Attachment 1
SAIC-91/6693

TECHNICAL EVALUATION REPORT
DIABLO CANYON UNITS 1 AND 2
STATION BLACKOUT EVALUATION

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An Employee-Owned Company

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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 licensees' conformance to the requirements of the SBO rule. To resolve this question, on January 4, 1990, NUMARC issued additional guidance as NUMARC 87-00 Supplemental Questions/Answers (10) addressing the NRC's concerns regarding the deficiencies. NUMARC requested that the licensees send their supplemental responses to the NRC addressing these concerns by March 30, 1990.

2.0 REVIEW PROCESS

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

A. Minimum acceptable SBO duration (Section 3.1),

B. 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 RG 1.155 provides a matrix for determining the required coping duration.

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

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

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

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

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

e. ability to provide appropriate containment integrity, and

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

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

The licensee's submittal for any proposed modifications to emergency AC sources, battery capacity, condensate capacity, compressed-air capacity, ventilation systems, containment isolation valves, 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.

This SBO evaluation is based upon the review of the licensee's submittals dated April 17, 1989 (12) and March 30, 1990 (13), the information available in the plant Updated Final Safety Analysis Report (UFSAR) (14), a telephone conversation with the licensee on May 6, 1991, and follow-up information dated August 15, 1991 (15), in response to questions raised during the telephone conversation. 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

The licensee initially stated that the minimum required coping duration is four hours. In its response to questions, the licensee stated that with the addition of the sixth emergency diesel generator, which is planned to be installed during Unit 2's fifth refueling outage, the coping duration will be two hours. The August 15, 1991, submittal will be used primarily with the other submittals as back-up. Our evaluation, therefore, considers the sixth EDG as a required modification to attain the two-hour coping duration.

3.1 Proposed Station Blackout Duration

Licensee's Submittal

The licensee, Pacific Gas and Electric Company (PG&E), calculated (15) a minimum acceptable station blackout coping duration of two hours for the Diablo Canyon Power Plant (DCPP) site. The licensee stated (15) that to attain this coping duration the addition of the sixth class-1E EDG will be needed. With the installation of the new EDG, DCPP will have three dedicated EDGs per unit. Presently, one of the five EDGs serves as a swing EDG between the two units.

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

1. Offsite Power Design Characteristics

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

   a. Independence of the plant offsite power system characteristics of "I1/2,"

   b. Expected frequency of grid-related LOOPs of less than one per 20 years,

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

d. Estimated frequency of LOOPs due to severe weather (SW) which places the plant in SW Group "1."

2. Emergency AC (EAC) Power Configuration Group

The licensee stated that following the modification to add the sixth EDG, DCPP will be equipped with three dedicated emergency diesel generators per unit. The licensee added that only one EAC power supply per unit is necessary to operate safe-shutdown equipment following a loss of offsite power. Therefore, the EAC power classification is "A."

In support of its statement, the licensee provided (15) the following list of loads necessary for the safe shutdown of one unit:

# Required	Equipment	Rated Load	kW
1	Aux. Saltwater Pump	450 bhp	361
1	Aux. Feedwater Pump	505 bhp	395
2	Component Cooling Water Pump	435 bhp	684
1	Centrifugal Charging Pump	500 bhp	396
Various	480-V Load Center (estimate)	various	501
		Total =	2337 kW

In addition to the above, the licensee stated that one residual heat removal (RHR) pump is an additional load of 337 kW, bringing the total load to 2674 kW. The licensee added that the auxiliary feedwater (AFW) pump would be stopped shortly after RHR pump operation began, and, therefore, consideration of both of these pumps is conservative. In addition, the consideration of the motor-driven AFW pump as a load on the EDG is an added measure of conservatism, in that the turbine-driven AFW pump is also assumed to be available. The licensee concluded that, based on each EDG having a 2000-hour rating of 2750 kW, one EDG has significant

margin to supply the minimum safe shutdown loads for one unit following an SBO.

