Attachment 1
SAIC-91/6666

TECHNICAL EVALUATION REPORT

CLINTON POWER STATION,

STATION BLACKOUT EVALUATION

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1.0 BACKGROUND

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

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

In order to achieve a consistent systematic response from licensees to the SBO rule and to expedite the staff review process, NUMARC deve' ed two generic response documents. These documents were reviewed and endorsed (13) 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 (14) addressing the NRC's concerns regarding the deficiencies. NUMARC requested that the licensees send their supplemental responses to the NRC addressing these concerns by March 30, 1990.

2.0 REVIEW PROCESS

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

A. Minimum acceptable SBO duration (Section 3.1),

B. SBO coping capability (Section 3.2),

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

D. Proposed modifications (Section 3.3), and

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

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

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

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

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

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

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

e. ability to provide appropriate containment integrity, and

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

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

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

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

This SBO evaluation is based upon the review of the licensee's submittals dated April 16, 1989 (10), and March 30, 1990 (12), May 17, 1990 (15), a telephone conversation with the licensee on February 20, 1991, the licensee's response to questions raised during the telephone conversation

(16), and the information available in the plant Updated Safety Analysis Report (USAR) (11); it does not include a concurrent site audit review of the supporting documentation. Such an audit may be warranted as an additional confirmatory action. This determination would be made and the audit would be scheduled and performed by the NRC staff at some later date.

3.0 EVALUATION

3.1 Proposed Station Blackout Duration

Licensee's Submittal

The licensee, Illinois Power Company (IP), calculated (10 and 12) a minimum acceptable station blackout duration of four hours for the Clinton Power Station (CPS) site. The licensee stated that no modifications are required to attain this coping duration.

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

1. **Offsite Power Design Characteristics**

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

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

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

   The EAC power configuration of the plant is "C." Clinton is equipped with two emergency diesel generators, one of which is necessary to operate safe-shutdown equipment following a loss of offsite power.

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

The licensee has selected a target EDG reliability of 0.95. The selection of this target reliability is based on having an average EDG reliability of greater than 0.90 for the last 20 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. The licensee's estimate of the expected frequency of LOOP due to ESW and SW conditions is consistent with the information provided in NUMARC 87-00.

The licensee stated that the independence of the plant offsite power system grouping is "I1/2." A review of the Clinton USAR indicates that:

1. The site has a single switchyard and an independent 138-kV line;

2. During normal power operation, the essential buses are powered from 345-kV offsite power, through the reserve auxiliary transformer (RAT);

3. Upon loss of the RAT, offsite power is provided from 138-kV offsite power through the emergency reserve auxiliary transformer (ERAT);

4. Both transformers are sized and designed to supply the required load to the essential buses.

Based on these and the criteria stated in Table 5 of RG 1.155, we conclude that the plant independence of offsite power system group is "I1/2."

The licensee classified the EAC classification of Clinton as "C." Clinton has two EDGs not credited as AAC power sources, one of which is necessary to safely shutdown the plant.

The licensee selected a target EDG reliability of 0.95 based upon the last 20 demands. The target EDG reliability which the licensee selected (10) and committed to maintain (12) is in conformance with both RG 1.155 and NUMARC 87-00. Although this is an acceptable criterion for choosing an EDG target reliability, the guidance in RG 1.155 requires that the EDG reliability statistics for the last 50 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. The licensee needs to have an analysis showing the EDG reliability statistics for the last 20, 50, and 100 demands in its SBO submittal supporting documentation.

Although the licensee is committed to maintain the target EDG reliability, it did not state whether the plant has any formal reliability program consistent with the guidance of RG 1.155, Section 1.2, and NUMARC 87-00, Appendix D. Therefore, an audit may be required to ensure compliance.

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. Clinton Power Station did not enter commercial operation until 1987. 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 Clinton site is "P1" with a minimum required SBO coping duration of four hours.

3.2 Alternate AC (AAC) Power Source

Licensee's Submittal

The licensee stated that the Division-III emergency diesel generator which provides power for the High Pressure Core Spray (HPCS) will be used as an AAC power source. The licensee added that the AAC power source meets the criteria specified in Appendix B to NUMARC 87-00, is available within 10 minutes of the onset of an SBO event, and has sufficient capacity and capability to operate systems necessary for coping with an SBO for a 4-hour duration to bring the plant to and maintain it in a hot-shutdown condition.

