UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

December 30, 1991

Docket No. 50-397

Mr G. C. Sorensen, Manager
Regulatory Programs
Washington Public Power Supply System
3000 George Washington Way
P.O. Box 968
Richland, Washington 99352

Dear Mr. Sorensen:

SUBJECT: SAFETY EVALUATION OF THE WASHINGTON PUBLIC POWER SUPPLY SYSTEM (WPPSS) NUCLEAR PROJECT NUMBER 2 STATION BLACKOUT ANALYSIS (TAC NO. M68626)

The Station Blackout (SBO) rule requires licensees to submit information as defined in 10 CFR 50.63 and to provide a plan and schedule for conformance to the SBO rule. The Washington Public Power Supply System (WPPSS or the licensee) provided responses to the SBO rule regarding the WPPSS Nuclear Project Number 2 (WNP-2) by letters dated April 17, 1989, March 30, 1990, and June 7, 1990, to the NRC. In addition, a conference call between members of your staff and the NRC staff was held on April 25, 1991. Additional information regarding SBO was provided by your letter dated July 1, 1991.

Your responses were reviewed by the NRC staff and by Science Applications International Corporation (SAIC) under contract to the NRC. SAIC did not review your response of July 1, 1991. Results of this review are documented in the attached Safety Evaluation (SE) and the SAIC Technical Evaluation Report (TER) SAIC-91/6658, "Washington Nuclear Plant Number 2, Station Blackout Evaluation," dated July 15, 1991, (Attachment 1 of Enclosure 1).

Based on our review of your submittals and the SAIC TER, we find that WNP-2 does not conform with the SBO rule, the guidance of Regulatory Guide 1.155, the Nuclear Management and Resources Council (NUMARC) report 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," dated November 1987, and NUMARC 87-00 Supplemental Questions/ Answers and Major Assumptions, dated December 27, 1989 (issued to the industry by NUMARC on January 4, 1990). The areas of non-conformance are identified in the enclosed SE.

In addition, the following areas may require follow-up inspection by the NRC to verify that the implementation of any modifications and the supporting documentations which you may propose as a result of this evaluation are adequate to meet the SBO rule. The staff is developing guidance for this follow-up inspection to verify the following:

a. Hardware and procedural modifications,

b. SBO procedures in accordance with RG 1.155, Position 3.4, and NUMARC 87-00, Section 4,

c. Operator staffing and training to follow the identified actions in the procedures,

d. EDG reliability program meets, as a minimum, the guidelines of RG 1.155,

e. Equipment and components required to cope with an SBO are incorporated in a QA program that meets the guidance of RG 1.155, Appendix A, and

f. Actions taken pertaining to the specific recommendations noted in the SE.

The guidance provided on technical specification (TS) for SBO states that the TS should be consistent with the Interim Commission Policy Statement on TS. The staff has taken the position that TS are required for SBO response equipment. However, the question of how specifications for the SBO requirements will be applied is currently being considered by the NRC on a generic basis in the Technical Specification Improvement Program and remains open at this time. In the interim, plant procedures are expected to reflect the appropriate testing and surveillance requirements to ensure SBO equipment operability. If the staff later determines that TS regarding SBO equipment is warranted, you will be notified on the implementation requirements and guidelines.

A revised response to the SBO rule which addresses the areas of non-conformance should be submitted for our review within 60 days of the receipt of this letter. The issue of conformance to the SBO rule for WNP-2 remains open pending acceptable resolution of the identified non-conformances.

Should you have any questions, please contact me.

Sincerely,

Patricia L. Eng, Project Manager
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Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc w/enclosure:
See next page

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(WNP-2)

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STATION BLACKOUT EVALUATION

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

WNP-2

DOCKET NO. 50-397

1.0 INTRODUCTION

On July 21, 1988, the Code of Federal Regulations, 10 CFR Part 50, was amended to include a new Section 50.63, entitled "Loss of All Alternating Current Power," (Station Blackout). The Station Blackout (SBO) rule requires that each light-water cooled nuclear power plant be able to withstand and recover from an SBO of a specified duration. The SBO rule also requires licensees to submit information as defined in Part 50.63 and to provide a plan and schedule for conformance to the SBO rule. The SBO rule further requires that the baseline assumptions, analyses, and related information be available for NRC review. Guidance for conformance to the SBO rule is provided by (1) Regulatory Guide (RG) 1.155, Station Blackout, (2) The Nuclear Management and Resources Council, Inc. (NUMARC) 87-00, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, and (3) NUMARC 87-00 Supplemental Questions/Answers and Major Assumptions dated December 27, 1989, (issued to the industry by NUMARC on January 4, 1990).

To facilitate the NRC staff's (hereafter referred to as staff) review of licensee responses to the SBO rule, the staff endorsed two generic response formats. One response format is for use by plants proposing to use an Alternate AC (AAC) power source and the other format is for use by plants proposing an AC independent response. The generic response formats provide the staff with a summary of the results from the licensee's analysis of the plant's SBO coping capability. The licensees are expected to verify the accuracy of the results and maintain documentation that supports the stated results Compliance to the SBO rule is verified by a review of the licensee's submittal, an audit review of the supporting documentation as deemed necessary, and possible follow-up NRC inspections to ensure that the licensee has implemented the appropriate hardware and/or procedure modifications that will be required to comply with the SBO rule.

The licensee's responses to the SBO rule were provided by letters from G. C. Sorensen on April 17, 1989, March 30, 1990, and June 7, 1990, to the U.S. Nuclear Regulatory Commission, Document Control Desk. Also, there was a teleconference between representatives of the licensee and the NRC staff on April 25, 1991, and licensee's responses to NRC questions regarding the SBO

submittals were received on May 8, 1991. The licensee provided additional information by letter dated July 1, 1991. The licensee's responses except July 1, 1991 response were reviewed by Science Applications International Corporation (SAIC) under contract to the NRC. The results of the SAIC review are documented by a Technical Evaluation Report (TER) SAIC-91/6658 "WASHINGTON NUCLEAR PLANT NUMBER 2 STATION BLACKOUT EVALUATION" dated July 15, 1991, (Attachment 1).

2.0 EVALUATION

After reviewing the licensee's submittals and the SAIC TER, the staff concurs with the SAIC analysis and conclusions as identified in the SAIC TER (refer to Attachment 1 for details). The staff findings and recommendations are summarized as follows.

2.1 Station Blackout Duration

The licensee has calculated a minimum acceptable SBO duration of 4 hours based on a plant ac power design characteristic Group "P1," an emergency ac (EAC) power configuration Group "C," and a target Emergency Diesel Generator (EDG) reliability of 0.95. The EAC power configuration Group "C" is based on two EDGs not credited as AAC power sources, with one EDG required to operate safe shutdown equipment following a loss of offsite power. The target EDG reliability was based on the Washington Nuclear Plant Number 2 (WNP-2) having an average EDG reliability greater than 0.94 for the last 50 demands. Although this is an acceptable criterion for choosing an EDG target reliability, the guidance of RG 1.155 requires that the EDG statistics for the last 20 and 100 demands also be calculated. The "P1" grouping is based on an independence of offsite power classification of Group "I1/2," a severe weather (SW) classification of Group "1," and an extremely severe weather (ESW) classification of Group "1."

After reviewing the available information in the licensee's submittal, RG 1.155, NUMARC 87-00, and SAIC's TER, the staff agrees with the licensee's calculation of a 4-hour SBO coping duration. However, the results using data from NUMARC 87-00 indicate that WNP-2 belongs to SW Group "2" rather than SW Group "1" as determined by the licensee. This discrepancy does not impact the recommended coping duration and therefore is not an issue.

2.2 Alternate AC (AAC) Power Source

The licensee has proposed to use the division-3 diesel generator as an AAC power source to operate systems necessary for the required SBO coping duration and recovery therefrom.

2.2.1 General staff position on AAC power sources

The definition in 10 CFR 50.2, RG 1.155 and NUMARC 87-00 define AAC power source in terms of four attributes: (1) connections to the offsite or the onsite AC power systems, (2) minimum potential for common cause failure with

offsite power or the onsite emergency AC power sources, (3) timely availability, and (4) required capacity and reliability. More specifically, in regard to the fourth attribute, the SBO Rule reads as follows:

> "(4) Has sufficient capacity and reliability for operation of all systems required for coping with station blackout and for the time required to bring and maintain the plant in safe shutdown (non-design basis accident)."

In view of the variety of types, capacities, capabilities of power sources proposed as AAC sources by various licensees, the staff has characterized proposed AAC power sources as being either optimum, fully capable, or partially capable. This characterization, which relates only to the capacity attribute cited above, was necessary in order to facilitate the staff review of licensee responses to the SBO Rule. It does not invalidate or revoke any of the requirements or guidance applicable to AAC power sources.

An optimum AAC power source design is one that is capable of powering simultaneously both safety trains of normal safe shutdown systems and equipment. Such a design, following actuation of the AAC source, would provide completely redundant normal safe shutdown capability during an SBO and allow recovery from the main control room.