3. Target Emergency Diesel Generator (EDG) Reliability

The licensee has selected a target EDG reliability of 0.95. The selection of this target reliability is based on having an average EDG reliability greater than 0.95 for the last 20, 50, and 100 demands, consistent with NUMARC 87-00, Section 3.2.4. The EDG reliabilities were calculated for each EDG for the last 20, 50, and 100 demands to start and associated demands to run. As of March 10, 1989, the unit EDG reliabilities are 1.00 for Unit 2 and 0.975, 0.99, and 0.995 for Unit 1 for the last 20, 50, and 100 demands, respectively.

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 3-3 of NUMARC 87-00, the expected frequency of LOOPs at Diablo Canyon due to SW condition is Group "1." Using Table 3-2 of NUMARC 87-00, the expected frequency of LOOPs due to ESW conditions place the Diablo Canyon site in ESW Group "1."

The licensee stated that the independence of the plant offsite power system grouping is "I1/2." A review of the Diablo Canyon UFSAR shows that:

1. All offsite power sources are connected to the plant through two unconnected switchyards;

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

3. Upon loss of power from the main generator, power is provided from the 230-kV switchyard through the stand-by start-up transformers, one per unit;

4. Upon loss of the 230-kV power supply, there is a main-generator motor-operated disconnect which can be manually opened and power can be backfed to the safety busses from the 500-kV switchyard.

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

The licensee categorized the EAC classification of DCPP as "A." Upon completion of the modification to add a sixth EDG, each unit will have three dedicated EDGs. The licensee stated that one EDG per unit is required to safely shutdown the plant. In order to justify the one-out-of-three categorization, each EDG must have both the capacity and the connectability to power the necessary equipment to maintain the plant in a safe shutdown condition for an extended period, consistent with the NUMARC 87-00 Supplemental Questions/Answers (10), Questions 3.4 and 3.5.

Connectability

Our review of the information available in the plant UFSAR (14) indicates that each unit has three ESF trains, labelled F, G, and H, which are not completely redundant.

- Bus F cannot power an RHR pump, bus G cannot power an auxiliary feedwater pump, and bus H can power neither an auxiliary saltwater pump nor a charging pump. Additionally, the licensee stated (15) that two component cooling water (CCW) pumps per unit are necessary to achieve safe shutdown. With only one EDG available, two CCW pumps cannot be powered since each train only powers one CCW pump.

- Upon review of the DC system, we found that there are six inverters, three powered from bus F, one from bus G, and two from

bus H. Should either bus F or H not be powered, bus G can support one inverter from either of the other two busses. Although it is not clear from the UFSAR, it appears that three inverters are necessary to provide a division of instrumentation and control (I&C). This means that bus F is capable of powering a full division but busses G and H are not. If only bus G or bus H were available, insufficient I&C would be available after the uncharged batteries expired, which is expected to occur around two hours.

The guidance provided in NUMARC 87-00 Supplemental Questions/Answers (10), Question 3.4 states that when determining the number of EAC power sources necessary to operate safe shutdown equipment, the shutdown loads powered must be capable of maintaining the plant in a safe shutdown condition for an extended period. Therefore, DCPP does not have the connectability to power the necessary equipment with only one EDG available.

Capacity

Our review of the loads provided by the licensee indicates that they differ from those shown in UFSAR Table 8.3-3. For our analysis, we assumed that the licensee has provided accurate values for the individual equipment loads. In its list of loads, the licensee did not include containment fan coolers. The load for one cooler is 220 kW (UFSAR Table 8.3-3), bringing the total necessary load to 2894 kW, which exceeds the EDG's 2000-hour rating of 2750 kW. The licensee stated that its consideration of the motor-driven AFW pump as a load on the EDG is an added measure of conservatism. Although the turbine-driven AFW pump is considered to be available during a LOOP, this does not mean that the licensee can neglect/shed the motor-driven AFW pump from its EDG loads when determining EAC classification. The licensee needs to consider all equipment loads which are part of the normally available capability for safe shutdown, as listed in Section 7.4.