Review of Licensee's Submittal

The proposed AAC power source, the Division-III EDG, has the capability and connectability to power the HPCS pump and its associated systems with minimal excess capacity. The Division-III diesel only supports its dedicated bus and it is not connectible to the other divisions of emergency buses. In addition, the licensee did not propose any modifications to use the excess capacity of this diesel to augment its ability to cope with an SBO event. Therefore, the Division-III EDG is not an AAC power source.

3.3 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's submittal stated that 121,900 gallons of water are required for the decay-heat removal during a 4-hour SBO coping period. The licensee stated that the suppression pool contains a minimum volume of 1,095,000 gallons of water, which is a sufficient amount to cope with a 4-hour SBO event. The licensee added that an additional source of water is the Reactor Core Isolation Cooling (RCIC) storage tank, which can provide 125,000 gallons of water. During the telephone conversation on February 20, 1991, the licensee stated that the RCIC storage tank is not safety-grade, and if this water source is not available, suppression-pool water will be used. If, however, the RCIC storage tank is available, it will be used as the primary source of water.

Following the telephone conversation on February 20, 1991, the licensee provided (16) information on the final conditions of the reactor and the suppression pool. At the end of the SBO event, the suppression-pool temperature will be 183°F, 2°F below the design temperature limit, and the vessel pressure will be kept between 178 psia and 209 psia. The licensee also stated that, at the final temperature of 183°F, the suppression pool does not have the heat capacity to accept blowdown of the vessel to lower pressure levels. This creates a conflict between the response to an SBO and the Emergency Operating Procedures (EOPs). The conflict occurs in the fourth hour when the suppression-pool temperature exceeds 175°F. The EOP would require further pressure reduction while the SBO response requires the 178-psia lower limit on pressure to prevent the pool from exceeding its design temperature. The licensee stated that this conflict is under review to assure that the SBO response is followed for the duration of the event, and that the resolution of this conflict is not expected to create any safety concerns.

The licensee concluded (16) that the elevated temperature of the suppression pool does not present a problem for the HPCS system since the pump is rated to handle fluid temperatures up to 212°F while the motor is air-cooled with a maximum ambient temperature of 149°F.

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 65,300 gallons. This estimate is based on 102% of a maximum licensed core thermal rating of 2894 MWt. In addition, condensate has to be provided to remove the sensible heat, to account for a leak rate of 61 gpm (18 gpm per recirculation pump and a technical specifications leak rate of 25 gpm), and to account for the shrinkage due to depressurization and cool-down. We estimated that 31,000 gallons were needed to remove the sensible heat, 14,600 gallons for leakage, and 12,400 gallons for shrinkage. This gives a total necessary condensate inventory of 123,300 gallons. Upon examining the HPCS pump, we found that it had sufficient head for it to take suction from the suppression pool at a temperature of 212°F.

The licensee stated (16) that in the fourth hour of the SBO event, the suppression-pool temperature exceeds the limit allowed by EOPs. At no point during an SBO event should any limits, design or otherwise, be exceed. The licensee needs to provide information on any modifications its plans to make in order to ensure that the suppression-pool temperature remains below its limit.

The licensee needs to verify that the use of the suppression-pool water as the only source of condensate is the bounding case during an SBO event. In addition, the licensee needs to verify that, if the RCIC storage tank water were used, the suppression-pool water level would not exceed the maximum allowable level.

2. Class-1E Battery Capacity

Licensee's Submittal

The licensee stated that the Division-III EDG energizes its division battery chargers and that the Division-I and -II class-1E batteries have sufficient capacity to meet station blackout loads for four hours provided that loads not necessary to cope with an SBO are stripped. The loads to be shed are identified in a procedure as are instructions for the operators to complete the load shedding within one hour.

