Attachment 1

SAIC-91/6684

TECHNICAL EVALUATION REPORT

CALLAWAY PLANT

STATION BLACKOUT EVALUATION

TAC No. 68524

SAIC
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1.0 BACKGROUND

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

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

In order to achieve a consistent systematic response from licensees to the SBO rule and to expedite the staff review process, NUMARC developed two generic response documents. These documents were reviewed and endorsed (9) 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 the licensees' conformance to the requirements of the SBO rule. To resolve this question, on January 4, 1990, NUMARC issued additional guidance as NUMARC 87-00 Supplemental Questions and Answers (10) addressing the NRC's concerns regarding the deficiencies. NUMARC requested that the licensees send their supplemental responses to the NRC addressing these concerns by March 30, 1990.

2.0 REVIEW PROCESS

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

A. Minimum acceptable SBO duration (Section 3.1),

B. 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 (11), and d) determination of the accepted EDG target reliability. Once these factors are known, Table 3-8 of NUMARC 87-00 or Table 2 of Regulatory Guide 1.155 provides a matrix for determining the required coping duration.

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

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

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

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

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

e. ability to provide appropriate containment integrity, and

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

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

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

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

This SBO evaluation is based on a review of the licensee's submittals dated April 12, 1989 (10), March 29, 1990 (11), May 17,1991 (15), May 31, 1991 (16), and June 28, 1991 (19), the information available in the plant Updated Final Safety Analysis Report (UFSAR) (12), and telephone conversations between

NRC/SAIC and the licensee on May 9, 1991 and June 21, 1991; 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 will be made and the audit may 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, the Union Electric, calculated (10 and 11) a minimum acceptable SBO duration of four hours for the Callaway Plant. The licensee stated that no modifications are necessary to attain this proposed coping duration.

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

1. **Offsite Power Design Characteristics**

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

   a. Independence of offsite power group of "I1/2,"

   b. Estimated frequency of LOOPs due to severe weather (SW) which places the plant in SW group "2,"

   c. Estimated frequency of LOOPs due to extremely severe weather (ESW) which places the plant in ESW Group "1," and

   d. Expected frequency of grid-related LOOPs of less than once per 20 years.

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

   The EAC power configuration of the plant is "C." The Callaway plant is equipped with two emergency diesel generators which are normally available to the plant's safe shutdown equipment. One emergency AC power supply is sufficient to operate the safe shutdown equipment following a loss of offsite power.

3. **Target Emergency Diesel Generator (EDG) Reliability**

The licensee has selected an EDG target reliability of 0.95 based on having a nuclear unit average EDG reliability of greater than 0.95 for the last 100 demands. The licensee stated (11) that the selected target reliability will be maintained. The licensee added that it will comply with NUMARC SBO Initiative 5A which has been revised to address EDG performance, including maintenance of the selected target reliability.

Review of Licensee's Submittal

Factors which affect the estimation of the SBO coping duration are: the independence of offsite power system grouping, the estimated frequency of LOOPs caused by grid-related failures, the estimated frequency of LOOPs caused by severe weather (SW) and extremely severe weather (ESW) conditions, the classification of EAC, and the selection of EDG target reliability.

According to the UFSAR (13) and the licensee's response to questions (16), the two 4.16 kV Engineered Safeguards Features (ESF) buses are supplied with power from two independent and redundant preferred offsite power sources. ESF Load Group 1 is normally powered from the switchyard via 13.8/4.16 kV ESF transformer XNB01. Transformer XNB01 is supplied by one of the two 345/13.8 kV Safeguard Transformers in the switchyard. A Safeguard Transformer is connected directly to each 345 kV bus through a disconnect switch. Each Safeguard Transformer has two low voltage-side breakers connected so that either transformer can be used to supply power to XNB01. XNB01 is normally supplied by Safeguard Transformer B with the capability for manual transfer to Safeguard Transformer A. ESF Load Group 2 is normally powered from one of the secondary windings of the Start-up Transformer XMR01 via ESF transformer XNB02. Transformer

XMR01 receives power from a 345 kV circuit in the switchyard. Additionally, the licensee stated either ESF bus can manually be connected to the opposite division's ESF transformer (XNB01 or XNB02) and the ESF transformers are sized (12 MVA) to carry both ESF busses following a LOOP. Therefore, we conclude that the licensee correctly classified the independence of offsite power (I) group as "I1/2", based on Table 5 of RG 1.155.