Based on the lack of both capability and capacity to shut down one unit with one EDG available, we conclude that two EDGs are required to supply

the necessary loads following a LOOP. Therefore, EAC power configuration is "D," based on needing two-out-of-three EDGs per unit to safely shut down the reactor.

The licensee selected the EDG target reliability of 0.95 based upon the EDG reliability data for the last 20, 50, and 100 demands. Since the EAC power configuration is "D," the licensee needs to select a target EDG reliability of 0.975 in order to meet the guidance of NUMARC 87-00, Section 3.2.4.

The licensee stated that it has a program which meets four of the five elements for an EDG program outlined in RG 1.155, Position 1.2. The licensee will meet the last element by March 1, 1992, when it establishes a database designed to track EDG component performance in accordance with Appendix D to NUMARC 87-00, and will incorporate monitoring of the achieved EDG reliability against the target reliability.

With regard to the expected frequency of grid-related LOOPs at the site, we can not confirm the stated results. The available information in NUREG/CR-3992 (3), which gives a compendium of information on the loss of offsite power at nuclear power plants in U.S., only covers these incidents through the calendar year 1984. Diablo Canyon Units 1 and 2 did not enter commercial operation until 1985 and 1986, respectively. In the absence of any contradictory information, we agree with the licensee's statement.

Based on the above, the offsite power design characteristic of the Diablo Canyon site is "P1" with a minimum required SBO coping duration of four hours. The EAC power configuration "D" requires the licensee to commit to a 0.975 target EDG reliability.

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 that 168,451 gallons of water are required for decay-heat removal during the four-hour coping period. The minimum permissible condensate storage tank (CST) level per technical specifications provides 178,000 gallons of water. Plant procedures require alignment to alternate sources of condensate with approximately 50,000 gallons remaining in the CST. First preference for an alternate source of water is the raw water reservoir, which has an approximate maximum capacity of 4.5 million gallons and is gravity-fed to the auxiliary feedwater (AFW) system. The licensee stated (15) that while the raw water reservoir volume is monitored in accordance with surveillance test procedure I-39, the reservoir is a Class-2 system and is not relied upon to mitigate the consequences of an accident. Therefore the licensee took no credit for the raw water reservoir.

The second preferred source is the fire-water storage tank (FWST) which is able to provide the total required amount of condensate for decay-heat removal for four hours. The minimum capacity of the FWST per the DCPP technical specifications is 270,000 gallons. The licensee stated (15) that to use the FWST as an alternate AFW source, Operating Procedure D-1:V requires several valves to be manually operated.

Based on the above, the licensee concluded (12) that there is sufficient condensate to cope with a 4-hour SBO event.

Review of Licensee's Submittal

Using the expression provided in NUMARC 87-00, we have estimated that the water required for removing decay heat during the four-hour SBO would be ~77,000 gallons. This estimate is based on 102% of a maximum licensed core thermal rating of 3411 MWt for Unit 2 (Unit 1 is rated at 3338 MWt). Based on the analyses from similarly-sized Westinghouse plants which plan to cooldown, we estimate that ~90,000 gallons of water will be necessary to depressurize the secondary side to 250 psig. With cooldown, the total amount of water necessary is ~170,000 gallons, which is consistent with the licensee's estimate.

The licensee stated (12) that the minimum CST level provides 178,000 gallons of water. However, suction is switched from the CST when the level reaches 50,000 gallons, which yields a usable volume of 128,000 gallons. As an additional source of water, the licensee stated that it will use the FWST, which is shared between the two units. The FWST holds 270,000 gallons of water for the two units per Technical Specifications. Following several proceduralized manual actions, the AFW system can be gravity-fed from the FWST. Therefore, we agree with the licensee that sufficient condensate will be available to cope with a four-hour SBO event.