A fully capable AAC power source design is one that is capable of powering at least one complete safety train of normal safe shutdown systems and equipment. This includes decay heat removal, battery charging, HVAC (heating, ventilation, and air conditioning), emergency lighting, and the associated controls and instrumentation. Thus, although redundant capability is not available, a fully capable AAC source would enable attainment of safe shutdown during an SBO and allow recovery from the main control room.

A minimally capable AAC power source design is one that is not capable of powering all (or any) normal safety train related safe shutdown equipment; but it is capable of powering specific equipment that, in conjunction with extensive manual operator actions both inside and outside of the control room, is critical for attaining safe shutdown during an SBO. Appendix R diesels proposed as an AAC source are examples of minimally capable AAC sources. With this design, operability of the main control room could not be assured unless the batteries were sized to operate for the SBO duration, or battery charging capability was provided by the AAC source.

2.2.1.1 Connectability of AAC power sources

The basic criteria governing the connectability of an AAC power source are contained in 10 CFR 50.2 (The AAC source should be connectable to but normally not connected to the offsite or onsite EAC power systems.), and 10 CFR 50.63 (SBO should not assume a concurrent single failure or design basis accident). Therefore, in a one unit site as a minimum an AAC source need only be connectable to one set of safe shutdown equipment, regardless of whether that equipment is part of a safety train or not.

2.2.2 Proposed AC (AAC) Power Source

The licensee proposes to use the division-3 diesel generator as an AAC power source to operate the systems necessary for the required coping duration of 4 hours and recovery therefrom.

The staff conceptually accepts that the division-3 diesel generator could meet the minimally capable AAC source requirements and the connectability criteria of Section 2.2.1.1 above if a cross-connect capability is provided to one of the other full divisions to power the required SBO loads. However, the licensee proposes to use the division-3 diesel generator only to power the HPCS pump and its associated systems. The division-3 diesel generator will not be connectable to other emergency trains, and the licensee did not propose to use the excess capacity to augment the plant's ability to cope with an SBO event. Therefore, the staff would not classify the division-3 diesel generator as an AAC source. However, it is acceptable to the staff to use the division-3 diesel generator to assist in coping during an SBO event. The licensee provided a coping analysis using the "AC-Independent" approach, so the issue of whether the division-3 diesel generator is or is not classified as an AAC source is not relevant.

2.3 Station Blackout Coping Capability

The characteristics of the following plant systems and components were reviewed to assure that the systems have the availability, adequacy, and capability to achieve and maintain a safe shutdown and to recover from an SBO for a 4-hour coping duration.

2.3.1 Condensate Inventory for Decay Heat Removal

The licensee stated that a plant specific analysis was performed using the guidances described in NUMARC 87-00 to determine the condensate required for decay heat removal and using a computer program written specifically for the WNP-2 SBO to determine the condensate required for primary system cooldown. It was determined that 104,226 gallons of condensate were required to cope with an SBO event of 4 hours. The licensee indicated that the Technical Specifications (TS) require a minimum condensate storage tank reserve of 135,000 gallons of water. This minimum level is checked once per shift by procedure. Furthermore, during normal operation verification that the minimum level is exceeded is assured since a low level would cause a loss of condenser vacuum and reactor shutdown.

Based on its review, the staff concludes that the analysis performed by the licensee is acceptable and that there is sufficient condensate water at the WNP-2 plant to cope with an SBO event of 4 hours.

2.3.2 Class 1E Battery Capacity

The licensee stated that the battery capacity calculations have been performed in accordance with NUMARC 87-00, Section 7.2.2, to verify that the 125V Class 1E (B1-1 and B1-2), 250V Class 1E (B2-1), and 250V non-Class 1E (B1-7) batteries have sufficient capacity to meet SBO loads for 4 hours. These calculations were performed using the guidance from IEEE Std. 485. The licensee indicated that the main turbine emergency oil pump and two reactor feed pump (RFP) turbine emergency lube oil pumps will be shed from battery B2-1 within one to two hours following the onset of an SBO per procedure PPM-5.4.1.

The licensee stated that non-safety related computer loads are stripped from the battery B2-1 to limit control room heat-up. The staff does not believe that these loads should be stripped since they provide information to the operators which could assist them in coping with or recovering from an SBO.

The licensee also indicated that the computer equipment load will be shed within 30 minutes from the non-Class 1E battery B1-7 to reduce control room heatup per existing SBO procedure. The B1-7 battery is not relied upon for any coping function.

The review of the battery sizing calculations for SBO loads provided by the licensee reveals the following concerns:

1. The licensee needs to verify that the battery room temperature of 74°F as used in the battery capacity calculations is the lowest anticipated electrolyte temperature during normal operation per NUMARC 87-00, Section 7.2.2.

2. The use of battery terminal voltage (210V or 105V) rather than the mimimum allowable equipment terminal voltage for dc amperes requirements from UPS is nonconservative. The voltage drop between the battery terminal and constant kW load terminal (i.e., inverter, motors) should be considered.

3. The UPS efficiency of 75% appears to be nonconservative since the UPS load is less than 50% of the UPS' rating. (15 kVA UPS loaded to 6.48 kVA and 6.72 kVA).

4. The licensee's calculation used a higher amperes per positive plate (RT = 143.6A and 147.5A for GN-15 and GN-13, respectively) than the batteries can provide. (PER EXIDE Catalog Sections 51-52, these are 922/7 = 131.71A and 817/6 = 136.17A for GN-15 and GN-13, respectively.)

5. A design margin of 10% to 15% as recommended by IEEE Std. 485 should be used.

Based on the above, the staff cannot verify the adequacy of the battery capacity.

Recommendation: The licensee needs to reevaluate the battery capacity adequacy without stripping the computer loads from the Class 1E battery B2-2 and considering the above concerns. The battery capacity verification and any resulting modification should be included in the documentation that is to be maintained by the licensee in support of the SBO submittals and results of this evaluation included in the licensee's revised response to the NRC.

2.3.3 Compressed Air

The licensee stated that no air operated valves are relied upon to cope with an SBO for 4 hours. The safety relief valves (SRVs), which together with high pressure core spray (HPCS) provide for decay heat transfer to the suppression pool, have an adequate nitrogen supply for 4 hours of SRV operation. Each of the SRVs utilized for automatic depressurization is equipped with an air accumulator and check valve arrangement. The accumulators are sized to be capable of opening the valves and holding them open against the maximum drywell pressure of 45 psig. Upon loss of ac power, the gas supply piping will automatically isolate from the normal nitrogen supply and the accumulators' backup compressed gas manifold subsystems will provide 150 psig nitrogen from banks of high pressure compressed nitrogen cylinders.

Based on the above, the staff concludes that the plant has sufficient compressed air for the operation of the needed valves during an SBO event.

2.3.4 Effects of Loss of Ventilation

The licensee has performed analyses to determine the effects of loss of ventilation during an SBO event in the areas containing equipment required to cope with the SBO event. The staff's evaluation of the effects of loss of ventilation in each of these areas is provided below.

2.3.4.1 HPCS Diesel and Electrical Equipment Room, HPCS Pump Room, and HPCS Service Water Pump Room

The licensee indicated that cooling in the HPCS diesel and electrical equipment room and HPCS pump room will be maintained during an SBO event, therefore, these rooms will be areas of no concern. Based on the fact that cooling will be available during an SBO event, the staff agrees with the licensee's conclusion that these rooms will be areas of no concern.

The licensee further indicated that cooling will not be provided to the HPCS service water pump during an SBO event. The calculated final steady state temperature for this room is 151°F. However, the licensee has not discussed the assessment of the operability of the equipment in this room. Therefore, the staff has not been able to conclude that the operability of the equipment at the above calculated temperature (151°F) in the HPCS service water pump room is assured.

Recommendation: The licensee should assess and confirm the operability of the equipment at the above calculated temperature of 151°F in the HPCS service water pump room.

2.3.4.2 Inverter Rooms

The licensee has identified the rooms containing the safety related inverters IN-2 (RPS-1 Room) and IN-3 (RPS-2 Room) and non-safety related inverter IN-5 (Switchgear Room 2) to be areas of concern. The calculated peak temperatures in these rooms during an SBO event are 123°F, 115°F, and 113°F, respectively.

The licensee utilized the NUMARC 87-00 methodology to perform the heat-up analyses for these rooms. The staff finds that the assumptions of inverter efficiencies used in the analyses are non-conservative (see Section 2.3.2). Therefore, the staff has not been able to conclude that the above peak temperatures calculated by the licensee for these inverter rooms are acceptable.

Recommendation: The licensee should reevaluate the temperature rises in the inverter rooms using more conservative inverter efficiencies including the non-safety related computer loads and reassess the equipment operability in these areas at the revised calculated peak temperatures. The results of this reevaluation should be included in the licensee's revised response to the NRC.

