Nebraska Public Power District

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NLS9100066
January 31, 1991

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Subject: Station Blackout Information Request, 10CFR50.63
Cooper Nuclear Station
NRC Docket No. 50-298, DPR-46
TAC #68534

Gentlemen:

This submittal provides information regarding Station Blackout for Cooper Nuclear Station as requested in a January 16, 1991, conference call with the NRC Staff. During this conference call the District committed to provide additional clarification and information on selected topics associated with Station Blackout.

The Staff questions are restated in the attachment along with the attendant District response. In addition, copies of the Cooper Nuclear Station Site Specific Weather Calculation and the Control Room Temperature Rise Calculation for Station Blackout are enclosed per the Staff's request.

The last staff question concerned implementing station procedural changes to verify closure of certain primary containment isolation valves during a Station Blackout (SBO) event. The District believes the valves in question are excluded from having their closure verified during a SBO based on the information presented in response to Question No. 4. The District will await NRC review of the attached information prior to implementing any changes to pertinent station procedures.

If you have any additional questions, please call.

Sincerely,

G. R. Horn
Nuclear Power Group Manager

GRH/grs:jw
Attachment

cc: U.S. Nuclear Regulatory Commission
Region IV
Arlington, TX

NRC Resident Inspector Office
Cooper Nuclear Station

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NRC QUESTION #1:

Provide a copy of the Cooper Nuclear Station (CNS) Site Specific Weather Calculation.

RESPONSE:

A copy of Calculation NPP1-SBO-005 is enclosed.

Regarding wind speed, the maximum recorded hourly average at CNS was 40.1 mph, over a 13-year time period from 1975 to 1987. Extrapolation of this data to the 30-meter elevation results in a maximum of 48.4 mph. Using a very conservative cutoff of 45 mph (the NUMARC 87-00 cutoff point is 75 mph), the probability of winds exceeding the 45 mph cutoff was 0.0769, calculated directly from the recorded data. On this basis, CNS was placed in Severe Weather Group 2 (SW2). Further concerning the wind speed, National Weather Service instantaneous wind speed data (39-year sample) indicated that the value of f=0.0769 is conservative.

The Extremely Severe Weather (ESW) category was evaluated based on site specific tornado data procured from the National Weather Service. A 39-year sample was used. Using a conservative cutoff value of 113 mph (the NUMARC 87-00 criterion is 125 mph), the frequency of severe storms was 2.357E-4, which places CNS in ESW Group 1. The combination of Groups ESW1 and SW2 places CNS in Offsite Power Group P1.

NRC QUESTION #2:

Provide analysis purpose and assumptions used for the primary containment analysis. How does this analysis conform to the conditions expected during station blackout? Explain and identify conservatism and non-conservatism in the analysis. Discuss drywell and suppression pool temperature response. Justify assumptions.

RESPONSE:

The Cooper Nuclear Station (CNS) primary containment analysis for station blackout (SBO) was performed using the IDCOR Modular Accident Analysis Program (MAAP) Version 2.0. This analysis was completed in mid-1987 and is described in detail in Reference 1. Its purpose was to provide a preliminary definition of the CNS station blackout coping time, in response to the then-proposed SBO rule. The analysis was performed in tandem with DC power system upgrades which were being implemented at CNS during that time period, to ensure that the proposed battery system would have sufficient capacity. Installation of the new 125 VDC and 250 VDC batteries was completed in 1989. The 1987 SBO analysis is up-to-date with respect to the latest DC power system configuration at CNS.

The MAAP analysis specifically addressed the conditions expected during SBO. The assessment considered only the hardware response and did not take any credit for operator actions or procedures.

Principal Features of the MAAP Model

The CNS primary system and containment were modelled. The primary system model included the principal reactor vessel components. Specifically, the core, upper plenum, lower plenum, downcomer, jet pumps and recirculation pumps (coastdown only), attendant emergency core cooling system piping and internal heat structures were modelled. The reactor vessel safety and relief valves, the high pressure coolant injection (HPCI) system, and the reactor core isolation cooling (RCIC) system were also modelled. The containment model included the drywell, the reactor pedestal volume, the torus air space, the pressure suppression pool, and the major heat sinks within each of these volumes, i.e. the pedestal wall, the drywell concrete floor and walls, the torus room walls, and the steel heat sinks within each volume.

