References 18, 19, and 20. In addition, the SBO rule states that at multi-unit sites where the combination of EAC power sources *'exceeds the minimum redundancy requirements for safe shutdown (non-DBA) of all units, the remaining EAC sources may be used as AAC sources'* provided that they meet the applicable requirements.

The rule statement requires *'minimum redundancy.'* This means that in order for an EDG to qualify as an AAC source there must be an EDG available in the NBO unit in addition to the number of EDGs required to meet the minimum EDG redundancy requirement for powering a normal safe shutdown loads following a LOOP event. Thus, the EDGs in a two-unit site with two dedicated EDGs per unit would not qualify as AAC sources. Two EDGs per unit would meet only the minimum redundancy requirement, and there is no excess EDG.

However, there are some plants at multi-unit sites which have EDGs that just meet the minimum redundancy but each EDG has sufficient capacity to power all the normal LOOP loads of the NBO unit and also has sufficient excess capacity to power the required safe shutdown loads of the SBO unit. Recognizing the existence of this type of situation, the staff has interpreted the *'literal'* excess EDG redundancy requirement of the SBO rule to allow large capacity EDGs to qualify as AAC sources, provided other applicable requirements are met.

In order to take credit for this interpretation, the NRC staff's basic position has been (18, 19, and 20) that:

1. no action should be taken that would exacerbate the already difficult situation in the NBO unit. Any actions that make operator tasks more difficult such as load switching or disablement of information readouts or alarms in the control room

are also considered to be a degradation of normal safe shutdown capability for LOOP in the NBO unit. And,

2. excess capacity of the EDG being designated as an AAC source should not be the capacity made available by shedding or not powering normal safe shutdown loads in the NBO unit. Examples of such loads are: motor driven auxiliary feedwater pumps; heating, ventilation and air conditioning loads; the power supply of the plant computer; one or more sets of redundant instrumentation; etc. The shedding of such loads constitutes degradation of the normal safe shutdown capability of the NBO unit.

It is not in the interest of safety to reduce the capability to handle various eventualities in one unit for the purpose of meeting the SBO rule in another unit. Each unit must meet the SBO rule on its own merits without reducing another unit's capability to respond to its own potential problems.

The excess capacity of the EDG in the NBO unit that qualifies it as an AAC source is, therefore, *'only that available capacity within the normal continuous rating but above the EDG load represented by the complete contingent of safety related and non-safety related loads normally expected to be available for the LOOP condition.'*

In its SBO supplemental response (16), the licensee provided a list of EDG loadings, both NBO and SBO loads, that are expected to be carried by one EDG. On the NBO load list, the licensee did not consider the load requirements associated with the residual heat removal (RHR) pump (215 kW) and turbine generator oil pump (45 kW). The licensee identified the following SBO loads: two battery chargers and associated loads (150 kW), air conditioning unit for the emergency switchgear room (15 kW), transformer loss (25 kW), and instrument air compressor (15 kW), for a total of 205 kW. The licensee stated that the instrument air compressors are powered from emergency buses 1J and 2J, therefore, an

air compressor may not be available until the electrical cross-tie is made.

To conform with the guidance stated above, the licensee needs to consider the load requirements associated with the RHR pump (215 kW), turbine generator oil pump (15 kW), and the air compressor (15 kW) as part of the required loads at the NBO unit. If we were to add this load, an additional of 275 kW, to the licensee's identified loads on the NBO unit, then the total NBO loads (2742 kW) will only be 8 kW less than the 2000 hour rating (2750 kW) of each EDG. Therefore, the site EDGs can not be considered as a viable AAC power source for the blacked out unit.

Based on the above, we conclude that the licensee's proposed AAC power source does not conform to the requirements of the SBO rule, and the licensee needs to provide an alternate power source to support the required SBO loads identified in its submittal.

3.3 Station Blackout Coping Capability

The plant coping capability with a station blackout for the required duration of eight hours is assessed based on the following results:

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

Licensee's submittal

The licensee stated that 56,495 gallons of water are required for decay heat removal for the proposed SBO duration of four hours. The minimum available water in the Emergency Condensate Storage Tank (ECST) per technical specifications is 110,000 gallons per unit. This volume of water exceeds the required quantity to cope with a SBO of 4-hour duration. The licensee stated that no plant modifications or procedure changes are needed to utilize this water source.