In response to the questions raised during the telephone conversation on February 20, 1991, the licensee provided (16) additional information on its battery calculations and the loads which will be stripped. The licensee stated that the stripped loads will not remove power from any of the instruments needed to monitor the containment/drywell during the event. Many of the instruments provide their input to the analog trip modules (ATMs). The ATMs are powered by the nuclear system protection system (NSPS) inverters, which are not stripped from their DC bus. The licensee noted that although the ATMs are located in panels which have their DC power removed by the load shedding process, this will not affect the operation of the instrumentation. For the battery calculations, the licensee used an aging factor of 1.25, a design margin of 1.00, and a minimum electrolyte temperature of 65°F. The licensee calculated that, at the end of the 4-hour SBO event, the battery capacity remaining for the Division-I and -II batteries would be 2.4% and 17.0%, respectively.

Review of Licensee's Submittal

As a result of the telephone conversation on February 20, 1991, the licensee provided (16) information on its battery calculations, a checklist of the equipment which will be shed, and the instrumentation which would be available during an SBO event. The licensee performed calculations for the Division-I and -II batteries, which, according to USAR Section 8.3.2.1.1, can supply the essential loads for four hours at the minimum regulated temperature (65°F) and at 80% of the battery service life. No calculations were performed for the Division-III and -IV batteries. The Division-III battery will have the HPCS diesel available and, therefore, it will be charged. According USAR Section 8.3.2.1.1, only Divisions -I, -II, and -III 125-VDC subsystems are required to be considered for the safe-shutdown analysis of the plant. Therefore, no analysis of the Division-IV batteries is required.

We reviewed the licensee's provided assumptions and the loads which will be carried by the batteries. We did not, however, review the specific voltages or currents required for the various loads. Our review assumed that the battery loads provided by the licensee are correct.

Our review identifies the following concerns with regard to the licensee's battery-capacity calculations:

1) When considering the last minute of the SBO event, the licensee has a load (~220 and ~211 amperes for batteries 1A and 1B, respectively) for recovery from the event. This load starts at 240 minutes and continues until 241 minutes. During this last minute period, the only load on the batteries is this recovery load. The licensee needs to ensure that this load includes the same equipment that will be running before the last minute in addition to the

equipment necessary to recover from the SBO event (i.e., circuit-breaker closure, EDG start).

2) The licensee assumes that the RCIC battery loads will not be needed or they are only applied for 30 seconds. We believe that this is not consistent with the plant EOP which calls for the operation of RCIC with HPCS as a back-up. In addition, the RCIC system starts automatically upon primary-system isolation and low vessel water level. The operator will not shut down the RCIC system unless they are instructed to do so through an EOP. The licensee either needs to revise its battery-sizing calculation to include the RCIC loads or provide procedural steps as needed.

3) We summed the expected Division-I battery loads that will come on automatically during the first 10 seconds and found a value of 722.493 Amperes (A), of which 573.553 A are transient loads and 148.94 A are continuous loads. This number is different from the licensee's stated 563.807 A. If we were to use a one-minute current of 722.493 A and the one-minute amperes per positive plate value given by the licensee, and consider an aging factor of 1.25 (i.e., no temperature or design-margin factors), the Division-I battery would not meet the capacity required to last for four hours. Consideration of other correction factors make the matter even worse.

4) The licensee used a design margin factor of 1.00 in its battery calculations. This is not consistent with the guidance provided in IEEE-Std 485, which recommends a design margin factor of 1.10-1.15 be used.

5) The licensee is planning to shed the emergency lighting at 60 minutes into the SBO event. The licensee did not identify what will be available in the absence of the

lighting, or whether the substitute lighting is sufficient for the operators to perform the needed actions.

6) The licensee did not state whether the inverter loads (DC Amperes) are for SBO loads or normal loads after the event. We assumed that the continuous inverter current used by the licensee is based on the maximum current which is drawn when the battery terminal voltage is at its lowest level during an SBO event.

[illegible] the above concerns into account, the licensee needs either [illegible] that it has sufficient battery capacity or take [illegible]ate actions to ensure that it will have sufficient battery [illegible].

[illegible] regard to the list of instrumentation provided by the licensee (16), we have some concerns. During the SBO event, the licensee will be unable to monitor the drywell, containment, and suppression-pool temperatures without using portable testing equipment. These parameters are important to have available to alert operator of potential leakage. In addition, since the suppression-pool temperature is estimated to reach 183°F (within 2°F of the design temperature), we believe that this temperature is an important piece of information to have availabie. We also have a concern about the availability of the ADS accumulator pressure indication. The licensee's list of available instrumentation indicates that the ADS accumulator pressure information is powered from a non-class-1E battery. The licensee needs to ensure that this instrumentation will be available during the period for which depressurization will take place.