2. Class-1E Battery Capacity

Licensee's Submittal

The licensee stated (12) that a battery capacity calculation performed pursuant to NUMARC 87-00 Section 7.2.2 verified that the class-1E batteries have sufficient capacity to meet SBO loads for four hours. The licensee revised its battery calculations (13) to include flashing of the EDG field, and stated that the ability to close the breakers at the end of the SBO event utilizing DC power was not considered since these breakers can be closed manually. The

licensee stated (13) that the revised calculations did not affect the results of its originally reported information.

The licensee revised (15) its statement regarding its battery capacity. Battery capacity is calculated with input to Sargent and Lundy computer code "ELMS-DC," version 2.00. The licensee stated that the UFSAR, which indicates a two-hour battery capacity, has not yet been revised to reflect the need for a four-hour battery capacity to account for the DCPP SBO required duration. The licensee's calculations performed in support of its initial SBO submittal (12) used the same aging factor (1.25), temperature factor (1.15), and design margin (1.00) as used in qualifying the batteries for a two-hour capacity. The licensee has revised the battery-capacity calculations to take into account changes to input assumptions (such as a revised manufacturer battery curve, consideration of EDG field flashing, and refining the battery load profile). While the previous calculations indicated a four-hour capacity, the new calculations indicate that, while a four-hour coping duration could still be met, some type of compensation would be required.

The licensee stated that it has investigated several methods to resolve this issue (e.g., potential design changes, further refinement of actual battery loads, load shedding, and a revised aging factor). The results of the investigation are as follows:

1. Battery loading has been investigated and is unclear how much additional margin could be obtained.

2. The licensee would prefer not to take credit for load shedding in the case of an SBO to compensate for battery margin. The licensee stated that load shedding would require the attention of personnel who otherwise could be assisting in plant recovery and also introduces the potential for error.

3. Currently, in conjunction with the 1.25 aging factor, the licensee performs surveillance on the batteries, increases the surveillance frequency when 90% of battery capacity or 85% of service life is reached, and replaces batteries when 80% of capacity is reached in accordance with Surveillance Test Procedure M-12A, "Battery Performance Test." The licensee stated that the increased surveillance trends the loss of battery capacity and provide assurance that the required battery capacity is available. The licensee has investigated the use of a reduced aging factor (battery replacement at a point higher than 80%) in combination with battery trending and accelerated battery replacement. The results indicate that with the use of a reduced aging factor, the batteries meet the four-hour coping duration. The licensee proposes to revise the applicable procedures in accordance with the new aging factor so that sufficient trending data are available and batteries are replaced in a timely manner to ensure that adequate battery capacity is maintained. The licensee stated that it should be noted that the currently installed batteries are approximately ten years old and have adequate margin with which to meet a higher capacity factor.

Review of Licensee's Submittal

As stated above, the licensee's claim is that the batteries have sufficient capacity for two hours but not for four hours. The licensee is using the installation of the sixth EDG as a relief not to perform any design changes to improve battery capacity. The licensee claims that after the sixth EDG is installed, the batteries will be required to last for two hours instead of four. This statement is based on an EAC power classification of "A." Our review indicates that the EAC power classification is "D" and the plant therefore needs to be able to cope with an SBO event for four hours (see Section 3.1).

In the information provided by the licensee, we found the following non-conservatism:

1. In its calculations, the licensee used a design margin of 1.00.

2. The licensee proposes to reduce the aging factor below 1.25 in order to be able to have the batteries last for four hours.

These assumptions are not consistent with the guidance provided in IEEE-Std 485, which recommends a design margin of 1.10-1.15 and an aging factor of 1.25 be used. Based on the statements and information provided by the licensee, the batteries do not have sufficient capacity to supply the SBO loads for four hours.

3. Compressed Air

Licensee's Submittal

The licensee stated that air-operated valves relied upon to cope with a station blackout for four hours can either be operated manually or have sufficient back-up sources independent of the preferred and class-1E power supply. The licensee also stated that valves requiring manual operation or valves that require back-up sources for operation are identified in plant procedures.