Review of Licensee's Submittal

The licensee estimated the needed condensate inventory for decay heat removal during a 4-hour SBO duration using a generic equation given in NUMARC 87-00. The licensee stated that the plant will be maintained in a hot standby condition during the SBO event.

For the purpose of this review we used data from Branch Technical Position ASB 9-2, "Residual Decay Heat Release Rate for Light Water Reactors," (14) to estimate the needed water to maintain hot standby condition for an 8-hour SBO event. Based on a maximum reactor thermal power of 2,700 MWt (102% of thermal power), we estimated that ~96,000 gallons of condensate would be needed to remove decay heat during an 8-hour SBO event. A review of the plant UFSAR (revision 6/90) indicates that the minimum ECST tank level per technical specifications is 96,000 during plant operation rather than the 110,000 gallons the licensee stated in its submittal. Although both volumes meet the required quantity, the licensee needs to clarify this difference. In addition, the licensee needs to describe the operability of the decay heat removal system in the absence of sufficient AC and DC power sources during an SBO event (see Section 3.2 above and item 2 below).

2. **Class 1E Battery Capacity**

Licensee's Submittal

The licensee stated in the August 1, 1990 submittal (16) that the station batteries are designed for a two-hour duty cycle without being charged. In accordance with normal LOOP procedures, the batteries not connected to the AAC powered charger will be disconnected from vital bus inverters. One station battery and two associated vital bus inverters will be charged from the AAC

power source and will remain operational for the required duration of the event.

Review of Licensee's Submittal

Since the AAC power source does not meet the guidance for the SBO rule, the assumption that one division of class 1E batteries are charged from AAC source is invalid. To conform with the guidance provided in NUMARC 87-00 Supplemental Questions/Answers, the licensee needs to ensure that the normal battery-backed plant monitoring and electrical system controls remain operational for successfully coping with and recovering from an SBO event. Therefore, the licensee needs to provide a separate AAC power source, or provide additional battery capacity to support the required SBO loads for eight hours without charge.

3. **Compressed Air**

Licensee's Submittal

In the April 17, 1989 (11) and August 1, 1990 (16) SBO submittals, the licensee has stated that all air-operated valves (AOVs) needed for one hour SBO coping can either be operated manually or have sufficient backup sources independent of the preferred and blacked out unit's class 1E power supply. Valves requiring manual operation or that need back-up power sources for operation are identified in plant procedures. Both units operate on a common compressed air system with one instrument air compressor per unit powered from an emergency bus. There are also separate air bottles for critical valves to allow control without a compressor. The licensee stated that a modification will be performed to add air bottles to the steam generator power operated atmospheric relief valves (PORVs) to support the one hour coping capability. An air compressor will be available within one hour after the electrical cross-connect is established.

Review of Licensee's Submittal

Since the air system is common between the units and the compressors are supported from emergency buses, the compressed air will be available within one hour when the electrical cross-connect is established. Based on the licensee's proposed addition of air bottles, the compressed air requirements for the steam generator PORVs appear to be adequately addressed. These PORVs are essential to the decay heat removal process which utilizes "feed-and-bleed" in the secondary side of the steam generators with natural circulation occurring in the primary coolant loops.

4. **Effects of Loss of Ventilation**

Licensee's Submittal

The licensee's calculated post-SBO steady state ambient air temperatures for the plant areas containing SBO equipment is as follows:

Area	Temperature (°F)	
	Final	Initial
Emergency Switchgear Room	179°F (<120°F)*	NP
Charging Pump Cubicle	366°F (<120°F)*	NP
Control Room	187°F (<120°F)*	NP
AFW Pump Room	187°F	NP
Containment	Temperature Rise ~15°F	

* = Temperature when HVAC is available @ 1 hour
NP = Not provided by the licensee

The licensee stated that forced ventilation is required for the control room (common to both units), emergency switchgear (ESR) room (separate rooms for each units), and the charging pump

cubicle during an SBO event. No heating, ventilation, and air conditioning (HVAC) system would be available to auxiliary feedwater (AFW) pump room during an SBO event.

