

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1) Cooper Nuclear Station	DOCKET NUMBER (2) 0 5 1 0 0 0 2 9 8	PAGE (3) 1 OF 0 6
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TITLE (4)
AC Voltage Regulation Concerns Identified During a NRC Inspection

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)		
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES		
0 2	1 7	8 9	8 9	0 0 5	0 0 0	0 3	2 0	8 9			
									DOCKET NUMBER(S) 0 5 0 0 0		

OPERATING MODE (9) N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR 5: (Check one or more of the following) (11)											
	20.402(b)			20.405(c)			50.73(a)(2)(iv)			73.71(b)		
	20.405(a)(1)(ii)			50.36(c)(1)			50.73(a)(2)(v)			73.71(c)		
	20.405(a)(1)(iii)			50.36(c)(2)			50.73(a)(2)(vii)			OTHER (Specify in Abstract below and in Text, NRC Form 366A)		
	20.405(a)(1)(iv)			50.73(a)(2)(ii)			50.73(a)(2)(viii)(A)					
	20.405(a)(1)(v)			50.73(a)(2)(iii)			50.73(a)(2)(viii)(B)					

LICENSEE CONTACT FOR THIS LER (12)

NAME Donald L. Reeves, Jr.	TELEPHONE NUMBER AREA CODE: 4 0 2 8 2 5 - 3 8 1 1
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COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE) NO

EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

During a Safety System Functional Inspection (SSFI) conducted by the NRC from May 11 to June 19, 1987, concerns were raised regarding the adequacy of the station AC Voltage Regulation systems. Based upon the AC Voltage Regulation studies that were reviewed, the adequacy of offsite power sources when in operation at voltages lower than normal were questioned. During a design basis accident, it appeared to the NRC SSFI Team that a simultaneous start of Emergency Core Cooling System (ECCS) equipment would result in actuating undervoltage protection schemes for the Startup Transformer. Additionally, it appeared that a sequential start of ECCS equipment would result in actuating the undervoltage protection scheme for the Emergency Transformer.

As a result of these concerns, an AC Voltage Drop analysis was performed. Additionally, field measurements were taken in an effort to assess the margin of conservatism in the analysis methods employed. Based upon a lower limit of 165KV for the 161KV System and 65.55KV for the 69KV System, the station AC Voltage Regulation systems were determined to be adequate. These values, which had not previously been defined, were incorporated into a Special Order for use by Operating personnel in assessing the operability of the offsite power sources. During the 1988 Outage, appropriate logic circuitry was modified to provide for the sequential start of ECCS components when powered from the Startup Transformer. As a result, the lower operability limit for the 161KV incoming line voltage was reduced from 165 KV to 159.4KV. Further action to be taken during the forthcoming 1989 Refueling Outage includes the addition of alarm circuitry associated with the 69KV System line voltage to provide annunciation when voltage conditions are such that ECCS equipment operation might be affected.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

A. Event Description

The Safety System Functional Inspection (SSFI) performed by the NRC over the period May 11 to June 19, 1987, identified the following instances in which the station AC voltage regulation systems appeared to be inadequately designed or were inadequately documented to support their design. As stated in the SSFI Report dated September 22, 1987, "The inspection team identified a number of non-conservative errors in Calculation 2.15.01, "Critical AC Voltage Regulation Study", Revision 1, that rendered the results of the study invalid. The most significant errors included incorrect entry into the computer program of the impedance for the normal station transformers, incorrect modeling of the motor starting conditions during a design basis accident when fed from offsite power, incorrect omission of the source impedance of the offsite transmission systems, and incorrect transmission system voltage ranges. The preliminary results of a new AC voltage regulation study performed by the licensee during the inspection were reviewed by the team revealing the following concerns:

- 1) Simultaneously starting all Emergency Core Cooling System (ECCS) loads on the startup transformer, as designed, appeared to lower the 4160 VAC system voltage sufficiently to actuate both levels of undervoltage protection for critical buses 1F and 1G. The preliminary analysis showed that bus voltage would drop to approximately 2600 VAC for longer than 13 seconds, while the ECCS motors were accelerating to rated speed. As described in Section VIII-3.6 of the Updated Safety Analysis Report (USAR), the first level of undervoltage protection actuates instantaneously at 2900 VAC and a second delayed trip occurs if the voltage remained below 3600 VAC for 10 seconds. Actuation of either of these trips isolates the critical 4160 VAC buses 1F and 1G from the startup transformer making it a non-viable source of offsite electrical power.