Review of Licensee's Submittal

Upon review of the UFSAR (Section 9.3.1.6.1), we found that the steam generator atmospheric steam dump valves (ADVs) have with back-up nitrogen supplies. The nitrogen system is capable of supplying motive force as long as required since the requirements are small compared to the system capacity. Since the nitrogen system is not seismically qualified, a second back-up system is

provided, which consists of compressed-air bottles which can supply varying amounts of air via solenoid valves controlled from the control room. Therefore, we believe that DCPP has sufficient compressed-air supplies to cope with a 4-hour SBO event.

4. Effects of Loss of Ventilation

Licensee's Submittal

The licensee stated (15) that it followed the NUMARC guidance to calculate the AFW turbine-driven pump room final temperature. The licensee added that it reviewed the expected final temperature for other rooms housing equipment required for coping with an SBO event. These other rooms were the class-1E battery rooms, cable spreading room, 480-V switchgear room, DC inverter/battery charger rooms, solid-state protection system (SSPS) room, and control room.

The licensee stated (13) that, rather than using the NUMARC methodology, it relied on detailed calculations of room temperatures following the loss of ventilation which were performed for the DCPP probabilistic risk assessment (PRA) study. The licensee believes that these calculations more accurately represent post-blackout conditions than does the NUMARC method. The one exception to the use of the PRA calculations was for the AFW pump room. The licensee stated that, because this room was identified in NUMARC 87-00 as a dominant area of concern (DAC), it used the NUMARC methodology and guidelines rather than the PRA calculations.

The following table summarizes the results provided by the licensee:

Area	Initial Temp. (°F)	Final Temp. (°F)
AFW Pump Room	104	<120
Cable Spread. Room	104	118
480-V Switchgear Rm	104	121
DC Inverter Room	unknown	123
SSPS Room	78	117
Control Room	74	96

For each of these rooms, the licensee provided the following details:

AFW Pump Room

The initial temperature of the AFW pump room was assumed to be 104°F in accordance with the NUMARC 87-00 guidance. The heat loads considered were DC lighting, hot pipes, and the pump itself. The licensee calculated (15) the final room temperature to be less than 120°F, and stated that this temperature is significantly less than the equipment operability limits.

Battery Room

The licensee stated (15) that the heat loads for the class-1E battery rooms were determined to be due to lighting, instruments, and battery terminal contact resistance losses. The licensee concluded (15), based on engineering judgement, that the total heat loads were of no concern.

Cable Spreading Room

The licensee stated (15) that an initial temperature of 110°F was assumed for the previously calculated cable spreading room temperature in which a 100% heat load profile was used. The licensee stated that this initial temperature is conservative in that the assumed initial temperature currently used for calculations is 104°F. The final temperature, assuming a 100% heat load, was calculated to be 118°F, which is less than the manufacturer operability limits for equipment in this room.

480-V Switchgear Room

The 480-V switchgear room was assumed to have an initial temperature of 104°F. The licensee calculated the temperature to be 121°F after four hours, assuming a 100% heat load. This final temperature is less than the manufacturer operability limits for equipment in this room.

DC Inverter and Battery Charger Rooms

The licensee identified (12) the DC inverter and battery charger rooms as a DAC. With the doors to these rooms open, the licensee determined that the temperature would reach 122°F, if a 100% heat load were used. The licensee stated that the inverters have been determined to be functional to an ambient temperature of 131°F. The licensee initially stated (12) that emergency procedure "Loss of All AC Power" (EP ECA-0.0) will be revised to include the requirement that operators open the inverter and battery charger room doors. The licensee stated (15) that the 100% heat load contains unnecessary conservatism and it recalculated the temperature in the DC inverter/battery charger rooms using a more realistic heat load of 41% of the full heat load. With the reduced heat load, the room temperature is 123°F with the doors closed, and less than the equipment operability temperature of 131°F. The licensee added (15) that while ECA-0.0 includes directions for operators to monitor this and several other room temperatures and take actions as appropriate, PG&E will not revise EP ECA-0.0 to specifically require opening of the inverter/battery charger room doors following an SBO event as previously committed.