Relief valve discharge was to the pressure suppression pool (PSP), whereas the reactor vessel safety valves discharged directly to the drywell if their lift pressure was reached. The safety and relief valves were both operated according to spring pressures in the MAAP model. Use of DC power and instrument air was not considered, since these are associated with remote manual operation from the control room.

In the MAAP model, vessel water level was controlled by automatic operation of the HPCI and RCIC systems, based on low and high water level trip setpoints. Design flow was delivered 25 and 30 seconds after system startup, for HPCI and RCIC, respectively. Normal system alignment is to the emergency condensate storage tank (ECST) at CNS. Automatic transfer of HPCI pump suction to the suppression pool (upon low ECST water level or high PSP water level) was modelled, in a manner consistent with present operation of this system at CNS. (The RCIC transfer is manually performed and procedurally controlled in the event it is necessary to transfer suction to the PSP). For battery sizing purposes, 6 cycles per hour were assumed for each of the HPCI and RCIC systems.

Principal Assumptions

The key assumptions for the MAAP analysis are listed below:

- The initiating event for the SBO assessment was a loss of offsite power coupled with failure of the emergency diesel generators. A complete loss of all AC power to the plant's switchgear was assumed.
- No operator actions by procedure or otherwise were assumed. Only the automatic response of hardware was considered.
- The plant was assumed to be at full power and in a normal operating configuration (normal RPV water level and steady state conditions) at the beginning of the SBO event, such that it was in full compliance with its technical specifications. MAAP conservatively assumes that the reactor is at 100% power until the control rods are fully inserted. Decay heat modelling followed the ANSI/ANS-5.1-1979 standard curve.
- No additional single active failures or postulated line breaks were assumed, and no spurious operation of any component was assumed.
- DC power was assumed to be available. Subsequent battery capacity calculations have confirmed the availability of DC power for the CNS 4-hour SBO coping duration. (See Appendix C of Reference 2).

Initial Conditions

The following conditions were specified at the onset of the SBO analysis.

Drywell Temperature	135°F
Suppression Pool Temperature	90°F
Suppression Pool Volume	89,050 ft^3

The initial temperatures are the same values used in the design basis loss-of-coolant accident (LOCA) analyses in the USAR. The suppression pool volume is conservative with respect to the USAR LOCA evaluations, for which a volume of 91,100 ft^3 was used.

The minimum PSP water volume allowed by CNS Technical Specifications is 87,650 ft^3. Use of this smaller volume would increase the suppression pool temperature rise by approximately 1 (one) Fahrenheit degree, and use of the 95^{O}F, LCO value for the initial temperature would add another 5F^{O}. This would not affect the SBO analysis conclusions, since there is ample margin (~20F^{O}) between the PSP temperature and the Heat Capacity Temperature Limit (HCTL) for a 4-hour SBO at CNS.

Highlights of Results

In the MAAP analysis, the primary system pressure oscillated about an average value of approximately 1040 psia, due to relief valve cycling and subsequent vessel refill by the HPCI and RCIC systems. The vessel water level remained well above top-of-active fuel (TAF) for the duration of the postulated SBO event.

After 4 hours, the calculated suppression pool temperature was about 155^{O}F. The peak calculated reactor vessel pressure was less than 1070 psia. At 1070 psia, the CNS HCTL is approximately 175^{O}F. Hence, the HCTL would not be exceeded during a 4-hour SBO. (Note: Conclusions in Reference 1 regarding the HCTL are no longer valid. The current CNS HCTL curve is substantially less restrictive than the 1987 version.)

The drywell temperature was calculated to be approximately 185^{O}F after 4 hours. Very early in the event, the drywell was heated for a brief period by direct discharge of steam from the reactor vessel safety valves, just after the MSIVs closed. Thereafter, all steam discharged from the reactor vessel went to the suppression pool via the relief valves, and the predominant factor in the drywell heating was the reactor vessel heat load in the absence of the drywell coolers. Other than the previously mentioned safety valve discharge, no inventory loss from the reactor system to the drywell was considered.

The analysis showed that there is adequate condensate storage at CNS to cope with a station blackout. The analysis also showed that there would be no automatic transfer of HPCI suction nor any need to manually transfer RCIC suction to the suppression pool because of high PSP water level.