We agree with the licensee's estimated frequency of LOOPs caused by severe weather (SW) and extremely severe weather (ESW) conditions. The weather-related parameters were taken directly for NUMARC 87-00 and the licensee is correct in its assessment of two rights-of-way for offsite power transmission lines.

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 the safe shutdown equipment following a LOOP. Callaway has two dedicated EAC sources with one required after a LOOP, placing the plant in EAC Group "C" (RG 1.155, Table 3) as the licensee correctly identified.

The final characteristic needed to establish the duration of Callaway's required coping capability is the target EDG reliability. The licensee stated (10) that the assignment of the EDG target reliability of 0.95 is based on having an average EDG reliability for the last 100 demands greater than 0.95 as determined by a diesel reliability analysis performed by the Callaway staff. We were unable, however, 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. Callaway is not included in NSAC-108 because the plant was not operating in during the study window (1983,1984 and 1985). Although the licensee's data was not reviewed, we agree that the licensee can choose a reliability goal of 0.95.

In response to the requirement for an EDG reliability program the licensee stated, during a telephone conversation held on May 9, 1991 that a reliability program consistent with the guidance provided in RG 1.155 and NUMARC 87-00 is being developed. The licensee needs to note that the present version of the revised Appendix D to NUMARC 87-00 has not been accepted by the staff. Therefore, the program needs to contain the five steps identified in 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., covers only the events prior to the calendar year 1984. No grid-related LOOPS for Callaway were reported.

Based on an SW group "2," ESW group "1," and an independence of offsite power group "I1/2," the offsite power design characteristics of Callaway is "P1." With this determination, in conjunction with an EDG reliability goal of 0.95, Callaway has a required coping duration of four hours.

3.2 Station Blackout Coping Capability

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

1. **Condensate inventory for decay heat removal**

Licensee's Submittal

The licensee stated (10 and 11) that based on a plant specific analysis, 158,000 gallons of water are required for cooldown and decay heat removal for the required coping duration of four hours and that the plant specific analysis is more conservative than NUMARC 87-00, Section 7.2.1. The licensee added that the Callaway technical specifications require a minimum condensate storage level of 281,000 gallons. This volume of condensates exceeds the amount required to cope with a four-hour SBO event.

Following the telephone conversation of May 9, 1991, the licensee stated (16) that the loads considered in the calculation are:

- o Decay heat removal for four hours (7.43×10^8 BTU),
- o Sensible heat removal from RCS for cooldown (1.13×10^8 BTU),
- o Sensible heat removal from the steam generator (SG) fluid, and
- o Restoration of SG levels to hot zero power conditions (40,000 gallons).

The licensee then added a 20 percent margin to reach the 158,000 gallon total.

Review of Licensee's Submittal

For calculating the condensate inventory requirement for Callaway during an SBO, the following should be considered:

1. Decay Heat -- Using NUMARC 87-00, Section 7.2.1 and the maximum power level (102%) of 3636 MWt, we estimate that the plant would require 80,428 gallons of condensate to remove decay heat for four hours.

2. Sensible Heat -- The sensible heat removal from the primary and steam generator fluid and associated structure should be considered. According to the plant UFSAR, Table 6.2-1-45, the total stored energy in the primary system, excluding that stored in accumulators, is 853.83×10^3 BTU. The average RCS fluid temperature is 592.7°F, according to Table 6.2-1-5. If the average core temperature is neglected, and

the entire RCS is assumed to be at 592.7°F, then, on the average, 175.5 gallons of water at 125°F would be needed to cool down the RCS one degree Fahrenheit. The RCS is cooled down to about 280 psig or 410°F, according to ECA-0.0 procedural guidance. Therefore, about 32,064 gallons of condensate would be needed. The licensee considered the removal of heat from the primary fluid, and apparently assumed that the 20 percent margin would adequately compensate for SG and primary and secondary structural (piping, vessels and supports) stored energy.

3. <u>Steam Generator Water Mass</u> -- Our calculation of the additional condensate needed to restore the steam generator levels to hot zero power conditions indicates that approximately 52,800 gallons of condensate would be needed. This calculation assumes that at the beginning of the incident the steam generator is at the low-low level, containing 82,000 lbm of water. At the end of the four hour cooldown to ~260 psig (per ECA-0.0), the steam generator mass is equivalent to that at the hot zero power conditions (~ 3560 ft^3 of water).