SSPS Room

The SSPS room was assumed to have an initial temperature of 78°F based on assumed HVAC environmental control operability prior to the onset of the SBO event. The licensee assumed a heat load of 70% of the full room heat load. By interpolation of the time-temperature curves, it was conservatively concluded that the final

SSPS room temperature would be approximately 117°F, which is less than the SSPS manufacturer operability limit of 122°F.

Control Room

The control room was assumed to have an initial temperature of 74°F based on the complete environmental control system being functional prior to the onset of an SBO event. The licensee determined that the heat load would be approximately 43% of the 100% heat load. The licensee added that, because the control room is shared between the two units, it is reasonable to assume that one of the four control room cooling units would be functional. Extrapolation from the 100% heat load calculations determined that the final temperature would be approximately 96°F and therefore below the equipment operability limits.

The licensee stated (12) that reasonable assurance of the operability of SBO response equipment in the DC inverter/battery charger rooms (the only DAC, based on a temperature >120°F) has been assessed using Appendix F to NUMARC 87-00. The licensee added that no modification or procedure change is required to provide reasonable assurance for equipment operability.

Review of Licensee's Submittal

The licensee's temperature-rise calculations were neither received nor reviewed. During the telephone conversation and in a set of follow-up questions, the licensee was asked to provide details of its heat-up calculations. The licensee provided (15) only a summary of its results. This summary included the initial temperature used, the final temperature calculated, and the percentage of the heat load used. Therefore, this review is based on these summaries. As such, the review only covers the assumptions and the methods identified by the licensee, and assumes the calculated temperatures to be accurate, pending future verification.

Based on the available information, we have the following concerns:

1. The licensee assumed initial temperatures of 78°F and 74°F for the SSPS room and the control room, respectively, which are non-conservative. However, if the licensee wishes to use these initial temperatures, then it must place administrative controls which ensure that the SSPS-room and control-room temperatures will not exceed the assumed temperature under any circumstances.

2. The licensee did not provide justification for using a fraction of the "100%" heat load for its calculation of the temperatures in the DC inverter and battery charger rooms, the SSPS room, and the control room. The licensee needs to justify its use of less than the 100% heat load and have these justifications in its SBO submittal supporting documentation.

3. Based on the information available and our analyses of other PWRs, the AFW pump room final temperature appears to be low. However, the equipment in the AFW pump room is qualified for a high-energy line break, which would produce a temperature considerably higher than 120°F. Therefore, equipment operability is not a concern in the AFW pump room.

Based on the licensee's calculation, we accept the licensee's results for the AFW pump room, the cable spreading room, and the 480-V switchgear room. However, due to a lack of detailed information, we are unable to concur with the licensee's conclusions concerning the DC inverter room, the SSPS room, and the control room.

5. Containment Isolation

Licensee's Submittal

The licensee stated (12) that the list of the plant 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 SBO conditions can be positioned with indication independent of the preferred and class-1 AC power supplies. The licensee initially stated (12) that no modifications or associated procedure changes were determined to be required to ensure that appropriate containment integrity can be provided under SBO conditions.

In response to the questions, the licensee provided (15) a list of all of the CIVs and its justification for excluding valves. The licensee used six exclusion criteria, the five given in RG 1.155 and one additional one. The additional criterion is:

- Penetrations that contain no valves and consist only of the penetration and associated pipe caps or similar separation devices.