The operability of the SBO response equipment in the dominant areas of concern has been assessed in accordance with Appendix F and the Topical Report to the NUMARC 87-00. The licensee has claimed that opening doors and dampers and initiating appropriate HVAC no later than one hour after the SBO will reduce the emergency switchgear room (ESR), charging pump cubicle and control room temperatures to less than 120°F. The licensee stated that the calculated steady-state temperature [187°F] in the AFW pump rooms can be reduced to 120°F by opening doors and dampers. Therefore, based on NUMARC 87-00 Appendix F and the short operator residence time for valve throttling, the higher AFW pump room temperature is not a problem for operator habitability during an SBO event. In addition, the licensee stated that the ESR and control room HVAC systems will be modified to ensure operation with only one EDG functioning during an SBO event.

Review of Licensee's Submittal

The licensee's submittal dated March 30, 1990 (12) implied that the NUMARC 87-00 method was used for calculating the steady state room ambient air temperature rise in dominant areas of concern. This method is not applicable to an eight hour room heat-up and therefore, a different method needs to be used.

Since the AAC power source does not have sufficient capacity, HVAC is not available in the blacked out unit, and an eight hour room heat-up calculation needs to be performed. This issue only affects those rooms which are not shared between the units.

In addition, the licensee needs to provide additional specific details on anticipated operator actions in the AFW pump room to

justify the acceptability of a 187°F environment. These details need to specifically address the ability of the operator to adequately perform his functions in this room during an SBO event.

The stated containment temperature rise for an SBO event is based on a generic Westinghouse analysis for a large, dry containment. Although this temperature rise appears to be reasonable, the licensee needs to verify that the assumptions used in the generic analysis are consistent with the SBO conditions at Surry nuclear power station.

The licensee's implicit assumption that HVAC operation after one hour will insure a temperature less than 120°F in the control room, ESR, and charging pump cubicle is incorrect. Detailed transient room heat-up calculations have shown that most of a room's temperature rise after the loss of HVAC occurs in the first hour. Thus, it is likely that, at one hour, the area temperatures to be almost the same as the final calculated temperatures before the AAC powered HVAC is assumed to be initiated. Therefore, it is expected that calculated final temperatures to be well in excess of 120°F.

Finally, since the proposed AAC power source does not have the capability to power the needed HVAC systems, the licensee needs to re-assess the SBO equipment operability at the calculated final temperatures resulting from the loss of HVAC during an 8-hour SBO event. Further, the licensee needs to justify why there is no mention of opening the control cabinet doors within 30 minutes from the onset of an SBO as guided in NUMARC 87-00 Supplemental Questions/Answers.

5. **Containment Isolation**

Licensee's Submittal

The licensee reviewed the plant list of containment isolation valves to verify that valves which must be capable of being closed or operated (cycled) during a 4-hour SBO duration can be positioned (with indication) independent of the preferred and blacked-out unit's class 1E power supplies. In the August 1, 1990 submittal (16), the licensee provided a tabulation of all applicable containment isolation valves and pertinent design information missing from the Surry UFSAR. The licensee stated that no procedure changes or plant modifications are required to ensure that appropriate containment integrity can be maintained under SBO conditions.

Review of Licensee's submittal

A review of the containment isolation valves (CIVs) was performed using the CIVs identified on Table 5.2-1 of the Surry UFSAR (13) and the associated table in the August 1, 1990 licensee SBO submittal (16). This review was performed in accordance with the criteria delineated in NUMARC 87-00 and RG 1.155. We concur with the licensee's statement that all CIVs which must be capable of being closed or operated (cycled) during the SBO coping duration can be positioned (with indication) independent of the preferred and blacked-out unit's class 1E power supplies.

6. **Reactor Coolant Inventory**

Licensee's Submittal

The licensee stated that a plant-specific analysis resulted in demonstrating that core uncovering would not occur during the one hour period following an SBO. A charging pump in the NBO unit is

started to provide make-up flow to the RCS of both units through a cross-connect line. This charging pump provides sufficient flow to ensure core cooling for the SBO period.