Based on the above, a total of 165,292 gallons of water would be needed to remove decay heat and cooldown the RCS. Although this estimate is larger than that provided by the licensee, the condensate needed during a four hour SBO is considerably less than the technical specification-required condensate storage tank inventory of 281,000 gallons. Therefore, we conclude that the site has adequate condensate inventory to cope with an SBO of four hours duration.

2. Class 1E Battery Capacity

Licensee's Submittal

The licensee stated (10 and 11) that a battery capacity calculation has been performed in accordance with NUMARC 87-00, Section 7.2.2 to verify that the class 1E batteries have sufficient capacity to meet SBO loads for four hours.

In response to the questions raised during the telephone conversation on May 9, 1991, the licensee stated (16) that station battery capacity has been assessed using the methodology of IEEE-Std 485. The licensee concluded that the class 1E batteries have adequate capacity for the four hour coping duration, taking into account a 60°F electrolyte temperature and a 25 percent margin for aging.

The licensee stated (16) that for the class 1E batteries, no load shedding is required to achieve a four-hour capacity. However, for prudence, procedural guidance is provided to allow the operators to de-energize the ESF Status Panels in order to conserve battery capacity. The licensee added, the nonsafety-related batteries do not supply any loads for decay heat removal during an SBO, however, they provide breaker control power to provide offsite power to ESF transformer XNB02. Thus, a non-vital inverter will be shed within one hour after the onset of an SBO to ensure the capability to operate the supply breaker to XNB02.

The licensee has revised the plant UFSAR incorporating the changes and additions required by the SBO rule. The licensee stated that a footnote will be added to UFSAR Table 8.3-2 to clarify that the batteries have been analyzed for a 240 minute loading cycle to support the SBO coping analysis.

Review of Licensee's Submittal

The Callaway DC power supply system consists of four separate. class 1E, 125 V subsystems. Each subsystem has a dedicated charger, inverter and battery, and Callaway has a centrally located battery charger and inverter that can be hooked to any subsystem. According to the plant UFSAR, Section 8.3.2.1.2, the batteries are sized to supply the necessary DC loads for a minimum of 200 minutes (3.3 hours).

During the telephone conversation of May 9, 1991, the licensee stated that the battery sizing calculations were performed using a temperature factor of 1.11 (60°F), an aging factor of 1.25, and a design margin of 25%. The 25% design margin was not explicitly stated in the licensee's response. Based on conservative temperature and design margin factors, we consider the batteries to have adequate capacity to support the SBO loads for four hours, pending future verification.

3. Compressed Air

Licensee's Submittal

The licensee stated (10 and 11) that air-operated valves relied upon to cope with an SBO for four hours can either be operated manually or have sufficient backup sources independent of the unit's preferred and class 1E AC power supplies.

Review of Licensee's Submittal

The turbine driven auxiliary feedwater (AFW) pump steam supply valve, associated bypass valve, and discharge control valves are normally closed air operated valves which have to be operated during an SBO event. Additionally, the steam generator power operated relief valves (PORVs) are air operated valves and are backed up by spring-operated safety valves. According to the UFSAR, Section 9.3.1, the plant compressed air system provides a safety-related backup supply of compressed gas (N_2) for the PORVs and AFW valves and is designed (nominal pressure) for eight hours of operation without recharging. The licensee stated (16) that the minimum allowed pressure will provide sufficient nitrogen for a five hour period with each atmospheric relief valve being stroked every ten minutes and each Auxiliary Feedwater control valve stroked three times per hour. Therefore, we agree with the licensee that the Callaway compressed air system meets the applicable SBO guidance.

4. **Effects of Loss of Ventilation**

Licensee's Submittal

The licensee stated (10) that the only dominant area of concern (DAC) is the steam driven AFW pump room, for which the calculated steady state ambient air temperature is 136.4°F. Equipment operability was assessed using Appendix F of NUMARC 87-00, and the licensee concluded that no modification is necessary to provide reasonable assurance of equipment operability in the AFW pump room. The licensee used Callaway-specific data for the heat generation from the AFW pump turbine and the piping rather than the NUMARC 87-00 methods (11).