Based on these six criteria, the licensee eliminated all but 16 valves. The licensee stated (15) that of these 16 valves, 14 are designated "safety" and are required to function for proper alignment of the emergency core cooling and other safety systems. The remaining two valves are designated "essential" and are motor operated valves (MOVs). These two MOVs are in series on the same line (Penetration 45), one inside containment and one outside containment. The valve outside containment (MOV 8100) will be included in EP ECA-0.0, "Loss of All AC Power." In this procedure, operators will be instructed to manually close this valve by means of a local handwheel in the event of an SBO.

Review of Licensee's Submittal

The additional exclusion criterion proposed by the licensee is reasonable since the penetrations to which this is applicable are sealed by pipe caps or by some other means. The list of CIVs provided (15) by the licensee identifies the valves which do not meet the exclusion criteria. We did not find any valves in addition to those identified by the licensee which could not be excluded by the criteria. Therefore, we agree with the licensee that containment integrity can be provided during an SBO event.

6. Reactor Coolant Inventory

Licensee's Submittal

The licensee stated that the ability to maintain adequate reactor coolant system (RCS) inventory to ensure that the core is sufficiently cooled has been assessed using the applicable generic analysis listed in NUMARC 87-00. The licensee determined that the resultant leak would not result in core uncovery during a 4-hour SBO event.

Review of Licensee's Submittal

Reactor coolant make-up is necessary to replenish the RCS inventory losses due to the reactor coolant pump seal leakage (25 gpm per pump per NUMARC 87-00 guideline), and the Technical Specifications maximum allowable leakage (estimated to be 25 gpm). The licensee stated that it used the generic analysis listed in NUMARC 87-00. The use of this analysis without providing justifications of its applicability is unacceptable.

We performed a calculation of the adequacy of the RCS inventory based on a postulated leak rate of 125 gpm. The total leakage from the RCS during the 4-hour SBO event is 30,000 gallons or

~4000 ft^3. Upon review of the UFSAR (Section 5.5), we found that the total RCS volume to be 12,070 and 12,160 ft^3 for Units 1 and 2, respectively, leaving an RCS volume of ~8000 ft^3 without any cooldown. If the primary system is cooled down following ECA 0.0, the RCS volume will be ~5000 ft^3 at the end of the SBO event, which is sufficient to keep the core covered. Therefore we concur with the licensee that sufficient RCS inventory exists to keep the core covered, and natural circulation, through reflux boiling, will keep the core cooled.

NOTE:

The 25-gpm RCP seal leak rate was agreed to between NUMARC and the NRC staff pending resolution of Generic Issue (GI) 23. If the final resolution of GI-23 defines higher RCP seal leak rates than assumed for the RCS inventory evaluation, the licensee needs to be aware of the potential impact of this resolution on its analyses and actions addressing conformance to the SBO rule.

3.3 Proposed Procedure and Training

Licensee's Submittal

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

1. Station response, and
2. AC power restoration.

The licensee stated (12) that it is unnecessary to develop and implement severe-weather guidelines or procedures due to the low risk of severe weather.

Review of Licensee's Submittal

We neither received nor reviewed the affected procedures. 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.

3.4 Proposed Modifications

Licensee's Submittal

The licensee stated that it is in the process of adding a sixth EDG. Upon completion of the modification, each unit will have three dedicated EDGs. The licensee stated (15) that this modification will be completed during Unit 2's fifth refueling outage.

The licensee stated (15) that it is currently establishing a database designed to track EDG component performance in accordance with Appendix D of NUMARC 87-00, and will incorporate monitoring of achieved EDG reliability against the target reliability. The licensee added that the addition of the database will be completed by March 1, 1992.

Review of Licensee's Submittal

Our analysis is based on the licensee's addition of the sixth EDG. The licensee did not provide a specific time table for the completion of the addition of the EDG.

When the licensee establishes the database for tracking EDG performance, it will have the five elements contained in Position 1.2 of RG 1.155 regarding EDG reliability. Additionally, our review has identified several concerns which may require modifications for their resolution.