3. Compressed Air

Licensee's Submittal

The licensee stated (10) that the air-operated valves relied upon to cope with an SBO for four hours can either be operated manually or have sufficient back-up sources independent of the preferred and blacked-out unit's class-1E power supplies. The licensee added that Valves requiring manual operation or that need back-up sources for operation are identified in plant procedures.

Review of Licensee's Submittal

Clinton Power Station has a back-up supply of compressed air consisting of two air-bottle tank farms, each having 8 bottles, for the ADS function (Section 9.3.1.2 of the USAR). Based on this it appears, CPS has sufficient back-up supplies of compressed air to cope with a 4-hour SBO event. However, the licensee need to state what information is available to the operators in the absence of ADS accumulator pressure indicator to ensure sufficient air capacity for the valve operation, (see also battery capacity review).

4. Effects of Loss of Ventilation

Licensee's Submittal

The licensee initially stated (10) that the control room at CPS does not exceed 120°F during the SBO period provided that the control-room doors to the corridor are opened within one hour of the start of the SBO. In a follow-up submittal (12), the licensee stated that an improper heat-sink credit had been taken for a wall in the control room, and that a revised calculation would be submitted by May 18, 1990. In its submittal dated May 17, 1990 (15), the licensee stated that the control room will exceed 120°F during an SBO event, and that plans are being formulated to provide a means of forced ventilation following an SBO.

As a result of the telephone conversation on February 20, 1991, the licensee provided (16) information on its heat-up calculations. The licensee stated that, whenever possible, the NUMARC methodology was used to analyze the effects of loss of HVAC.

1) RCIC System/Main Steam Tunnel

The licensee stated (10) that the peak temperatures in the main steam tunnel, RCIC pump room, and RCIC instrument panel room will be 223°F, 146°F, and 166°F, respectively. The licensee stated that reasonable assurance of the operability of SBO response equipment in these areas has been assessed using Appendix F to NUMARC 87-00. The licensee added that procedures will be changed to instruct the operators to disable the automatic trips for RCIC due to high main steam tunnel temperature.

2) Inverter Rooms

At CPS, there are four inverter rooms. The Division-III inverter room is cooled by the Division-III diesel, and, therefore, its temperature will not change. For the other three inverter rooms, the licensee assumed an initial temperature of 80°F, which was derived from the HVAC calculations of the VC (control room) and VX (switchgear room) systems. The licensee stated that the inverter rooms are cooled by the same HVAC system that maintains the battery room temperatures at 77°F, ±3°F. The licensee stated that the final temperature in the Division-IV inverter room is 101°F. For the Division-I and -II inverter rooms, which are smaller than the Division-III and -IV rooms, the licensee calculated a final temperature of 111°F.

3) Control Room

The licensee stated that the NUMARC methodology could not be applied to the main control room because the NUMARC assumptions concerning wall and ceiling composition were not in agreement with the installed conditions. In order to calculate the control-room temperature, the licensee used a transient heat-transfer computer model. The model included the heat loads from personnel and from equipment powered by battery-fed inverters. After the preliminary computer runs, the licensee determined that additional cooling would be required to maintain the control-room temperature below 120°F. The licensee developed an air-flow model which induces outside ambient air with an assumed temperature of 96°F into the control room and exhausts air from the control room using a gasoline-powered fan. The model established that a flow rate of 5200 cubic feet per minute (cfm) of 96°F outside air, initiated at 30 minutes into the SBO event, would prevent the control room temperature from exceeding 120°F.