The licensee stated (10) that the control room will not exceed 120°F and therefore is not a DAC. The licensee used a plant-specific analysis to determine the control room temperature (11). In response to questions raised during the telephone conversation of May 9, 1991, the licensee provided the control room and Instrument and Control (I&C) Cabinet room heat up calculations (15), as well as descriptions of its approach to analyzing room heat-up (16). Following the second telephone conversation (June 21, 1991), the licensee submitted an addendum to the SBO Room

Temperature Analysis (19). Additionally, the licensee stated (16) that Callaway Plant Procedure OTO-GK-00001, entitled "Loss of Control Room HVAC with High Control Room Temperature," will require that the control room cabinet doors be opened within approximately 30 minutes of the onset of the SBO event.

The licensee stated (11) that walls constructed of fully grouted concrete masonry units were used as heat sinks in the battery and DC Switchboard rooms. This is based on the 1989 ASHRAE Fundamentals Handbook which states that thermal properties for fully grouted block may be approximated using values for poured concrete.

Following the telephone conversation of May 9, 1991, the licensee provided (16) the following summary of room temperature analyses performed for SBO:

Room	Initial Temperature	Final Temperature
Turbine AFW Pump Room	113°F	142°F
Inverter Room	90°F	103.9°F
Battery Rooms	90°F	93.7°F
Control Room	N/A	111.5°F
I&C Cabinet Room	N/A	98.1°F
MS/MFW Tunnel	120°F	202.2°F

The licensee stated (16) that two plant specific containment heat-up analyses were performed. The first analysis assumed a 111 gpm RCS system leakage and concluded that the maximum temperature would be 166°F. The second analysis assumed no RCS system leakage and concluded that the maximum temperature would be 173°F. The licensee stated that both temperatures are well below the Environmental Qualification envelope temperature of 384.9°F for Main Steam Line Break. The licensee concluded that containment temperature is not a concern for SBO.

Review of Licensee's Submittal

We reviewed the licensee's provided analysis of the control room and I&C cabinet room heat-up calculations and summary information for the other plant area heat-up calculations. For areas that we did not receive the heat-up calculation, we accept the licensee's results pending future audit/verification and subject to the following comments.

o **Control Room and I&C Cabinet Room**

We reviewed the original (15) and addended (19) licensee-provided portions of calculations of the control room and I&C cabinet room heat-up heat-up. The licensee stated (16) that since NUMARC 87-00 methodology is not appropriate due to control room construction, a steady state calculation for the combined area of the control room and I&C cabinet rooms was used.

The licensee used a formulation of the conservation of energy equation for the internal energy of each room, calculated overall heat transmission coefficients based on a combination of individual thermal resistances for each boundary surface of the rooms, and assumed outside boundary temperatures and room heat loads which were calculated in a separate calculation and was not provided for our review. The thermal resistance factors were obtained from the ASHRAE Handbook (17).

This calculation assumed that rooms adjacent to the two rooms of interest are not heat sources (i.e. their temperatures are less than the control and equipment cabinet rooms), surrounding room initial temperatures are at normal values, and wall temperatures in surrounding rooms are constant during this four hour period. The licensee's assumption of normal initial temperatures for surrounding rooms is not conservative for an SBO evaluation. These rooms can operate at considerably higher temperatures without shutting down the plant or taking any other actions. Therefore, the maximum allowable temperatures for these need to considered. The licensee can use these low numbers, if it does provide controls to ensure that these temperatures will not be exceeded under any circumstances during normal plant operation.

Another non-conservative licensee assumption is the use of 101°F and 96°F for outside wall temperatures. Based on NUREG/CR-1390 (18), the Callaway site is expected to have a maximum temperature of 110°F with an expected occurrence frequency of once per 50 years. Therefore, 110°F should have been used in this calculation.

In support of its results, the licensee included in the addended calculation the results of a test in which the control room and I&C cabinet room temperatures were measured for three hours with the HVAC secured. The test showed a 12.5°F rise in control room temperature and a 13.4°F rise in I&C cabinet room temperature. However, the room heat loss was not adequately quantified and, apparently, the exhaust fans were operating. Also, the test was performed in October, during the night, while the ambient air temperature varied from 60.3°F to 54.2°F. Without quantification of all room heat loads, no exhaust fans operating and the added heat from a hot summer day with significant solar heat, this test does not provide sufficient justification of the room heat-up calculation.