2.3.4.3 Control Room

The licensee indicated that the WNP-2 control room heat-up analysis was performed using a transient room heat-up program to benchmark the NUMARC 87-00 methodology. The results of this analysis show that the control room temperature will reach 128°F during an SBO event. The licensee further indicated that operator actions and plant modifications will be pursued to reduce the temperature to 120°F or less in lieu of providing reasonable assurance of operability for SBO equipment at 128°F. The staff will evaluate the licensee's proposed resolution upon submittal and will report its findings in a supplement to the SE.

Recommendation: The licensee should (1) provide a reevaluation of the temperature rises in the control room without stripping the computer loads from the Class 1E battery B2-1 (see Section 2.3.2) and using the TS temperature limit of 85°F as the initial temperature, and (2) provide a procedure in accordance with the guidance described in NUMARC 87-00 for opening the control room cabinet doors within 30 minutes of the onset of an SBO event.

2.3.4.4 Steam Tunnel

The licensee calculated a steam tunnel temperature of 169°F using NUMARC 87-00 methodology. The licensee stated that there is no HPCS and RCIC equipment located in the steam tunnel and that main steamline isolation has been provided consistent with NUMARC 87-00, Section 7.2.5, criterion 2. Therefore, the licensee did not identify the steam tunnel as a DAC. Based on the above, the staff agrees that the temperature of the steam tunnel is not a concern for the WNP-2 SBO coping analysis.

2.3.4.5 RCIC Pump Room

The licensee did not perform a heat-up calculation for the RCIC pump room during an SBO. The licensee claims that no analysis of this room would be needed due to the availability of HPCS, which is supported by its dedicated diesel. The licensee, however, stated that both RCIC and HPCS pumps will be available to maintain the RCS inventory, and the RCIC pump will not be shut down. It is the staff's understanding that the licensee will use RCIC until it fails due to high temperature (no other failure is assumed). Since HPCS can support the functions provided by the RCIC pump, the staff concludes that RCIC failure is of no concern.

2.3.4.6 Containment

The licensee evaluated the containment temperature rise during an SBO event utilizing the GOTHIC computer code. The preliminary analysis indicated a bulk drywell temperature of 240°F at the end of 4 hours. This temperature is less than the qualification temperature for SBO equipment located inside containment. The licensee indicated that this analysis is in the process of verification.

Upon completion of the verification of the analysis, the licensee will inform the NRC if the temperature should significantly increase. After receiving and reviewing this information, the staff will report its findings in a supplement to the SE.

Recommendation: The licensee needs to complete the verification of the containment heat-up analysis during an SBO event and confirm that there is a reasonable assurance of SBO equipment operability at the evaluated temperature in the containment.

2.3.5 Containment Isolation

The licensee stated that the plant list of containment isolation valves (CIVs) had been reviewed to verify that valves which must be capable of being closed or that must be operated (cycled) under SBO conditions can be positioned (with indication) independent of the preferred and blacked out unit's Class 1E power supplies.

The licensee indicated that 222 out of 284 CIVs met one or more of the five exclusion criteria given in RG 1.155 and provided justifications for discounting the need of SBO action for the remaining 62 CIVs. The licensee further stated that no plant modifications or procedure changes are required to ensure appropriate containment integrity under SBO condition.

After reviewing SAIC's TER and the list of containment isolation valves provided by the licensee, the staff concurs with the SAIC TER that there are several sets of valves (see attached TER for details) for which the licensee must take the appropriate action with regard to containment isolation.

Recommendation: The licensee needs to list the valves identified in the attached TER in an appropriate procedure and identify the actions necessary to ensure that these valves can be fully closed during an SBO event. The valves closure needs to be confirmed by position indication (local, mechanical, remote, process information, etc.). This information should also be included with the other documentation that is to be maintained by the licensee in support of the SBO submittals.

2.3.6 Reactor Coolant Inventory

The licensee stated that the Division-3 emergency diesel generator which will be available within ten minutes of the onset of an SBO event, will provide power to the necessary makeup systems to maintain adequate reactor coolant system inventory to ensure that the core is cooled for the 4-hour SBO coping duration. WNP-2 has a dedicated HPCS diesel and a HPCS pump which can supply 1650 gpm of water to the reactor vessel. This exceeds the amount required to replenish the assumed RCS leak rate of 61 gpm (18 gpm per pump plus 25 gpm for the maximum allowed Technical Specification leakage). The licensee further stated that reactor pressure vessel (RPV) level is to be maintained between +13 and +54.5 inches during an SBO using HPCS and/or RCIC, but preferring RCIC. With RCIC operating, the preferred suction path will be from the suppression pool. After reviewing the supporting documentation and SAIC's TER, the staff finds that WNP-2 has sufficient capability to maintain reactor coolant inventory for the 4-hour SBO event. However, if the licensee plans to use the RCIC system for level control, the licensee needs to analyze the effect of the RCIC system on each part of the coping calculation and include the revised coping analysis with the documentation that is to be retained by the licensee in support of the SBO submittal.

The reactor coolant inventory evaluation as discussed above was based on the guidance of NUMARC 87-00 of 18 gpm recirculation pump seal leak rate for boiling water reactors. The 18 gpm 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 recirculation pump seal leak rate than assumed for the RCS inventory evaluation, the licensee should be aware of the potential impact of this resolution on its analysis and actions addressing conformance to the SBO rule.

2.4 Procedures and Training

The licensee stated that the plant procedures will be reviewed and modified, if necessary, to meet the guidelines of NUMARC 87-00, Section 4, in the following areas:

AC power restoration per NUMARC 87-00, Section 4.2.2;
Severe weather per NUMARC 87-00, Section 4.2.3.

The licensee also stated that the plant procedures have been reviewed, and changes necessary to meet NUMARC 87-00 will be implemented in the following area:

> Station Blackout response per NUMARC 87-00, Section 4.2.1;
> Procedure changes associated with any modifications required after assessing coping capability per NUMARC 87-00, Section 7.

The licensee indicated that no plant modifications have been identified due to procedure changes. The licensee stated that these procedure changes will be completed within two years after the issuance of the SE.

The staff did not review the affected procedures or training. The staff expects the licensee to maintain and implement these procedures including any others that may be required to ensure an appropriate response to an SBO event. Although personnel training requirements for an SBO response were not specifically addressed in the licensee's submittals, the staff expects the licensee to implement the appropriate training to ensure an effective response to an SBO.

2.5 Proposed Modifications

The licensee stated in its initial submittal that no modifications to assure a 4-hour coping capability have been identified as being necessary. However, during the course of the technical review, several modifications (replacement of inverters IN-2 and IN-3, design changes to the Containment Nitrogen Inerting System, and removal of ceiling panels in the control room) were identified as being necessary. Also, some modifications may be required as a result of the reevaluation of the effects of loss of ventilation and to resolve other open items as identified in this SE.

Recommendation: The licensee should include a full description including the nature and objectives of the required modifications in the documentation that is to be maintained by the licensee in support of the SBO submittals.

2.6 Quality Assurance and Technical Specifications

The licensee stated that all SBO equipment supported by the division-3 diesel generator is safety grade. [illegible] the suppression pool is a source of safety grade water for HPCS in the event of an SBO, the licensee did not consider the CSTs as SBO equipment. Additionally, the licensee stated that it will provide an SBO quality assurance program only for such equipment that is not in service during normal operation.

The staff agrees with SAIC TER and concludes that all equipment required during an SBO is not covered under an appropriate quality assurance program.

The TS for the SBO equipment are currently being considered generically by the NRC in the context of the TS Improvement Program and remains an open item at this time. However, the staff would expect that the plant procedures will

reflect the appropriate testing and surveillance requirements to ensure the operability of the necessary SBO equipment. If the staff later determines that TS regarding the SBO equipment is warranted, the licensee will be notified of the implementation requirements.

Recommendation: The licensee needs to list all equipment that will be used to provide information and/or to support plant coping during an SBO and should verify that all SBO equipment is covered by an appropriate QA program consistent with the guidance of RG 1.155, Appendix A. Furthermore, this verification should be documented as part of the package supporting the SBO Rule response.

2.7 EDG Reliability Program

The licensee's submittals on SBO did not specifically address the commitment to implement an EDG reliability program to conform to the guidance of RG 1.155, Position 1.2. However, in the submittal of March 30, 1990, the licensee committed to maintain the EDG target reliability of 0.95. The licensee is monitoring the NUMARC and NRC efforts relative to the development of a program to monitor and maintain diesel generator reliability by revision of NUMARC 87-00, Appendix D, "EDG Reliability Program," and the resolution of Generic Issue B-56, "Diesel Generator Reliability." Although the licensee has committed to a reliability program pending resolution of GI B-56, they are required to implement a program that meets as a minimum the guidance of RG 1.155, Position 1.2.

Recommendation: The licensee should provide confirmation and include in the documentation supporting the SBO submittals that a program meeting as a minimum the guidance of RG 1.155, Position 1.2, is in place or will be implemented.