The model assumed an initial temperature of 73°F for the control room and calculated a peak temperature of 119°F before the start of the proposed gasoline-powered fan at 30 minutes into the event. While technical specifications maximum control-room temperature is 86°F maximum, the use of 73°F as an initial temperature is justified based on having two fully redundant 100%-capacity trains of HVAC in the control room. The licensee provided (16) a temperature vs. time curve which depicts the control-room temperature rise over time. The licensee stated that if an initial temperature of 86°F were to be used, the peak temperature is not expected to be 132°F, which is a direct sum of the difference between the two initial temperatures (13°F) and the calculated peak temperature at the lower initial temperature (119°F). The licensee justifies a lower final temperature using the temperature vs. time curve which shows the control-room temperature reaches 86°F from an initial 73°F temperature in the first three minutes. If the curve is extrapolated for another three minutes beyond the first 30 minutes, as if the time scale were shifted three minutes, a peak temperature of 121°F is obtained before the forced ventilation is initiated. This small temperature difference is due to the flattening of the curve as the temperature continues to rise above 100°F.

The licensee added that the modifications to add the gasoline-powered fan for control-room ventilation is scheduled to be designed and implemented in 1992. The modification will most likely use commercial-grade equipment designed to remove smoke and gases from a room in support of fire-fighting activities. The design process will determine where the equipment and fuel will be stored, as well as resolving any procedural impacts. The licensee also stated (12) that procedures will be revised to include the opening of the control-room electrical cabinet doors within 30 minutes of the onset of an SBO event.

4) <u>Containment/Drywell</u>

The licensee stated (16) that, with regard to the loss of HVAC in the drywell, it has confirmed that the temperature peak in the containment/drywell as a result of an SBO event is enveloped by the LOCA/HELB analyzed peak temperature. In support of its statement, the licensee provided a graph from a 1985 letter regarding the drywell temperature response to an SBO event. The graph has been extrapolated from one hour to four hours, and indicates that the maximum drywell temperature of ~225°F, which is below the LOCA/HELB maximum temperature of 250°F.

Review of Licensee's Submittal

The licensee's temperature-rise calculations were neither received nor reviewed. Therefore, this review is based on the summaries provided (10 and 16) by the licensee in its submittals. 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.

In response to the questions raised during the telephone conversation on February 20, 1991, the licensee provided (16) a summary of its heat-up calculations for the inverter rooms and the main control room, and a confirmatory statement that the drywell/containment heat-up during an SBO is enveloped by the LOCA/HELB maximum temperature of 250°F.

1) RCIC System/Main Steam Tunnel

   The licensee provided the results of its calculations for the main steam tunnel, RCIC pump room, and RCIC instrument panel room. The licensee calculated a final temperature of 223°F for the main steam tunnel. The licensee needs to ensure that at this temperature, the RCIC turbine steam supply valve will be able to be closed should containment isolation become necessary. The licensee also stated that procedures will be changed to instruct the operators to disable the automatic RCIC high steam tunnel temperature trips. The licensee needs to ensure that the procedures will instruct the operators to disable the trip before the main steam tunnel temperatures reach the trip set point. The timing of the bypassing of the trip is not critical because the plant is equipped with HPCS which provides the same function as RCIC with a higher capacity.

2) <u>Division-I and -II Inverter Rooms</u>

Using an initial temperature of 80°F, the licensee calculated a maximum final room temperature of 111°F. During the telephone conversation, the licensee stated that the heat-up calculation was based on the heat-generation rates from normal inverter loads. We have two comments on this calculation. First, the 80°F initial temperature is non-conservative. For this temperature to be acceptable, the licensee needs to have/establish a control which ensures that this temperature would not be exceeded under any circumstances, or use the maximum allowable temperature for these rooms. Second, for the heat load in the room due to the inverters, the licensee needs to verify that it has used an inverter efficiency loss consistent with the expected inverter load, or use a constant efficiency loss based on the rated capacity of the inverter. For example, if the inverter has an efficiency of 0.8, the licensee could assume a heat load of equivalent to the 20% of the rated capacity of the inverter, regardless of the inverter's output.