Review of Licensee's Submittal

We performed an independent evaluation to assess the reactor coolant inventory depletion. This evaluation considered the volume of water above the core available for leakage prior to core uncovering and the charging pump capacity at normal expected RCS pressure as compared to the leakage rate from both units. The blacked out unit requires a charging flow rate of 100 gpm, 25 gpm per pump for seal leak and an assumed 25 gpm for the maximum allowed technical specification leak rate, for maintaining the RCS inventory. The NBO unit requires a charging flow to replenish the losses from the nominal seal leakage from pumps and the level shrink caused by cooldown. At each unit there are three charging pumps, each with a design flow rate capacity of 150 gpm. Therefore, one charging pump has sufficient capacity to maintain the RCS inventory at the NBO unit and prevent core uncovering at the blacked out unit provided that the reactor at the NBO unit is also kept at hot standby condition during an SBO event. However, the licensee needs to justify the adequacy of this method for maintaining the RCS water level above the core without the benefit of instrumentation or DC power in the blacked out unit after two hours when the batteries are depleted.

3.4 Proposed Procedures and Training

Licensee's Submittal

The licensee stated that the following procedures have been reviewed against the guidance of NUMARC 87-00, Section 4, and have been or will be modified where necessary:

1. AC power restoration including the Virginia Power Transmission System Restoration Plan.

2. Hurricane shutdown procedure including Station Procedure AP-37.0, "Abnormal Environmental Conditions."

3. Station blackout response including implementation of the AAC source to achieve safe shutdown.

4. Station ECA-1 Series (Emergency Contingency Action) procedures based on Westinghouse generic procedures changed in accordance with NUMARC 87-00 for SBO "defense-in-depth".

5. Power restoration to a de-energized emergency bus procedures.

6. Procedures for using the proposed new manual cross-tie between transfer busses D and E and operator flexibility in electrical load selection consistent with plant conditions and the 2000 hour rating of the EDG.

The licensee stated that all of the aforementioned procedure changes will be implemented within two years after a notification is received from the NRC in accordance with 10 CFR 50.63(c)(3).

Review of Licensee's Submittal

We neither received nor reviewed the affected procedures. These procedures are plant specific actions concerning the required activities to cope with an SBO. We believe 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 Modifications

Licensee's Submittal

The licensee has proposed the following modifications:

1. addition of a new class 1E diesel generator,

2. installation of a new cross-tie between transfer Buses "D" and "E," see Figure 1,

3. addition of air bottles to the steam generator PORVs, and

4. improvement to the control room and emergency switchgear room HVAC systems to allow their operations with any operating EDG.

The licensee stated that the modifications of procedures are to be implemented within two years after a notification is provided by the staff in accordance with 10 CFR 50.63 (c)(3). In the licensee's August 1, 1990 submittal (16), it was also stated that other modifications would be performed on a schedule dependent on NRC approval and the subsequent refueling outage schedule.

Review of Licensee's Submittal

Our review finds the above modifications to be essential for the plant to cope with an SBO event. Addition of a new EDG lowers the requirement on the target EDG reliability for the same coping duration. The cross-tie connection between the transfer Buses "E" and "D" creates an acceptable path for powering an air compressor from operating EDGs. The addition of air bottles allows operation of the PORVs for releasing decay heat to the atmosphere.

Our review also identifies another potential modification which has a potential impact on minimum coping duration. Cross-ties between

transfer Buses "D" and "F" and Buses "E" and "F," (see Figure 1), would allow the site to be classified as "I2" and "P2*" with a required coping duration of four hours instead of eight hours.

Finally, the licensee needs to provide details of the required modifications for the staff's review.

3.6 Quality Assurance And Technical Specifications

The licensee's submittals do not document the conformance of the plant's SBO equipment to the guidance of RG 1.155, Appendices A and B.