2.8 Scope of Staff Review

The SBO rule (10 CFR 50.63) requires licensees to submit a response containing specifically defined information. It also requires utilities "...to have baseline assumptions, analyses, and related information used in their coping evaluations available for NRC review." The staff and its contractor (SAIC) did not perform a detailed review of any proposed hardware and procedural modifications which are scheduled for later implementation. However, based on our review of the licensee's supporting documentation, we have identified the following areas for focus in any follow-up inspection or assessment that may be undertaken by the NRC to verify conformance with the SBO rule. Additional items may be added as a result of the staff review of the actions taken by the licensee in response to this SE.

a. Hardware and procedural modifications,

b. SBO procedures in accordance with RG 1.155, Position 3.4, and NUMARC 87-00, Section 4,

c. Operator staffing and training to follow the identified actions in the SBO procedures,

d. EDG reliability program meets, as a minimum, the guidelines of RG 1.155,

e. Equipment and components required to cope with an SBO are incorporated in a QA program that meets the guidance of RG 1.155, Appendix A, and

f. Actions taken pertaining to the specific recommendations noted above in the SE.

3.0 SUMMARY AND CONCLUSION

The staff has reviewed the licensee's responses to the SBO rule (10 CFR 50.63) and the TER prepared by the staff's consultant, SAIC. The staff agrees with the licensee's calculation of a 4-hour SBO coping duration. Since the division-3 diesel generator is only being used to power the HPCS system, the staff would not classify the diesel as an AAC power source. However, the licensee provided a coping analysis using the "AC-Independent" approach, so the issue of whether the division-3 diesel generator is or is not classified as an AAC source is not relevant.

Based on the staff's review of the licensee's submittals and the SAIC TER, the staff finds that WNP-2 does not conform with the SBO rule and the guidance of RG 1.155, and therefore recommends that the licensee reevaluate the areas of concern that have been identified in this SE. Guidance for the licensee to review and implement the staff's recommendations is provided in RG 1.155, NUMARC 87-00 and the supplementary guidance (NUMARC 87-00 Supplementary Questions/Answers; NUMARC 87-00 Major Assumptions) dated December 27, 1989, which was issued to the industry by NUMARC on January 4, 1990. The staff's concerns that are identified in this SE should be addressed by the licensee, and a revised response resubmitted to the NRC within 60 days. The licensee is expected to ensure that the baseline assumptions of NUMARC 87-00 are applicable to the WNP-2 plant. Also, the licensee is expected to document all analyses and related information, and verify that these are available for NRC review.

4.0 ATTACHMENT

SAIC-91/6658 "Technical Evaluation Report, Washington Nuclear Plant Number 2, Station Blackout Evaluation," July 15, 1991.

Principal Contributor: A. Pal

Date: December 30, 1991

Attachment: Technical Evaluation Report
Washington Nuclear Plant Number 2
Station Blackout Evaluation

Attachment 1
SAIC-91/6658

TECHNICAL EVALUATION REPORT

WASHINGTON NUCLEAR PLANT NUMBER 2

STATION BLACKOUT EVALUATION

TAC No. 68626

Science Applications International Corporation
An Employee-Owned Company

Final
July 15, 1991

Prepared for:

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

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WASHINGTON NUCLEAR PLANT NUMBER 2
STATION BLACKOUT EVALUATION

1.0 BACKGROUND

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

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

In order to achieve a consistent systematic response from licensees to the SBO rule and to expedite the staff review process, NUMARC developed two generic response documents. These documents were reviewed and endorsed (10) by the NRC staff for the purposes of plant specific submittals. The documents are titled:

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

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

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

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

2.0 REVIEW PROCESS

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

A. Minimum acceptable SBO duration (Section 3.1),

B. SBO coping capability (Section 3.2),

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

D. Proposed modifications (Section 3.3), and

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

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

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

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

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

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

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

e. ability to provide appropriate containment integrity, and

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

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

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

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 preliminary SBO evaluation is based upon the review of the licensee's submittals dated April 17, 1989 (13), March 30, 1990 (14), and June 7, 1990 (15), the licensee's response (16) to questions discussed at the April 25, 1991 telephone conference, and the information available in the plant Updated Final Safety Analysis Report (UFSAR) (12); it does not include a concurrent site audit review of the supporting documentation. Such an audit may be warranted as an additional confirmatory action. This determination would be made and the audit would be scheduled and performed by the NRC staff at some later date.

3.0 EVALUATION

3.1 Proposed Station Blackout Duration

Licensee's Submittal

The licensee, Washington Public Power Supply System, calculated (13, 14) a minimum acceptable station blackout duration of four hours for the Washington Nuclear Plant Number 2 (WNP-2) Plant 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. Off-site 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 "C." WNP-2 is equipped with two emergency diesel generators not credited as AAC power sources. One emergency AC power supply is necessary to operate safe shutdown equipment following a LOOP. The plant is also equipped

with a dedicated diesel which supports the High Pressure Core Spray (HPCS) System, designated as the division-3 diesel.

3. Target Emergency Diesel Generator (EDG) Reliability

The licensee has selected a target EDG reliability of 0.95. The selection of this target reliability is based on having a nuclear unit average EDG reliability of greater than 0.94 for the last 50 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 WNP-2 site in ESW Group "1," which is in agreement with what was stated in the licensee's submittal (13).

Using data from Table 3-3 of NUMARC 87-00, the expected frequency of LOOPs due to SW conditions place the WNP-2 site in SW Group "2." In it's submittal (13), the licensee's calculations placed the WNP-2 site in SW Group "1." The reason for this discrepancy is that the licensee used a site specific value for the expected snowfall per year of 13.2 inches from the plant UFSAR (12), compared to a value of 53 inches listed in Table 3-3 of NUMARC 87-00.

The SW classification was performed assuming that there are multiple rights-of-way among the incoming transmission lines. In response to questions raised during the telephone conference on April 25, 1991, the licensee stated (16) that the switchyards for the 230-kV and 115-kV offsite power sources are electrically independent, being located several miles apart on the same side of the plant. The licensee further stated that all offsite power sources converge in the transformer yard. This assumption can not be verified using

information available in the plant UFSAR (12). This assumption has no impact on the results of the SW grouping classification, however.

The licensee stated that the independence of the plant offsite power system grouping is "I1/2." A review of the WNP-2 UFSAR (12) shows that:

- All offsite power sources are connected to the plant through two electrically independent switchyards;

- During normal operation, offsite power is provided to the essential buses from the main generator through the normal auxiliary power transformers via the main generator;

- Upon loss of power from the main generator, there is an automatic transfer of all essential buses to the preferred 230-kV power source and if that source fails another automatic transfer to the alternate (115 kV) power source.

Based on the above, the plant independence of offsite power system group is "I1." This determination is based on the guidance of Table 5 of RG 1.155.

Establishment of the proper Emergency AC (EAC) Configuration Group is based on the number of available EAC sources and the number of EAC sources required to operate safe shutdown equipment following a LOOP. WNP-2 has two dedicated EAC sources, one of which is required after a LOOP. We agree with the licensee's assessment which places the plant in EAC Group "C."

The licensee selected (13) the EDG target reliability of 0.95 based upon having a nuclear unit average EDG reliability greater than 0.94 for the last 50 demands. Although this is an acceptable criterion for choosing an EDG target reliability, the guidance of RG 1.155 requires that the EDG statistics for the last 20 and 100 demands also be calculated. Without this information, it is difficult to judge how well the EDGs have performed in the past and if there should be any concern. We are unable to verify the demonstrated start and load-run reliability of the plant EDGs. This information is only available

onsite as part of the submittal's supporting documents. Based on the information in NSAC-108, which gives EDG reliability data at US nuclear power plants for the calender years 1983 to 1985, the EDGs at WNP-2 experience an average reliability of 0.965 per diesel per year. The licensee's selection of the EDG target reliability meets the criteria specified in RG 1.155 and NUMARC 87-00. The licensee stated (14) its understanding that this reliability is to be maintained. The licensee also stated that it is reviewing NUMARC and NRC efforts relative to the development of a program to monitor and maintain diesel generator reliability by revision of NUMARC 87-00 Appendix D and the resolution of Generic Issue B-56. The licensee added that when the NUMARC program on this issue is completed, it will be reviewed it for its application to WNP-2. However, the licensee did not state whether the plant has an EDG reliability program which, at a minimum, meets the requirements of RG 1.155 Position 1.2.

With regard to the expected frequency of grid-related LOOPs at the site, we can not confirm the stated results. The available information in NUREG/CR-3992 (3), which gives a compendium of information on the loss of offsite power at nuclear power plants in the U.S., indicates that WNP-2 did not have any symptomatic grid-related LOOP prior to the calender year 1984. In the absence of any contradictory information, we agree with the licensee's statement.

Based on the above, we concur with the licensee that the offsite power design characteristic of the WNP-2 site is "P1" with a minimum required SBO coping duration of four hours. Note that there is a single discrepancy with the licensee claiming to belong to SW Group "1," while the results using data from NUMARC 87-00 indicate that WNP-2 belongs to SW Group "2." This discrepancy does not impact the recommended coping duration, therefore no response is required.