The heat load used in the calculation of room heat-up for the control room and equipment cabinet area is based on a separate licensee calculation which was provided with Reference 19. During the June 21, 1991 telephone conversation, the licensee revealed that no human heat load was included in the total room heat source. The addended calculation includes a heat load of 315 BTU/hr. (92 Watts) for each of ten people. This heat load is too low. Based on ASHRAE Handbook Chapter 8, Table 5-c, a human heat load of 250 watts per person for 10 people needs to be included as a heat source for the control room.

In summary, the general methodology used by the licensee in calculating room heat-up, although different from the NUMARC 87-00 method, is based on sound principles and has been previously used by others for this application. The results of the calculation need to be revised based on the aforementioned comments regarding initial room temperatures, outside wall temperatures, room heat load, and adjacent room effects.

o Containment

The maximum temperature calculated with 111 gpm RCS leakage (166°F) and with no leakage (173°F) does not appear to be justified. With 111 gpm leakage at the beginning of the event, the containment environment receives ~5.5 MWt more thermal energy from the saturated steam than in the case without leakage. At the end of the four hours, the additional energy is ~2.90 MWt. It is not clear why the maximum temperature is lower when more energy is introduced into the containment. Both temperatures, however, are significantly less than the design limit. Therefore, although we did not receive the plant-specific containment heat-up analysis to review, we agree with the licensee's conclusion that containment temperature is not a concern for SBO since Callaway has a large dry-type containment and the temperature are significantly below equipment operability limits.

o Inverter Room

The licensee used a non-conservative initial temperature of 90°F for the inverter room heat-up analysis. The licensee needs to use a more conservative temperature that is consistent with technical specification or other formal guidance. The licensee can use this low temperature, if it does provide controls to ensure that these temperature will not be exceeded under any circumstances during normal plant operation. If we were to use an initial temperature of 104°F consistent with NUMARC 87-00, and the NUMARC method (assuming it was used by the licensee), the room can reach a final temperature of 118°F. At this temperature, the equipment operability is assured provided that the inverters are qualified for an ambient temperature of 50°C (122°F). The licensee needs to verify that the inverters are qualified for 118°F, or provide the procedural controls to maintain the room temperature below 90°F at all times during plant operations.

5. Containment Isolation

Licensee's Submittal

The licensee stated (10) that containment isolation valves (CIVs) that 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. Additionally, the licensee stated that procedure ECA-0.0 will be revised to include all actions required to provide appropriate containment integrity during an SBO event. In its second submittal (11), the licensee added that four containment recirculation sump isolation valves are within encapsulations which are an extension of the containment boundary. The licensee excluded these valves from consideration because it is a violation of technical specifications to operate with these valves open.

Following a request for more specific information about the valves that were excluded based on plant specific analysis, the licensee provided (16) details on the treatment of CIVs. The licensee stated that procedure ECA-0.0 identifies the CIVs that needs to be verified closed, and directs the operators to ensure all valves are closed using the control room ESF status panels which are DC operated. The licensee added, three analyses were used to exclude certain CIVs:

- Residual Heat Removal (RHR) suction isolation valves from the hot legs: The licensee stated that although these valves do not meet the exclusion criteria of NUMARC 87-00, they could not be open at the onset of an SBO because of their control circuit design. The licensee excludes these valves because they have interlocks which prevent them from being opened when RCS pressure is above 425 psig.

RHR and containment spray suction isolation valves from the containment sumps: These valves are maintained closed during all power operations, and opening the valves would result in entry into Technical Specification action statements. These valves are only operated for surveillance testing during refueling outages in Mode 5 and 6.

Review of Licensee's Submittal

Our review of the containment penetrations and associated CIVs discovered no additional penetrations other than those discussed above which were not covered by the basic SBO exclusion criteria. We find the licensee's actions to conform with the guidance provided in RG 1.155 and NUMARC 87-00. In addition, the licensee has proceduralized the actions necessary to ensure that containment isolation is obtainable during an SBO event.

6. Reactor Coolant Inventory

Licensee's Submittal

The licensee stated (10 and 11) that the ability to maintain adequate reactor coolant inventory was assessed in a plant-specific analysis. The analysis shows that expected rates of reactor coolant inventory loss under SBO conditions do not result in core uncovery for an SBO of four hours. The licensee concluded that no make-up systems are required to cope with an SBO with a duration of four hours.