3) <u>Control Room</u>

In the licensee's control-room calculation, we found the following non-conservatism:

a) The licensee's use of 96°F for the outside air temperature is non-conservative. The maximum temperature recorded at Springfield is 112°F, and at Peoria is 103°F (USAR Section 2.3.1.1). Using the data from NUREG/CR-1390 (17), we found that the extreme annual maximum temperature for the 50-year return period for the Clinton site is 111°F. Therefore, a higher temperature than 96°F should have been assumed for the outside ambient-air temperature.

b) The licensee assumed a personnel heat load of 255 Btu/hr (~75 Watts) per person. The ASHRAE handbook (18) recommends a heat load of ~250 Watts per person.

c) The licensee's use of an initial control-room temperature of 73°F instead of the technical specifications limit of 86°F is non-conservative. However, if the licensee wishes to use a 73°F initial temperature, then it must place an administrative control which ensures that the control-room temperature will not exceed the assumed temperature under any circumstances.

d) With regard to the licensee's method for extrapolating the temperature curve to determine the final temperature for an initial temperature of 86°F, the method is valid if the initial temperature is the only input parameter that changes. Since other parameters which affect the final temperature also need to be revised, the extrapolation method used by the licensee is not applicable.

e) The licensee stated that the fan used in the control-room heat-up model is capable of delivering 5200 cfm. However, the licensee did not state whether this flow rate was given in standard cfm or if the flow rate had been adjusted for the elevated outside air temperature. The licensee needs to clarify this and have the clarification in its SBO submittal supporting documentation.

Based on our review, the licensee needs to re-evaluate its control-room heat-up calculation, taking into account the aforementioned non-conservatism.

4) <u>Containment/Drywell</u>

For the drywell calculations, the licensee did not provide detailed information. The licensee stated that it has verified that the drywell temperature under SBO conditions is bounded by that expected under the LOCA/HELB conditions. We accept the licensee's statement pending future verification.

5. Containment Isolation

Licensee's Submittal

The licensee stated that the plant list of containment isolation valves (CIVs) was reviewed and it was determined that all of the valves which must be capable of being closed or 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 also said that although no modifications are necessary to ensure that appropriate containment integrity can be provided under SBO conditions, a minor procedure change is required.

Review of Licensee's Submittal

Upon review o: the list of containment isolation valves (USAR Table 6.2-47), we found that there are several valves (i.e., RHR shutdown cooling, LPCS suppression pool suction, etc.) which do not meet the exclusion criteria outlined in RG 1.155. The licensee needs to list in an appropriate procedure the CIVs which are either normally closed or open and fail as-is upon loss of AC power and cannot be excluded by the criteria given in RG 1.155, 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.).

6. Reactor Coolant Inventory

Licensee's Submittal

The licensee stated that the AAC source powers the necessary make-up systems to maintain adequate reactor coolant system (RCS) inventory to ensure that the core is cooled for the rcquired coping duration.

Review of Licensee's Submittal

Reactor coolant make-up is necessary to remove decay heat, to cooldown the primary system, and to replenish the RCS inventory losses due to the 61-gpm leak rate (18 gpm per recirculation pump per NUMARC 87-00 guideline and 25 gpm for the technical specifications maximum allowable leakage). The HPCS pump, which is powered by the Division-III EDG, has the capability to inject CST water at a rate of 5010 gpm. In addition, the RCIC pump will also be available. The combination of these two pumps is sufficient to compensate for the postulated leak rate in addition to the injection rate necessary to remove decay heat and to keep to core covered and cooled for the duration of the SBO event.

NOTE:

> The 18-gpm recirculation pump 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 Procedures and Training

Licensee's Submittal

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

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

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

Review of Licensee's Submittal

We neither received nor reviewed the affected SBO procedures. We consider these procedures as plant specific actions concerning the required activities to cope with an SBO. It is the licensee's responsibility to revise and implement these procedures, as needed, to mitigate an SBO event and to assure that these procedures are complete and correct, and that the associated training needs are carried out accordingly.

3.5 Proposed Modifications

Licensee's Submittal

The licensee initially stated (10) that no modifications were identified as necessary for CPS to meet the requirements of the SBO rule. As a result of its heat-up analysis, the licensee determined (16) that a modification to add a 5200-cfm gasoline-powered fan for the ventilation of the control room is necessary. The licensee stated that the modification will most likely use commercial-grade equipment designed to remove smoke and gases from a room in support of fire-fighting activities. The licensee also stated that the modification is scheduled to be designed and implemented in 1992.

Review of Licensee's Submittal

We have a concern about the adequacy of the capacity of the 5200-cfm fan. The licensee needs to re-evaluate the necessary capacity of the fan after taking into consideration the concerns outlined in the Effects of Loss of HVAC section of this report. In addition, our review has identified several concerns which the licensee needs to respond and may require modifications for their resolutions.