Applicability to Present SBO Evaluation

The discussion thus far has focused on the 1987 SBO study detailed in Reference 1. The latest CNS SBO evaluation (1990) is presented in Reference 2, which is the CNS SBO Coping Assessment Report. In Reference 2, it was noted that the drywell response during a 4-hour SBO would be bounded by the conditions during design basis LOCA events. Since the suppression pool heatup calculated in the 1987 MAAP analysis indicated that the HCTL would not be exceeded, rigorous analyses of primary containment heatup were not performed for inclusion in the CNS SBO Coping Assessment Report.

The Coping Assessment Report concludes that CNS has a 4-hour SBO coping capability, and that there is adequate condensate in the ECSTs to support this requirement. The results of the 1987 study support these conclusions. Generally speaking, the results of the 1987 study are considered directly applicable or else conservative with respect to the evaluations in the Coping Assessment Report.

The major difference between the two SBO evaluations is HPCI operation. The 1987 study assumes automatic operation of both HPCI and RCIC, as noted. The 1990 evaluation assumes that HPCI is secured after one cycle of operation, to conserve battery energy. Thereafter, reactor vessel level is controlled by automatic operation of the RCIC system. One cycle of HPCI is sufficient to stabilize level, with no core uncovery expected. Other BWR analyses have indicated that RCIC alone is sufficient for level control. (See Reference 3 and pages 25 and 26 of Reference 2). Therefore, the 1987 study is conservative with respect to both battery margin and torus heatup.

As noted above regarding PSP heatup, the 1987 results are conservative. The combined flow rate of HPCI and RCIC (4650 gpm) is over eleven times greater than the RCIC flow rate alone (400 gpm). This translates to a significantly greater steaming rate to the suppression pool in the 1987 analysis, yielding a conservative pool temperature calculation as a result.

With respect to condensate inventory, the 1990 evaluation used a total value of 50 gpm leakage from two recirculation pumps for 4 hours. The ECST inventory was more than sufficient to support vessel makeup water requirements, in agreement with conclusions of the 1987 analysis, which did not factor in the recirculation pump leakage.

The drywell heat load due to recirculation pump leakage was not considered in the 1987 analysis, which is potentially non-conservative. However, the calculated SBO drywell temperature of 185°F is significantly less than the CNS drywell peak temperature of 295°F, calculated for a main steam line break (MSLB) in the design basis LOCA analyses documented in the USAR. Considering the large margin between the SBO and the LOCA analyses, it is not expected that the peak drywell LOCA temperature would be exceeded if the recirculation pump leakage term were factored into the SBO analysis.

A 25 gpm leak rate from each recirculation pump seal essentially amounts to a small break in the drywell. Liquid from the pump seal would enter the drywell and flash to steam. This steam would condense locally on walls, grating and other thin steel heat structures, and then drip to the drywell floor. The main area affected would be the annular space between the reactor pedestal and the drywell wall. A break this small would be much less severe than the design basis accident, which assumes a double-ended guillotine break of the recirculation line and is itself bounded by the MSLB mentioned above.

Conservatism in the Analysis

Various conservatisms in the 1987 SBO analysis have been identified previously in this response. The principal conservatisms are use of both HPCI and RCIC for vessel water level control and the assumption that the reactor is at 100% power until the control rods are fully inserted. Other than the recirculation pump seal leakage discussed above, the District knows of no non-conservatism in the earlier analysis. The District asserts that the existing USAR LOCA analyses would bound an SBO case with the pump seal leakage factored in.

Conclusion

The CNS 1987 MAAP analysis provides assurance that the drywell environment during a 4-hour SBO would be bounded by the design basis LOCA environment. This analysis is also conservative with respect to suppression pool heatup. Based on the discussion herein, further rigorous analysis of drywell and containment heatup is considered unnecessary.

References

1) "Cooper Nuclear Station Station Blackout Coping Time", Sargent & Lundy Report SL-4435, dated June 19, 1987.

2) "Station Blackout Coping Assessment for the Cooper Nuclear Station", Enercon Services, Inc. Report NPP1-PR-01, Revision 1, dated January 11, 1990.