3.2 Alternate AC (AAC) Power Source

Licensee's Statement

The licensee proposes to use the division-3 diesel as an AAC power source. The licensee stated (13) that the AAC power source is available within ten minutes of the onset of an SBO event and has sufficient capacity and capability to operate systems necessary for coping with an SBO for the 4-hour coping duration to bring and maintain the plant in safe shutdown.

The licensee stated (13) that it is currently evaluating design changes to the containment Nitrogen Inerting System (NIS) to reduce the risk that failures of this system represent to the diesels. In a later submittal (14), the licensee stated that one item remaining to be resolved is the risk that a tornado missile may cause the failure of the NIS nitrogen tank resulting in a common-cause failure of all diesels, since the EDGs' combustion air intakes are located near the tank. The licensee added that a dispersion analysis is underway to confirm that the wind which is present following a tornado would be sufficient to dilute and/or disperse the nitrogen cloud, such that the tank does not represent a single-point weather-related event that could disable the onsite emergency AC power sources (the two EDGs) and the AAC power source (the HPCS diesel).

Review of Licensee's Submittal

The proposed AAC power source, the division-3 diesel, has the capability and connectability to power the HPCS pump and its associated systems with minimal excess capacity. This DG will not be connectable to the other emergency trains, and the licensee did not propose to use the excess capacity to augment its ability to cope with an SBO event. Therefore, the division-3 diesel is not an AAC power source. This conclusion was communicated to the licensee during the telephone conversation on April 25, 1991, and the licensee concurred with our conclusion in its response dated May 7, 1991 (16).

With regard to the potential loss of all three diesels due to a tornado and the subsequent rupture of the NIS nitrogen tank, the licensee needs to verify that

the winds will sufficiently dilute or disperse the nitrogen. If this cannot be verified, the licensee needs to perform an analysis of the operability of the RCIC system, to which the HPCS system acts as a back-up, for the 4-hour SBO coping duration.

3.3 Station Blackout Coping Capability

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

1. Condensate Inventory for Decay Heat Removal

Licensee's Submittal

The licensee stated (16) that 104,226 gallons of water are required to remove decay heat during the four-hour coping period. This calculation uses the expression provided in NUMARC 87-00, Section 7.2.1. The licensee assumed a seal leak rate of 25 gpm per pump and a maximum allowable technical specification RCS leakage rate of 25 gpm. The design of the condensate storage tank (CST) and connected piping provides a minimum level of 135,000 gallons of water, which exceeds the required quantity for coping with a 4-hour SBO event. This minimum level is checked once per shift by procedure. Furthermore, during normal operation verification that the minimum level is exceeded is assured, since a low level would cause a loss of condenser vacuum and reactor shutdown.

Review of Licensee's Submittal

Using the expression provided in NUMARC 87-00, we estimated that 73,505 gallons of water would be required to remove decay heat during a 4-hour SBO event, assuming no primary system cooldown. This estimate is based on the maximum licensed core thermal rating of 3373 MWt listed in the WNP-2 UFSAR (12). The licensee indicated that the primary system will be cooled down, requiring an additional 30,721 gallons of condensate. The licensee also accounted for the effects of

RCS seal and technical specification leakage. Although we didn't repeat the licensee's calculations, we concur with the licensee that, based on a minimum available CST volume of 135,000 gallons, the site has sufficient condensate for both decay heat removal and cooldown during a four hour SBO event.

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

Licensee's Submittal

In its initial submittal (13), the licensee stated that a battery capacity calculation has been performed pursuant to NUMARC 87-00, Section 7.2.2 to verify that the non-Division-3, 125- and 250-VDC class-1E batteries have sufficient capacity to meet SBO loads for four hours without any load stripping. The licensee concluded that only the 250-VDC class-1E batteries would require stripping of loads not needed for SBO, and added that these loads are identified in plant procedures.

In its later submittal (14), the licensee provided the following information:

- The battery capacity calculations for the 125-VDC batteries B1-1 and B1-2 were performed in accordance with IEEE-Std 485.

- The need for DC power to close breakers and/or flash the EDG field to re-establish AC was included in each calculation as random loads that can occur anytime during the four hour SBO period.

- Station blackout procedure, PPM 5.4.1, provides for the shedding of computers to limit control room heat-up. This provides a significant load reduction on non-safety related battery B1-7, which provides power to non-safety related breakers to re-establish connection to the restored 230-kV offsite power source.

In response to questions raised during the April 25, 1991, telephone conference, the licensee stated (16) the following:

- The 250-VDC class-1E battery B2-1 is required to achieve isolation capability on some containment penetrations. Loads stripped from this battery are the reactor feed pump (RFP) turbine emergency lube oil pumps 1A and 1B and the main turbine emergency oil pump. Non-safety related computer loads are also stripped from this battery to limit control room heat-up.

- The EDG field flash is not applied in battery load calculations unless the diesel has accelerated above cranking speed. The field flash load is 58 amperes and it is switched off when the generator voltage reaches 60% or in 10 seconds, whichever comes first. In the SBO calculation, the field flash load was included in the random one minute load.

- The major load on non-class-1E battery B1-7 is the TDAS/Prime computer located in the control room and fed by IN-5. The total continuous load on battery B1-7 is 285 amperes of which 199 amperes is from IN-5. The existing SBO procedure requires that the computer equipment load be shed within 30 minutes to reduce control room heat-up. After this load is shed, the remaining load on B1-7 is only 86 amperes which is less than its 12 hour rating. As battery B1-7 is not relied upon for any coping function, no formal SBO battery load calculation is performed.

- The class-1E battery rooms have class-1E heaters to maintain the rooms between 74° and 78°F during non-SBO conditions. The SBO calculation assumed the rooms would be at the minimum of their normal range; i.e. 74°F.

- The licensee provided a copy of its SBO battery load profiles and sizing calculations.

Review of Licensee's Submittal

The batteries should be able to provide the normal plant monitoring and control for the entire SBO duration of four hours. According to the WNP-2 UFSAR, the design basis for battery sizing is two hours.

Our review of the licensee's provided battery sizing calculations for SBO loads reveals the following concerns:

- The licensee assumed a minimum cell voltage of 1.81 VDC in its calculation. This is equivalent to 105- and 210-VDC battery terminal voltages for the 125- and 250-VDC batteries, respectively. In its calculation, these minimum voltages were used to estimate the inverter current. This method ignores the voltage drop between the battery terminals and the inverter. Since the voltage at the inverter terminal is less than that at the battery terminal, a higher estimate of the input current would be needed. The licensee needs to verify the appropriateness of the use of 105- or 210-VDC at the inverter and other constant kW load input terminals.

- For estimating the DC input current to the inverters, the licensee used a 0.75 efficiency factor. Inverters usually have constant losses which are independent of their loading. Therefore, as loading decreases, inefficiency increases. In general, a 0.80 efficiency factor is used to estimate heat loss at a rated load. The licensee needs to verify that the use of a 0.75 efficiency factor is conservative (see pages 19 and 20 for the estimated inverter efficiency during an SBO event).

- The licensee assumed the generator field flash, amongst others, as a random load. We believe the generator field flash could occur within the first minute, and should be considered as such. (Other random loads; i.e. circuit breaker operations identified by the licensee seem reasonable). The change in the generator field flash load assignment does not change the final result, however.

- The licensee used a design margin factor of 1.0 in its calculation. This is not consistent with the recommendation in IEEE-Std 485, which states a 10 to 15% design margin needs to be considered.

- It appears that the licensee has used a larger value for one minute amperes per positive plate in its calculation. Our information on Excide, calcium flat plate type GN, batteries indicates a one-minute performance current of 817 and 922 amperes for GN-13 and -15, respectively. This results in a value of 136.17 and 131.71 amperes per positive plate for GN-13 and -15, respectively. The licensee used 147.5 and 143.6 amperes per positive plate for the same period, respectively.

- The licensee assumed a non-conservative electrolyte temperature of 74°F. The licensee needs to verify that under no circumstances, including normal operation and DBA, will the battery room temperature be less than 74°F. Otherwise, a more appropriate temperature needs to be used.

Thus, based on the assumption that the battery load profile calculations carried out by the licensee are correct, it appears that the existing battery capacity marginally meets the loads with a design margin factor of 1.0. If a lower temperature and a higher design margin were to be used, the batteries will not meet the 4-hour SBO loads. Therefore, the licensee needs to resolve the concerns identified above.

3. Compressed Air

Licensee's Submittal

The licensee stated that no air-operated valves are relied upon to cope with a SBO for four hours.

The SRVs, which together with HPCS provide for decay heat transfer to the suppression pool, have an adequate nitrogen supply for four hours of SRV operation.

Review of Licensee's Submittal

Examination of the plant UFSAR (12) reveals that the ADS system uses 7 of the 18 safety/relief valves that discharge the high pressure steam into the suppression pool. Each of the safety/relief valves utilized for automatic depressurization is equipped with an air accumulator and check-valve arrangement. The accumulators are sized to be capable of opening the valves and holding them open against the maximum drywell pressure of 45 psig. Upon loss of AC power, the gas supply piping will automatically isolate from the normal nitrogen supply and the ADS accumulator back-up compressed-gas manifold subsystems will provide 150 psig nitrogen from banks of high-pressure compressed-nitrogen cylinders. Therefore, these valves have sufficient back-up sources of compressed air for their operation during an SBO event.