3.6 Quality Assurance and Technical Specifications

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

4.0 CONCLUSIONS

Based on our review of the licensee's submittals and the information available in the USAR for Clinton Power Station, we find that the submittal conforms with the SBO rule by following the guidance of RG 1.155 with the following exceptions:

1. Emergency Diesel Generator Reliability Program

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

2. Condensate Inventory

   The licensee stated (16) that in the fourth hour of the SBO event, the suppression-pool temperature exceeds the limit allowed by EOPs. At no point during an SBO event should any limits, design or otherwise, be exceed. The licensee needs to provide information on any modifications its plans to make in order to ensure that the suppression-pool temperature remains below its limit.

   The licensee needs to verify that the use of the suppression-pool water as the only source of condensate is the bounding case during an SBO event. In addition, the licensee needs to verify that, if the RCIC storage tank water were used, the suppression-pool water level would not exceed the maximum allowable level.

3. Class-1E Battery Capacity

   Our review identifies the following concerns with regard to the licensee's battery-capacity calculations:

1) When considering the last minute of the SBO event, the licensee has a load (~220 and ~211 amperes for batteries 1A and 1B, respectively) for recovery from the event. This load starts at 240 minutes and continues until 241 minutes. During this last minute period, the only load on the batteries is this recovery load. The licensee needs to ensure that this load includes the same equipment that will be running before the last minute in addition to the equipment necessary to recover from the SBO event (i.e., circuit-breaker closure, EDG start).

2) The licensee assumes that the RCIC battery loads will not be needed or they are only applied for 30 seconds. We believe that this is not consistent with the plant EOP which calls for the operation of RCIC with HPCS as a back-up. The licensee either needs to revise its battery-sizing calculation to include the RCIC loads or provide procedural steps as needed.

3) We summed the expected Division-I battery loads that will come on automatically during the first 10 seconds and found a value of 722.493 Amperes (A), of which 573.553 A are transient loads and 148.94 A are continuous loads. This number is different from the licensee's stated 563.807 A. If we were to use a one-minute current of 722.493 A and the one-minute amperes per positive plate value given by the licensee, and consider an aging factor of 1.25 (i.e., no temperature or design-margin factors), the Division-I battery would not meet the capacity required to last for four hours.

4) The licensee used a design margin factor of 1.00 in its battery calculations. This is not consistent with the guidance provided in IEEE-Std 485, which recommends a design margin factor of 1.10-1.15 be used.

5) The licensee is planning to shed the emergency lighting at 60 minutes into the SBO event. The licensee did not identify what will be available in the absence of the lighting, or whether the substitute lighting is sufficient for the operators to perform the needed actions.

Taking the above concerns into account, the licensee needs either to verify that it has sufficient battery capacity or take appropriate actions to ensure that it will have sufficient battery capacity.

During the SBO event, the licensee will be unable to monitor th drywell, containment, and suppression-pool temperatures witho using portable testing equipment. These parameters are important to have available to alert operator of potential leakage. We also have a concern about the availability of the ADS accumulator pressure indication. The licensee's list of available instrumentation indicates that the ADS accumulator pressure information is powered from a non-class-1E battery. The licensee needs to ensure that this instrumentation will be available during the period for which depressurization will take place.

4. Effects of Loss of Ventilation

1. <u>RCIC System/Main Steam Tunnel</u>
The licensee provided the results of its calculations for the main steam tunnel, RCIC pump room, and RCIC instrument panel room. The licensee calculated a final temperature of 223°F for the main steam tunnel. The licensee needs to ensure that at this temperature, the RCIC turbine steam supply valve will be able to be closed should containment isolation become necessary. The licensee also stated that procedures will be changed to instruct the operators to disable the automatic RCIC high steam tunnel temperature trips. The licensee needs to ensure that the procedures

will instruct the operators to disable the trip before the main steam tunnel temperatures reach the trip set point. The timing of the bypassing of the trip is not critical because the plant is equipped with HPCS which provides the same function as RCIC with a higher capacity.