3.5 Quality Assurance and Technical Specifications

The licensee stated (15) that, with the exception of portions of the electrical distribution system, all equipment relied upon to mitigate an SBO event as documented in PG&E's established emergency operating procedures are administratively controlled in accordance with the requirements of PG&E's graded quality assurance program. The licensee did not clarify how this program meets the steps given in Appendix A of RG 1.155.

4.0 CONCLUSIONS

Based on our review of the licensee's submittals and the information available in the UFSAR for Diablo Canyon Nuclear Power Plant, we find that the submittal conforms with the requirements of the SBO rule and the guidance of RG 1.155 with the following exceptions:

1. EAC Power Configuration Group

   The licensee determined that the EAC power configuration group for DCPP is "A" based on needing one of the three dedicated EDGs to shut down one unit. DCPP has neither the capability nor capacity to shut down one unit with a single EDG available. Therefore, we conclude that two EDGs are required to supply the necessary loads following a LOOP. Therefore, EAC power configuration is "D," based on needing two-out-of-three EDGs per unit to safely shut down the reactor.

2. Target EDG Reliability

   The licensee needs to commit to an EDG target reliability of 0.975, as is required for a plant in EAC power configuration "D."

3. Condensate Inventory

   We were unable to verify that the licensee will be able to control the AFW flow control valves, which control the rate at which feedwater is provided to the steam generators. The licensee needs to verify that it will be able to control the valves (i.e., the valves are DC powered). If power will not be available to these valves during an SBO event, the licensee needs to have a procedure which instructs the operators to perform the necessary actions associated with the manual operation of the AFW flow control valves.

4. Class-1E Battery Capacity

In the information provided by the licensee, we found the following non-conservatism:

1. In its calculations, the licensee used a design margin of 1.00.

2. The licensee proposes to reduce the aging factor below 1.25 in order to be able to have the batteries last for four hours.

These assumptions are not consistent with the guidance provided in IEEE-Std 485, which recommends a design margin of 1.10-1.15 and an aging factor of 1.25 be used. Based on the statements and information provided by the licensee, the batteries do not have sufficient capacity to supply the SBO loads for four hours.

5. Effects of Loss of Ventilation

Our review of the information provided by the licensee identified the following concerns:

1. The licensee assumed initial temperatures of 78°F and 74°F for the SSPS room and the control room, respectively, which are non-conservative. However, if the licensee wishes to use these initial temperatures, then it must place administrative controls which ensure that room temperatures will not exceed the assumed initial temperature under any circumstances.

2. The licensee did not provide justification for using a fraction of the "100%" heat load for its calculation of the temperatures in the DC inverter and battery charger rooms, the SSPS room, and the control room. The licensee needs to

justify its use of less than the 100% heat load and have these justifications in its SBO submittal supporting documentation.

6. Proposed Modifications

Our analysis is based on the licensee's addition of the sixth EDG. The licensee did not provide a specific time table for the completion of the addition of the EDG.

When the licensee establishes the database for tracking EDG performance, it will have the five elements contained in Position 1.2 of RG 1.155 regarding EDG reliability. Additionally, our review has identified several concerns which may require modifications for their resolution.

7. Quality Assurance

Although the licensee stated that it has a QA program, it did not clarify how this program meets the steps given in Appendix A of RG 1.155.

Fig. 1

5.0 REFERENCES

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

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

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

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

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

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

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

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

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

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

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

12. Shiffer, J.D., letter to U. S. Nuclear Regulatory Commission Document Control Desk, "Diablo Canyon Units 1 and 2, Station Blackout," dated April 17, 1989.

13. Shiffer, J.D., letter to U. S. Regulatory Commission Document Control Desk, "Diablo Canyon Units 1 and 2, Station Blackout," dated March 30, 1990.

14. Diablo Canyon Power Plant Updated Final Safety Analysis Report.

15. Shiffer, J.D., letter to U. S. Nuclear Regulatory Commission Document Control Desk, "Diablo Canyon Units 1 and 2, Additional Information Regarding Station Blackout," dated August 15, 1991.