4. **Effects of Loss of Ventilation**

Licensee's Submittal

The licensee stated that the HPCS Diesel and Electrical Equipment Room and the HPCS Pump Room receive cooling during an SBO and, as such, they do not meet the definition of a "dominant area of concern," consistent with NUMARC 87-00. The final temperatures for these rooms, based on the architect engineer's calculation rather than NUMARC 87-00 methodology, are as follows (14):

Area:	Final Temp.
• HPCS Diesel and Electrical Equip. Room, temperature at the electrical equipment.	104° F
• HPCS Pump Room	123° F
• HPCS Service Water Pump Room	151° F

In addition, the licensee identified the rooms containing the safety related inverters IN-2 and IN-3 and non-safety related inverter IN-5 to be dominant areas of concern, along with the control room. The licensee also performed an analysis for the steam tunnel. The assumed initial room temperatures and the calculated four hour SBO temperatures for these areas are (16):

Area:	Initial Temp.	Final Temp.
• RPS-1 Room (IN-3 and IN-1)		
- doors open	104°F	123° F
- doors closed		117°F
• RPS-2 Room (IN-2)		
- doors open or closed	104°F	115° F
• Switchgear Room 2 (Contains IN-5)	104°F	113° F
• Control Room	78°F (air) 83°F (panels)	128°F
• Steam Tunnel	N.P. *	169°F

* N.P. - not provided

With regard to initial temperatures assumed in DACs, the maintenance of the RPS and switchgear rooms to less than or equal to 104°F is a technical specification requirement.

The control room initial air temperature of 78°F was taken as a more reasonable temperature than the technical specification value of 85°F. The licensee stated (16) that the control room air temperature is controlled at 75 ± 3°F with no difficulty. The licensee further stated (16) several reasons to support the assumed initial control room air temperature of 78°F, including: (1) that this is consistent with the NUMARC 87-00 guidance of 2.2.1. that supporting systems are assumed to be at their normal operating conditions, (2) it is also consistent with SBO being a non-design-basis event and the goal of the NUMARC 87-00 initiatives to reduce the overall risk of SBO (NUMARC 87-00,

Section 1.2), and (3) forcing the 78°F value to be a technical specification requirement as indicated in the telephone conference on April 25, 1991, is contrary to the NRC Interim Policy Statement of February 6, 1987 on technical specifications which states that the purpose of technical specification is to impose those conditions or limitations upon reactor operation necessary to obviate the possibility of an abnormal situation or event giving rise to an immediate threat to the public health and safety.

The final temperatures for the two RPS rooms and the switchgear room were calculated using the NUMARC 87-00 methodology. The following inverter efficiencies were used in the heat-up calculations (16):

- IN-1 (RPS-1 Room) 89%
- IN-2 (RPS-2 Room) 75%
- IN-3 (RPS-1 Room) 75%
- IN-5 (Switchgear Room) 75%

In its original submittal the licensee stated (13) that the control room is not expected to exceed 120° F provided that actions are taken to reduce non-essential heat loads and ceiling panels are removed to promote heat transfer to the concrete ceiling. The licensee later stated (16) that final resolution of the issue of control room heat-up will be achieved by an analysis using a transient room heat-up program to benchmark the NUMARC 87-00 methodology. The model includes consideration of the drop ceiling in the control room. The results of the analysis show that the control room temperature will reach 128°F during the four hour coping period which exceeds the NUMARC 87-00 value of 120°F for which the control room does not have to be considered as a dominant area of concern. The licensee is currently evaluating the options available to address this concern and stated (16) that it will provide additional information to the NRC staff by June 29, 1991.

The licensee calculated a steam tunnel temperature of 169°F using NUMARC 87-00 methodology. The licensee did not identify the steam tunnel as a DAC. The licensee further stated (16) that there is no HPCS or RCIC equipment located in the steam tunnel and main steamline isolation has been provided for, consistent with NUMARC 87-00, Section 7.2.5, criterion 2. Thus, the temperature of the steam tunnel has no impact on the WNP-2 SBO coping analysis.

The licensee has reviewed SBO equipment and described measures to provide for reasonable assurance of operability (RAO). The licensee stated (16) that the Supply System is currently planning to replace IN-2 and IN-3. The inverters are planned to be purchased with the specification which require operation at a room temperature of 122°F. The licensee added that since the Switchgear Room-2 temperature is less than 120°F, RAO of recovery equipment located in this room is established. Furthermore, the licensee stated that PPM 5.6.1, "Station Blackout" provides for the opening of doors in RPS Room-1 and Room-2 and control room panels containing SBO equipment if the temperature cannot be maintained below 100°F. The licensee, however, did not identify the SBO equipment for which these local elevated temperatures should be of concern.

In addition, the licensee intends to evaluate containment temperature during an SBO event, utilizing the GOTHIC computer code. The results of this analysis will be provided at a later date.

Review of Licensee's Submittal

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

• HPCS Room

Based on the licensee's statement that HVAC will be available to the HPCS and its auxiliaries during an SBO, these areas will be of no concern. The temperatures provided by the licensee for these areas are considered to be those that are expected to be present during HPCS operation when HVAC is operating. Therefore, the operability of the equipment at the calculated temperatures is assured. The licensee needs to verify that the above statement is correct.

• Main Steam Tunnel

The licensee calculated a steam tunnel temperature of 169°F using NUMARC 87-00 methodology. Based on the information provided by the licensee concerning main steamline isolation and SBO equipment locations (16), we agree that the temperature of the steam tunnel has no impact on the WNP-2 SBO coping analysis.

• Inverter Rooms

The licensee has identified the rooms containing the safety related inverters IN-2 and IN-3 and non-safety-related inverter IN-5 to be areas of concern, and calculated final SBO temperatures for these areas. The licensee's calculated loads, as part of the battery-sizing calculation, for IN-2 and IN-3 inverters indicate that the loads drawn from IN-2 and IN-3 are 6.48 kVA and 6.72 kVA, respectively. These inverters are rated at 15 kVA each. Using constant heat loss considerations, the efficiency of these inverters at the estimated load will be 66% instead of the 75% estimated by the licensee. The licensee assumed an 89% efficiency for IN-1. Usually, a 80% efficiency factor is used for the inverters at their rated load. Since the battery load profile calculation indicates that IN-1 is fully loaded, then the licensee needs to consider an 80% efficiency. The licensee is planning to replace IN-2 and IN-3 with ones that are qualified for higher operating ambient temperatures (122°F). The licensee selected this temperature based on the maximum calculated inverter-room temperature with the doors closed. The licensee did not

state whether IN-1 and IN-5 will remain operational at the calculated temperatures. Even though these inverters are non-class 1E, they support equipment the licensee intends to use during an SBO event. The licensee intends to open the inverter room doors when the temperature reaches 100°F, according to SBO Procedure PPM 5.6.1. The licensee needs to open the doors within 30 minutes, consistent with the NUMARC 87-00 guidance, if it intends to take credit for opening doors.

Based on the above, the licensee needs to revise the temperature calculations for the inverter rooms and re-assess the equipment operability in these areas at the new calculated temperatures. In addition, the licensee needs to verify that IN-1 and IN-5 inverters will remain operational at the calculated temperature. Further, the licensee needs to revise SBO procedure PPM 5.6.1 to include opening the inverter-room doors within 30 minutes, as guided in NUMARC 87-00.

• Control Room

The licensee assumed an initial control room air temperature of 78°F. This value is non-conservative. Since WNP-2 has a technical specification control room temperature limit of 85°F, it is conceivable that the HVAC system could be in a failed or degraded condition and the licensee would not be required to take any action until the air temperature exceeds that limit. Thus, a control room air temperature greater than 78°F could potentially be experienced without any notification to the NRC. With respect to the third reason cited by the licensee in support of its control room air temperature assumption, the licensee has misinterpreted the NRC's position regarding the use of technical specification values for initial room temperatures. The position is that the heat-up calculation be performed using a conservative initial temperature, and is not as the licensee interpreted it. The licensee needs to use the technical specification temperature in the control room heat-up calculation. In addition, the licensee needs to revise SBO Procedure PPM 5.6.1 to open the control room cabinet doors within 30 minutes in the absence of AC, consistent with the guidance

provided in NUMARC 87-00 Supplemental Questions and Answers (11).

- Containment

The licensee intends to evaluate containment temperature during an SBO event, utilizing the GOTHIC computer code. This remains an open issue, pending the results of an analysis which will be provided by the licensee at a later date.