In response to the questions raised during the telephone conversation on May 9, 1991, the licensee stated (16) that the RCS inventory calculation is based on the following assumptions and data:

- o 25 gpm per recirculation pump seal leak,
- o 11 gpm maximum technical specification-allowed leakage,
- o 125 gpm for 10 minutes leakage until letdown is isolated, and
- o an estimated 2390 ft^3 RCS shrinkage.

This gives a total RCS level loss of 6118 ft^3 over the four hour SBO duration, which leaves a 3172 ft^3 margin of coolant over the top of the core.

Review of Licensee's Submittal

According to the plant UFSAR, the RCS water volume at 100% power is 11,393 ft^3. Using the licensee's assumed leakage, and a final RCS pressure of 280 psia and temperature of 410°F, we found that 5242.43 ft^3 of water will remain in the RCS at the end of four hours. This exceeds the RCS inventory required to keep the core covered since the reactor vessel water volume is 3700 ft^3.

Therefore, we agree with the licensee's statement that no additional make-up capabilities are necessary to cope with an SBO of four hours duration.

NOTE:

> "The 25 gpm RCP seal leak rate was agreed to between NUMARC and the staff pending resolution of Generic Issue (GI) 23. If the final resolution of GI-23 defines higher 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."

3.3 Proposed Procedures and Training

Licensee's Submittal

The licensee stated that plant procedures have been reviewed to assure compliance with guidance of NUMARC 87-00, Section 4, in the following area:

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

The licensee stated that no changes are necessary for AC power restoration and severe weather procedures to be in compliance with the guidance. The station blackout response procedure will be revised three months after notification provided by the NRC in accordance with 10 CFR 50.63.

Review of Licensee's Submittal

We neither received nor reviewed the affected procedures or training. These procedures are plant specific actions concerning the required activities to cope with a 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 in their contents and that the associated training needs are carried out accordingly.

3.4 Proposed Modifications

Licensee's Submittal

The licensee stated (10) that no modifications would be required to cope with an SBO with a duration of four hours.

Review of Licensee's Submittal

Our review has identified several concerns which may require modifications as part of their resolutions.

3.5 Quality Assurance And Technical Specifications

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

4.0 CONCLUSIONS

Based on our review of the licensee's submittals, telephone conversations between NRC/SAIC and the licensee, and the information available in the UFSAR for the Callaway Plant, we find the submittal conforms with the requirements of the SBO rule and the guidance of RG 1.155 with the following exceptions:

1. **Effects of Loss of Ventilation**

a. Control Room

The licensee performed a plant-specific analysis of the control room using non-NUMARC methods. Upon request, the licensee provided the control room heat-up calculation to be reviewed. The control room heat-up calculation has resulted in several concerns which could appreciably increase the final room temperature estimate. The licensee needs to provide a response to the individual concerns delineated in the text. Additionally, the licensee needs to evaluate and provide reasonable assurance of the operability of equipment in the control room and associated I&C cabinet room.

b. Inverter Room

The licensee used a non-conservative initial temperature of 90°F for the inverter room heat-up analysis. The licensee can use this temperature if it provides controls which ensure that this temperature will not be exceeded under any circumstances at any times during normal operation. The licensee can use a more conservative temperature that is consistent with the guidance (104°F) and to asses equipment operability at the final room temperature.

2. Proposed Modifications

The licensee did not identify any modifications to be needed to cope with an SBO event. However, our review has identified several concerns which may require modifications as part of their resolutions.

3. Quality Assurance And Technical Specifications

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

5.0 REFERENCES

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

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10. Schnell, D. F., letter to U.S. Nuclear Regulatory Commission Document Control Desk, "Docket No: 50-483, Callaway Plant, Station Blackout, NRC TAC No. 68524," ULNRC-1973, April 12, 1989.

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

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16. Schnell, D. F., letter to U.S. Nuclear Regulatory Commission Document Control Desk, "Docket No: 50-483, Callaway Plant, Station Blackout, NRC TAC No. 68524," ULNRC-2416, May 31, 1991.

17. "ASHRAE Handbook & Product Directory - 1977 Fundamentals," Published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

18. NUREG/CR-1390, "Probability Estimation of Temperature Extremes for the Contiguous United States," May 1980.

19. Shafer, D., "Callaway Plant, Response to Station Blackout Questions," June 28, 1991 (Addendum to Reference 16).