3) D. H. Cook, et al, "Station Blackout at Browns Ferry Unit One-Accident Sequence Analysis", NUREG/CR-2182, Oak Ridge National Laboratory, November 1981.

NRC QUESTION #3:

Provide a copy of the CNS Station Blackout Control Room Heatup Calculation. Summarize the approach to the calculation and the results.

RESPONSE:

A copy of Calculation NPP1-SBO-007 is enclosed. Highlights from that calculation are summarized below.

The control room temperature was determined via transient response analysis using the HEATING-6 and CONTEMPT-LT/028 computer codes. HEATING-6 was used to establish a steady periodic solution for the roof temperature, whereas CONTEMPT-LT/028 was employed for the actual room heatup calculation.

Thermal Response of Roof

The roof response computations were performed to determine an appropriate initial temperature for use in the CONTEMPT-LT/028 model. Actual solar data from Omaha, Nebraska (approximately one degree latitude north of CNS) were employed. Application of the solar data took a mid-summer day (i.e., near the solstice) of maximum heat flux from several years of data. These data were applied four days in a row to get the steady periodic solution for the roof temperature. ASHRAE one-percent summer design values for Omaha were used for the exterior temperature. To simulate the 4-hour SBO time period, results were used from 14:00-18:00 hours, which is a combination of highest ambient temperature and highest roof temperature, both conservative with respect to control room heatup response. In the roof heatup calculation, no credit was taken for shading of the control room by the adjacent buildings.

Initial Conditions

It was determined in the HEATING-6 analysis that 90°F would bound the temperature in the concrete control room roof for the conditions noted above. This temperature was used to initialize the control room wall heat structures in the CONTEMPT-LT/028 model. The north wall of the control room does not receive direct solar flux. The south and east walls border air conditioned spaces. The air temperatures of adjacent, unconditioned spaces bordering the control room do not normally exceed about 85°F. Since the roof temperature was derived from a surface that receives considerable solar radiation, initialization of the control room walls and floor at 90°F is conservative. Initialization of interior walls at a temperature near 75°F to 80°F would actually be more appropriate.

The control room initial air temperature was assumed to be 23°C (73.4°F), which is considered to be a realistic normal operating comfort setpoint. It was assumed that the air conditioning maintains a constant interior air space temperature for purposes of initialization calculations. The temperature of adjacent interior air spaces was assumed to be 90°F for the duration of the 4-hour SBO event. This is considered conservative, based on the roof heatup computations discussed above. For the north wall, a sinusoidal exterior temperature was imposed based on the ASHRAE design values noted above.

Control Room Modelling

The control room was modelled as a lumped air volume with an energy source term to account for personnel and electrical heat loads. The control room model included wall, ceiling and floor heat structures via a one-dimensional conduction model, with individual boundary conditions for each structure. No credit was taken for passive heat sinks within the room. The air volume above the control room suspended ceiling was not included in the room net free volume calculation. However, the air space above the ceiling was modelled as part of the roof/ceiling heat structure.

The individual control room heat loads are small. Uniform distribution of the internal energy generated within the room was assumed, based on the distributed locations of the heat sources. The electrical energy was assumed to be immediately and perfectly distributed to the room air mass, rather than accounting for heating of panels. Control room heat loads totalled about 16.5KW and included power panels, emergency lighting, computer terminals, annunciators, the security system, and allowance for eight people.

No credit was taken for cooling of the room by fans or other devices. Although it is required by CNS procedures to open doors if room cooling is lost, no credit was taken for this. Air leakage from the control room was considered via one door frame. The peak calculated leakage rate during the 4-hour SBO was about 0.35 air exchange per hour (AX/HR), with the nominal leakage rate being less than 0.02 AX/HR after about 30 minutes. The modelled leakage rate is indicative of a very "tight" room and is considered a conservative estimate of the actual leakage, since several doors exist for entry into the control room.

Summary of Results

The CONTEMPT-LT/028 calculation predicted that the control room would heat up quickly to about 92°F in the first 30 minutes after SBO initiation. The heatup rate slowed, with a gradual increase toward equilibrium noted thereafter. The maximum calculated air temperature after 4 hours was 100.3°F. The heatup rate between hours 3 and 4 was approximately 1 Fahrenheit degree per hour.