- RCIC Pump Room

The licensee did not perform a heat-up calculation for the RCIC pump room during an SBO. The licensee claims that no analysis of this room would be needed due to the availability of HPCS, which is supported by its dedicated diesel. The licensee, however, stated (16) both RCIC and HPCS pumps will be available to maintain the RCS inventory, and the RCIC pump will not be shut down. It is our understanding that the licensee will use RCIC until it fails due to high temperature (no other failure is assumed). Since HPCS can support the function provided by the RCIC pump, we conclude that RCIC failure is of no concern. However, we believe that the licensee needs to evaluate the RCIC pump room temperature and ensure that it would not fail due to high temperature, as such action is not considered good operating practice.

5. Containment Isolation

Licensee's Submittal

In its initial submittal, the licensee stated (13) that the plant list of containment isolation valves (CIVs) has been reviewed to verify that valves which must be capable of being closed or that must be operated (cycled) under station blackout conditions can be positioned with indication independent of the preferred class-1E power supplies. The licensee further stated that no plant modifications were determined to be required to ensure appropriate containment integrity and

procedures will be revised to provide guidance on those valves which do not meet the NUMARC 87-00 exclusion criteria.

The licensee stated in a later submittal (14) that in the performance of its containment isolation analysis, a sixth category for the exclusion of valves (in addition to the five listed in NUMARC 87-00 Section 7.2.3) was included in its analysis. This category was:

(6) all valves required to be closed by procedure during power operation.

The licensee recognizes that the sixth CIV exclusion criterion (in addition to the five listed in NUMARC 87-00, Section 7.2.3) utilized in its March 30, 1990, submittal (14) is not acceptable. In a later submittal, the licensee provided (16) the results of a detailed containment isolation review which was performed consistent with NUMARC 87-00 guidance. The licensee stated (16) that a review of 284 penetration isolation valves, CRD line and instrumentation line isolation valves for the 110 containment penetrations listed in UFSAR Table 6.2-16 has been performed. The licensee conducted the CIV review utilizing the five valve exclusion criteria contained in NUMARC 87-00. The licensee's review of these valves eliminated those which met one or more of the five NUMARC 87-00 exclusion criteria. For the remaining valves, the licensee stated that closure/isolation could be achieved by the following means:

- Powered by either DC from the batteries or AC from the HPCS diesel (15 valves).

- Has an in-series check valve (13 valves).

- Provided with interlocks to prevent the valve from being opened, or could not be in an open position due to the manner in which the system is operated (8 valves).

- Located below the minimum suppression-pool water level which forms a loop seal (21 valves).

- Provided with a 30-day air supply from a class-1 air-storage system (3 valves). The licensee stated that these valves will be included in a procedure.

- Provided with a handwheel which can be used to close the valve (1 valve). The licensee stated that this valve will be included in a procedure.

- Has an in-series DC-operated valve (4 valves). The licensee stated that these valves will be included in a procedure.

Review of Licensee's Submittal

The available containment isolation system data in the UFSAR was examined (UFSAR Table 6.2-16 and Figure 6.2-31). Upon review of UFSAR Table 6.2-16 and Figure 6.2-31, it appears that the licensee has identified a complete list of CIVs that cannot be excluded using the guidance of NUMARC 87-00, Section 7.2.5. The licensee provided arguments to discount the need for SBO action for these CIVs. Our review of the licensee's response is summarized below.
The licensee appears to have provided reasonable arguments with regard to discounting the need for requiring SBO action to assure the containment isolation of several sets of CIVs. Although the SBO guidance contained in NUMARC only assumes that no action other than the loss of AC power occurs, it is the staff's position that should containment isolation be needed for any reason, the operators should be aware of the necessary actions to ensure containment integrity is adequately maintained.

Upon review of the CIVs identified by the licensee which did not meet the exclusion criteria of NUMARC 87-00, Section 7.2.5, there are several sets of valves for which the licensee must take the appropriate action with regard to containment isolation. The licensee needs to list these

valves in a procedure which identifies the actions needed to ensure that these valves could be closed, if needed, to provide adequate containment integrity. The following valves have been identified during our review:

- There were several valves identified by the licensee where an in series check valve downstream of the CIV would provide containment isolation (RFW-V-65A, RFW-V-65B, RCC-V-5, RCC-V-104, RWCU-V-40, LPCS-V-5, RHR-V-53A, RHR-V-53B, RHR-V-42A, RHR-V-42B, RHR-V-42C, RCIC-V-13, RHR-V-23). Upon review of UFSAR Figure 6.2.31, we were unable to verify that these check valves were part of the containment penetration boundary or if they were in the immediate vicinity of the penetration. The use of downstream valves does not conform to the guidance.

- For those valves that were discounted as requiring SBO action by the licensee due to the manner in which the system is operated or the presence of valve interlocks would prevent the valve from being open (RHR-V-27A, RHR-V-27B, RHR-V-16A, RHR-V-17A, RHR-V-16B, RHR-V-17B, RHR-V-8, RHR-V-9), it is the staff's position that assurance of containment integrity consistent with the guidance should be maintained in such cases.

- For those valves located on a containment piping penetration in which the suppression pool forms a loop seal for the penetration (LPCS-V-1, LPCS-V-12, LPCS-FCV-11, RHR-V-4A, RHR-V-4B, RHR-V-4C, RHR-V-21, RHR-V-24A, RHR-V-24B, RHR-FCV-64C, RHR-RCV-64A, RHR-FCV-64B, RCIC-V-31, RCIC-V-68, HPCS-V-12, HPCS-V-15, HPCS-V-23, FPC-V-153/154 and FPC-V-149/156), it is the staff's position that these valves need to be included in the CIV list for maintaining appropriate containment integrity.

- For those valves identified by the licensee in which closure of an in-series DC-operated valve downstream of the CIV would provide containment isolation (MS-V-16, MS-V-19, RWCU-V-4, and RCIC-V-8) we were unable to verify that these valves were part of the

containment penetration boundary or if they were in the immediate vicinity of the penetration. The use of downstream valves does not conform to the guidance.

Thus, the licensee needs to list the 46 valves identified above in an appropriate procedure and identify the actions necessary to ensure that these valves are fully closed, if needed, upon the loss of AC power. The staff's position is that the valve closure needs to be confirmed by position indication (local, mechanical, remote, process information, etc.).

6. **Reactor Coolant Inventory**

Licensee's Submittal

The HPCS diesel generator 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 of four hours.

The licensee further stated (16) that RPV level is to be maintained between +13 and +54.5 inches during an SBO using HPCS and/or RCIC but preferring RCIC. With RCIC operating, the preferred suction path will be from the suppression pool.

Review of Licensee's Submittal

WNP-2 has a dedicated HPCS diesel and a HPCS pump which can supply 1650 gpm of water to the reactor vessel at 1110 psid. This exceeds the amount required to remove decay heat and to replenish the assumed RCS leak rate of 61 gpm (18 gpm per pump plus 25 gpm for maximum allowed technical specification leakage). Therefore, WNP-2 has sufficient capability to maintain reactor coolant inventory the 4-hour SBO event.

In its first three submittals (13, 14 and 15), the licensee did not consider the use of the RCIC system to control RPV level as part of its coping

analysis. If the licensee plans to use the RCIC system for level control, as was stated in its latest submittal (16), the licensee needs to submit a revised coping analysis which takes into account the effect of an available RCIC system to each part of the coping calculation.

NOTE:

The 18-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 Recirculation Pump 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 in its submittal (13) that plant procedures will be reviewed and modified, if necessary, to meet the guidelines of NUMARC 87-00, Section 4 in the following areas:

- AC power restoration per NUMARC 87-00, Section 4.2.2;
  - PPM 4.7.1.10, "Loss of All Off-site Power"
  - PPM 4.7.1.11, "Restoration of All Off-site Power"
  - "Northwest Power Pool System Restoration Plan," dated 1986
- Severe weather per NUMARC 87-00, Section 4.2.3;
  - PPM 13.3.2, "High Winds/Tornados," PPM 4.12.4.8 "Tornado"

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

- Station blackout response per NUMARC 87-00, Section 4.2.1;

  - PPM 4.12.4.4, "FAZ Recovery"
  - PPM 5.4.1, "Station Blackout"

- Procedure changes associated with any modifications required after assessing coping capability per NUMARC 87-00, Section 7.

The licensee stated that these procedure changes will be completed within two years after the notification provided by the NRC in accordance with 10 CFR 50.63 (c)(3).

Review of Licensee's Submittal

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

3.5 Proposed Modification

Licensee's Submittal

The licensee initially stated that no modifications to assure a four hour coping capability had been identified as being necessary (13). During the course of the technical review of its SBO evaluation, the licensee identified several modifications which are necessary to satisfy the four hour coping duration. These modifications are as follows:

- The licensee stated (16) that final resolution of the issue of control room heat-up will be achieved by an analysis using a transient room heat-up program to benchmark the NUMARC 87-00 methodology. The model

includes consideration of the drop ceiling via the removal of ceiling panels to promote heat transfer to the concrete ceiling.

- The licensee stated (13 and 14) that it is currently evaluating design changes to the containment Nitrogen Inerting System (NIS) to reduce the risk that failures of this system represent to the diesels and verify that the tank does not represent a single-point weather-related event that could disable the onsite emergency AC power sources (the two EDGs) and the division-3 diesel (the HPCS diesel).