2) Division-I and -II Inverter Rooms

Using an initial temperature of 80°F, the licensee calculated a maximum final room temperature of 111°F. During the telephone conversation, the licensee stated that the heat-up calculation was based on the heat-generation rates from normal inverter loads. We have two comments on this calculation. First, the 80°F initial temperature is non-conservative. For this temperature to be acceptable, the licensee needs to have/establish a control which ensures that this temperature would not be exceeded under any circumstances, or use the maximum allowable temperature for these rooms. Second, for the heat load in the room due to the inverters, the licensee needs to verify that it has used an inverter efficiency loss consistent with the expected inverter load, or use a constant efficiency loss based on the rated capacity of the inverter. For example, if the inverter has an efficiency of 0.8, the licensee could assume a heat load of equivalent to the 20% of the rated capacity of the inverter, regardless of the inverter's output.

3. Control Room

With regard to the licensee's control-room heat-up calculation, we have the following concerns:

a) The licensee's use of 96°F for the outside air temperature is non-conservative. The maximum temperature recorded at Springfield is 112°F, and at Peoria is 103°F (USAR Section 2.3.1.1). Using the data from NUREG/CR-1390 (17), we found that the extreme annual maximum temperature for the 50-year return period for the Clinton site is 111°F. Therefore, a higher temperature than 96°F should have been assumed for the outside ambient-air temperature.

b) The licensee assumed a personnel heat load of 255 Btu/hr (~75 Watts) per person. The ASHRAE handbook (18) recommends a heat load of ~250 Watts per person.

c) The licensee's use of an initial control-room temperature of 73°F instead of the technical specifications limit of 86°F is non-conservative. However, if the licensee wishes to use a 73°F initial temperature, then it must place an administrative control which ensures that the control-room temperature will not exceed the assumed temperature under any circumstances.

d) With regard to the licensee's method for extrapolating the temperature curve to determine the final temperature for an initial temperature of 86°F, the method is valid if the initial temperature is the only input parameter that changes. Since other parameters which affect the final temperature also need to be revised, the extrapolation method used by the licensee is not applicable.

e) The licensee stated that the fan used in the control-room heat-up model is capable of delivering 5200 cfm. However, the licensee did not state whether this flow rate was given in standard cfm or if the flow rate had been adjusted for the elevated outside air temperature. The licensee needs to clarify this and have the clarification in its SBO submittal supporting documentation.

The licensee needs re-evaluate its control-room heat-up calculation, taking into account the aforementioned concerns.

4. Drywell/Containment

For the drywell calculations, the licensee did not provide information on its assumptions for this calculation (i.e., initial temperature, leak rate, etc.), and, therefore, we cannot confirm that the SBO temperature bounds the LOCA/HELB maximum temperature. The licensee needs to re-examine the calculated drywell conditions and to ensure that the assumptions used accurately reflect the conditions expected during an SBO event and include a leak rate of 61 gpm.

5. Containment Isolation

Upon review of the list of containment isolation valves (USAR Table 6.2-47), we found that there are several valves which do not meet the exclusion criteria outlined in RG 1.155. The licensee needs to list in an appropriate procedure the CIVs which are either normally closed or open and fail as-is upon loss of AC power and cannot be excluded by the criteria given in RG 1.155, and identify the actions necessary to ensure that these valves are fully closed, if needed.

6. Proposed Modifications

Our review has identified several concerns which the licensee needs to respond and may require additional modifications for their resolutions.

7. Quality Assurance and Technical Specifications

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

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. Holtzscher, D. L., letter to NRC Document Control Desk, "Response to Station Blackout Rule," Docket No. 50-461, dated April 16, 1989.

11. Clinton Station Updated Final Safety Analysis Report.

12. Spangenberg, F. A., III, letter to NRC Document Control Desk, "Supplemental Response to Station Blackout Rule," Docket No. 50-461, dated March 30, 1990.

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

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

15. Spangenberg, F. A., III, letter to the NRC Document Control Desk, "Supplemental Response to the Station Blackout Rule," dated May 17, 1990.

16. Supplemental information package provided as a result of the telephone conversation on February 20, 1991.

17. U.S. Nuclear Regulatory Commission, "Probability Estimates of Temperature Extremes for the Contiguous United States," NUREG/CR-1390, May, 1980.

18. "ASHRAE Handbook, 1977 Fundamentals," American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York, 1977.