The control room would be well below the temperature thresholds of concern for habitability (110°F) and Dominant Area of Concern (120°F). Considering the margins between these thresholds and the computed results and the fact that the analysis approach was conservative, there is good confidence that neither the operability of equipment nor the ability of the operators to perform their duties would be compromised by lack of ventilation in the control room during a 4-hour SBO.

NRC QUESTION #4:

Provide a list of the containment isolation valves evaluated under the following two exclusion categories.

(7) At least one valve is normally closed, AC-powered, failing as-is.

(8) Valve(s) are normally open, AC-powered, failing as-is, and failure position is acceptable, if not desirable.

Also, provide a basis for these exclusion categories.

RESPONSE:

The subject valves and the basis for their exclusion are summarized in the attached table. Numbering of the exclusion categories above correlates to the CNS Station Blackout Coping Assessment Report.

The Residual Heat Removal (RHR) and Core Spray (CS) systems are pertinent to the two categories above. These systems could not operate during an SBO because AC power is unavailable. Hence, valves in these systems would remain in their pre-existing positions during an SBO, because valve operation is procedurally controlled, and there is no reason to attempt system operation until power is restored. The pre-existing positions are specified by the system operating instructions. Control room indicator lights would verify the proper valve positions prior to the SBO. If either system were required when AC power is restored, valve operation would be as directed by the Emergency Operating Procedures.

All valves in Category 7 are normally closed. Isolation is in some cases redundant, i.e. by two valves in series. Valves in Category 8 are normally open. This position is desirable, to protect the RHR and CS pumps, as noted in the accompanying table.

ISOLATION OF CNS CONTAINMENT PENETRATIONS
(SBO EXCLUSION CATEGORIES 7 & 8)

PENETRATION IDENTIFICATION	LINE IDENTIFICATION	VALVE NO.	EXCLUSION CATEGORY[(a)]	Basis
X-211A, B	RHR to suppression pool spray header	6" 515MV243W 18" 514MV143W 6" 526MV243W 18" 527MV143W	7	Redundant isolation by normally closed, AC-powered valves outside containment; not expected to change position in SBO.
X-39A, B	RHR-drywell spray	10" 511MV143W 10" 510MV143W 10" 531MV143W 10" 530MV143W	7	Redundant isolation by normally closed, AC-powered valves outside containment; valves not expected to change position in SBO.
X-210A, B	RHR to suppression pool/ chamber	18" 516MV243W 4" 537MV143W 18" 525MV243W 4" 533MV143W	7	Normally closed, AC-powered valves outside containment; not expected to change position in SBO.
X-225A,B,C,D	RHR pump suction from suppression pool	20" 504MV123W 20" 513MV123W 20" 534MV123W 20" 518MV123W	8	Valves are normally open to provide pressure head to the RHR pumps to prevent the failure of the pumps on auto initiation; since the system will be required upon restoration of AC-power, do not want to isolate this line.

ISOLATION OF CNS CONTAINMENT PENETRATIONS (CONTINUED)
(SBO EXCLUSION CATEGORIES 7 & 8)

PENETRATION IDENTIFICATION	LINE IDENTIFICATION	VALVE NO.	EXCLUSION CATEGORY(a)	Basis
X-223A, B	Core spray pump minimum flow	3" 688MV143W 3" 687MV143W	8	Valves are normally open to protect pumps on auto initiation, and lines terminate below the suppression pool water level; therefore, there is no need to isolate these penetrations.
X-223A,B	Core spray test to suppression pool	10" 682MV243W 10" 683MV243W	7	Valves are normally closed & AC-powered; they are not expected to change position in SBO.
X-227A,B	Core spray pump suction	14" 679MV123W 14" 675MV123W	8	Valves are normally open to protect pumps on auto initiation by providing pressure head; do not want to isolate.

Note: a) Exclusion categories 7 and 8 are defined as follows:

(7) At least one valve is normally closed, AC-powered, failing as-is.

(8) Valves are normally open, AC-powered, failing as-is, and failure position is acceptable, if not desirable.

NRC QUESTION #5

Prepare a commitment to enact procedural changes to verify the positions of those valves identified under Question #4.

RESPONSE:

At present, the District does not consider the procedure changes referred to in NRC Question #5 to be warranted, based upon the information contained in the response to NRC Question #4.