- The licensee stated (16) that the Supply System is currently planning to replace IN-2 and IN-3. It is planned that the specification will require operation at a room temperature of 122°F.

Review of Licensee's Submittal

Our evaluation found several areas where the licensee needs to perform re-evaluations, some of these may result in modifications/changes to the existing equipment.

3.6 Quality Assurance and Technical Specifications

Licensee's Statement

The licensee stated (14) that with regard to quality assurance provisions for SBO equipment, all SBO equipment supported by the division-3 diesel generator is safety grade. As the suppression pool is a source of safety grade water for HPCS in the event of an SBO, the licensee did not consider the CSTs as SBO equipment. Furthermore, the licensee stated that it will provide an SBO quality assurance program only for such equipment that is not in service during normal operation.

Review of Licensee's Submittal

The licensee's statements with regard to quality assurance provisions for equipment do not seem to cover all equipment that is going to be

an SBO. The licensee needs to list all equipment that will be used to provide information and/or to support plant coping during an SBO. Based on this list, the licensee needs to identify the equipment that is not covered under 10 CFR 50 Appendix B and Appendix R and provide an appropriate quality assurance program consistent with the requirement of RG 1.155, Appendix A. The licensee did not provide any information on how the plant complies with the guidance of RG 1.155, Appendix B, regarding Technical Specifications needs.

4.0 CONCLUSIONS

Based on our review of the licensee's submittals and the information available in the UFSAR for WNP-2, 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. **Severe Weather Category**

   Our review identifies a single discrepancy with the licensee classifying the site to be in SW Group "1," while the results using NUMARC 87-00 data place WNP-2 in SW Group "2." This discrepancy, however, does not impact the offsite power characteristic and the recommended coping duration.

2. **EDG Reliability Program**

   The licensee stated (14) that it is reviewing NUMARC and NRC efforts relative to the development of a program to monitor and maintain diesel generator reliability by revision of NUMARC 87-00 Appendix D and the resolution of Generic Issue B-56. The licensee added that when the NUMARC program on this issue is completed, it will review the issue for application to WNP-2. However, the licensee did not state whether the plant has an EDG reliability program which, at a minimum, meets the requirements of RG 1.155 Position 1.2.

3. **Division-3 DG Operability During an SBO**

   The licensee stated that there is a potential for the NIS nitrogen tank to rupture during a tornado, causing the unavailability of the three diesels. The licensee needs to verify that the winds following the tornado will sufficiently dilute or disperse the nitrogen so that it would not cause the failure of all diesels.

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

Our review of the licensee's provided battery sizing calculations for SBO loads revealed several concerns:

- The licensee assumed a non-conservative electrolyte temperature of 74°F.

- The licensee assumed a minimum cell voltage of 1.81 VDC in its calculation which was used to estimate the inverter current. This method ignores the voltage drop between the battery terminals and the inverter and is non-conservative.

- For estimating the DC input current to the inverters, the licensee used a 0.75 efficiency factor which is non-conservative.

- The licensee used a design margin factor of 1.0 in its calculation. This is not consistent with the recommendation in IEEE-Std 485, which states a 10 to 15% design margin needs to be considered.

- It appears that the licensee has used a larger value for one-minute amperes per positive plate in its calculation. Our information on Excide, calcium flat plate type GN, batteries indicates a one-minute performance current of 817 and 922 amperes for GN-13 and -15, respectively. This results in a value of 136.17 and 131.71 amperes per positive plate for GN-13 and -15, respectively. The licensee used 147.5 and 143.6 amperes, respectively, for the same period.

Thus, based on the assumption that the battery load profile calculations carried out by the licensee are correct, it appears that the existing battery capacity would marginally meet the loads with a design margin factor of 1.0. If a lower temperature and a higher design margin is used, the batteries will not meet the 4-hour SBO loads. Therefore, the licensee needs to resolve the concerns identified above.

5. **Effects of Loss of Ventilation**

a. Control Room

The licensee stated that, based on a recent control-room heat-up analysis, the control-room temperature would be 128°F during a 4-hour SBO event. The licensee is in the process of reviewing its options to lower the control-room temperature. For this calculation, the licensee used a non-conservative initial room temperature of 78°F. The licensee needs to use the technical specification temperature in the control room heat-up calculation. In addition, the licensee needs to revise SBO Procedure PPM 5.6.1 to open the control room cabinet doors within 30 minutes in the absence of AC, consistent with the guidance provided in NUMARC 87-00 Supplemental Questions and Answers (11).

b. Inverter Rooms

The licensee used high inverter efficiency in its calculation of room heat-up (see text for detail). This assumption tends to under estimate the final temperature rise in these rooms. The calculation resulted in planning to change the IN-2 and IN-3 inverters with ones that a qualified to 122°F. Therefore, the licensee needs to revise its temperature calculation in these rooms using a more realistic inverter efficiency and re-assess the equipment operability in these areas at the new calculated temperatures. In addition, the licensee needs to verify that IN-1 and IN-5 inverters will remain operational at the calculated temperature. Further, the licensee needs to revise SBO procedure PPM 5.6.1 to include opening the inverter-room doors within 30 minutes, as guided in NUMARC 87-00.

c. RCIC Pump Room

The licensee did not perform a heat-up calculation for the RCIC pump room during an SBO. The licensee claims that no analysis of this room would be needed due to the availability of HPCS, which is supported by its dedicated diesel. The licensee, however, stated (16) both RCIC and HPCS pumps will be available to maintain the RCS inventory, and the RCIC pump will not be

shut down. It is our understanding that the licensee will use RCIC until it fails due to high temperature (no other failure is assumed). Since HPCS can support the function provided by the RCIC pump, we conclude that RCIC failure is of no concern. However, we believe that the licensee needs to evaluate the RCIC pump room temperature and ensure that it would not fail due to high temperature, as such action is not considered a good operating practice.

6. **Containment Isolation**

Upon review of those valves identified by the licensee which did not meet the CIV exclusion criteria of NUMARC 87-00 Section 7.2.5, there are several sets of valves for which the licensee must take the appropriate action with regard to containment isolation that have been identified during our review:

- There were 13 valves identified by the licensee where an in series check valve downstream of the CIV would provide containment isolation. We were unable to verify that these check valves were part of the containment penetration boundary or if they were in the immediate vicinity of the penetration. The use of downstream valves does not conform to the guidance. Thus, the licensee needs to provide for adequate containment isolation for these valves.

- There were eight valves that were discounted as requiring SBO action by the licensee due to the manner in which the system is operated or the presence of valve interlocks would prevent the valve from being open. It is the staff's position that assurance of containment integrity consistent with the guidance should be maintained in such cases.

- The licensee identified 21 valves located on a containment piping penetration in which the suppression pool forms a loop seal for the penetration and discounted them from SBO requirements. It is the staff's position that these valves need to be included in the CIV list for maintaining appropriate containment integrity.

- There were four valves identified by the licensee in which closure of an in series DC operated valve downstream of the CIV would provide containment isolation. We were unable to verify that these valves were part of the containment penetration boundary or if they were in the immediate vicinity of the penetration. The use of downstream valves does not conform to the guidance. Thus, the licensee needs to provide for adequate containment isolation for the aforementioned set of valves.

Thus, the licensee needs to list the 46 valves identified above in an appropriate procedure and identify the actions necessary to ensure that these valves are fully closed, if needed. Valve closure needs to be confirmed by position indication (local, mechanical, remote, process information, etc.).

7. **Quality Assurance and Technical Specifications**

The licensee's statements with regard to quality assurance provisions for SBO equipment do not seem to cover all equipment that is going to be used during an SBO. The licensee needs to list all equipment that will be used to provide information and/or to support plant coping during an SBO. Based on this list, the licensee needs to identify the equipment that is not covered under 10 CFR 50 Appendix B and Appendix R and provide an appropriate quality assurance program consistent with the requirement of RG 1.155, Appendix A. In addition, the licensee needs to provide information on how the plant complies with the guidance of RG 1.155, Appendix B, regarding Technical Specifications needs.

5.0 REFERENCES

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

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

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

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

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

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

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

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

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

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

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

12. Washington Nuclear Plant Number 2 Updated Final Safety Analysis Report (UFSAR).

13. Sorensen G. C., letter to NRC Document Control Desk, "Response to Station Blackout Rule Using HPCS Division III as Alternate AC Power Source," Docket No. 50-397, dated April 17, 1989.

14. Sorensen G. C., letter to NRC Document Control Desk, "Station Blackout Implementation, Additional Information (TAC 68626)," Docket No. 50-397, dated March 30, 1990.

15. Sorensen G. C., letter to NRC Document Control Desk, "Station Blackout, Additional Information," Docket No. 50-397, dated June 7, 1990.

16. Sorensen G. C., letter to NRC Document Control Desk, "Additional Information regarding SBO," Docket No. 50-397, dated May 7, 1991.