4.0 CONCLUSIONS

Based on our review of the licensee's submittals and the related supporting documents and discussions for the Surry Power Station Units 1 and 2, we find that the submittal does not conform to the requirements of the SBO rule and the guidance of RG 1.155 for the following reasons:

1. Offsite Power Design Characteristics

The licensee classifies the site as "I1/2" and "P2*" with a required coping duration of four hours based on a 0.95 EDG target reliability. Our review indicates that the site is "I3," since upon loss of power from RSST "C" (preferred power source) only one division of emergency buses can be powered. The RG 1.155 position is that both division of emergency buses be powered from the alternate power source. With "I3" classification the site offsite power design characteristic is "P2" with a required coping duration of eight hours. The licensee can use an EDG target reliability of 0.975 and reduce the required coping duration to four hours.

2. Alternate AC Power Source

The licensee's proposed load shedding of the non-blacked-out (NBO) unit is not in conformance with the requirements of the SBO rule and the guidelines provided in RG 1.155, NUMARC 87-00 Supplemental Questions/Answers. The load shedding scheme will result in the degradation of the LOOP safe shutdown capability of the NBO unit. The excess capacity made available by load shedding could not be credited as an AAC source for the blacked out unit (see the discussion under the AAC power source in Section 3.2). Therefore, the AAC power source does not have sufficient capacity to power the selected safe shutdown equipment in the blacked out unit.

3. **Condensate Inventory for Decay Heat Removal**

Although sufficient condensate inventory exists for each unit in the emergency condensate storage tanks, the ability of the auxiliary feedwater system to provide that water to the steam generators is in doubt due to the lack of DC power for control and instrumentation, resulting from insufficient AAC capacity (see items 2 and 4).

4. **Class 1E Battery Capacity**

The licensee states that each class 1E battery will last for two hours without being charged. However, the batteries are needed to supply the connected loads for eight hours. Since the proposed AAC power source does not conform to the requirements of the SBO rule, the assumption that one division of the Class 1E batteries will be charged from the AAC source is invalid. Therefore the licensee needs to provide a separate AAC power source, or provide additional battery capacity to ensure that the class 1E batteries will last for eight hours without charge. To conform with the guidance provided in NUMARC 87-00 Supplemental Questions/Answers, the licensee needs to ensure that the normal battery-backed plant monitoring and electrical system controls remain operational for successfully coping with and recovering from an SBO event.

5. **Effects of Loss of Ventilation**

The licensee's submittal indicates that the NUMARC 87-00 method was used to calculate the ambient air temperature rise in the dominant areas of concern. This method is only applicable to a four coping plant. The licensee also takes credit from the availability of the AAC powered HVAC to selected areas in the blacked out unit. Since the AAC power source does not conform to the requirements of the SBO rule, the assumption of the availability of the required HVAC is invalid. Therefore, the

licensee needs to re-assess the room heat-up calculations and SBO equipment operability using an appropriate method for an 8-hour SBO event without HVAC, or provide an alternate AAC source. In addition, the acceptability of an AFW pump room at 187°F for operator entry and manual actions needs to be further justified by the licensee. Further, the licensee needs to justify why there is no mention of opening the control cabinet doors within 30 minutes from the onset of an SBO as guided in NUMARC 87-00 Supplemental Questions/Answers.

6. **Reactor Coolant Inventory**

The licensee proposes to use a charging pump from the NBO unit to provide the needed RCS make-up in the blacked out unit. Our review indicates that the NBO charging pump has sufficient capacity to maintain an adequate RCS inventory in the SBO unit. However, the licensee needs to justify the adequacy of this method for maintaining the RCS inventory above the core without the benefit of instrumentation or DC power in the blacked out unit.

7. **Proposed Modifications**

Our review indicates that additional modifications are required. The selection of one of the EDGs as an AAC power source does not conform with the requirements of the SBO rule. Therefore, additional modifications are necessary for the Surry power station to become an AAC plant.

8. **Quality Assurance and Technical Specifications**

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

5.0 REFERENCES

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

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15. Thadani, A. C., letter with attachment to A. Marion of NUMARC, "Publicly Noticed Meeting, December 27, 1989," dated January 3, 1990 (confirming "NUMARC 87-00 Supplemental Questions/Answers," December 27, 1987).

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