- 2) Sequentially starting all ECCS loads on the emergency transformer, as designed, also appeared to actuate the undervoltage devices and to isolate the 4160 VAC buses 1F and 1G from the transformer. The licensee's preliminary analyses revealed that bus voltage could decrease to 3040 VAC assuming an incoming voltage of 66.7KV from the 69KV offsite source. However, the contract with Omaha Public Power District (OPPD), that supplied the 69KV source, specified a minimum voltage of 62.1KV, which would result in an analyzed bus voltage below both instantaneous and delayed undervoltage trip devices. A review of the history of the grid voltage on the 69KV line revealed that bus voltage had never dropped below 66.7KV. The licensee initiated action during the inspection to review its contract with OPPD to ensure that minimum voltage would be greater than 66.7KV.

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3) The preliminary AC voltage regulation study did not address the adequacy of voltages supplied to the 120 VAC essential load panels fed from critical 4160 VAC buses 1F and 1G through the critical 480 VAC system. These panels were fed from essential 480 VAC motor control centers LX or TX through either of two unregulated 75KV transformers. Consequently, the licensee did not know whether the AC power system feeding the critical 120 VAC panels was able to provide adequate voltage for the essential loads fed from the panels or whether the loads on these panels could be expected to perform their safety function.

At the management meeting held in the NRC Region IV office, the licensee committed to verify all design inputs and finalize the preliminary analyses for the AC voltage regulation study. This verification involved measuring and recording individual loads of the applicable plant systems and performing the necessary modeling calculations. In a letter dated August 14, 1987, the licensee concluded that the startup and emergency transformers were adequately sized to support post-accident loads. Analyses were still in progress to determine whether the 120 VAC and 480 VAC systems design were adequate. The inspection team did not review the final analyses."

B. Plant Status

At the time of the SSFI Inspection in 1987, the plant was in a normal, load follow mode of operation with no operating restrictions in effect.

C. Basis for Report

A situation where, due to design analysis inadequacies, the operability of offsite power sources could not be determined, reportable under 10CFR50.73(a)(2)(v).

A Licensee Event Report had not been submitted prior to the SSFI followup inspection conducted during the week of February 13, 1989, since the condition was already the subject of correspondence between the District and the NRC and submittal of an LER on this subject had not been considered necessary.

D. Cause

Design. Apparently, during the initial design process, design information used to establish the basis for determining operability of the offsite power sources was not adequate.

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E. Safety Significance

In the event that a Loss of Coolant Accident (LOCA) were to occur when offsite power source voltages were not being correctly maintained, the potential existed for operation of the Emergency Core Cooling System (ECCS) pump motors at sustained low voltages. Under these conditions, failures may occur due to the higher amperage requirements necessary to achieve and maintain the required system flows. Operator intervention could have been required to transfer the ECCS loads to the Emergency Transformer or Diesel Generators.

F. Safety Implication

The design of the onsite emergency AC power system was based on a LOCA coincident with a Loss of Offsite Power (LOOP). This design was modified in 1980 to include a LOCA coincident with a sustained degraded grid voltage condition. However, the voltage initiation setpoint for this second level undervoltage actuation was set at a voltage level that could allow ECCS loads (4160 and 480 volt motors and 120 volt components) to operate below their voltage specifications. Long-term operation at a reduced voltage could adversely affect the operability of motors and prevent the operation of AC relays and solenoid valves. If a LOCA and degraded offsite power condition (resulting in 4160 volt bus voltage between 3880 and 3600 volts) occurred concurrently, operator action would be required to manually transfer the ECCS loads to another power supply for proper performance of the ECCS equipment.

G. Corrective Action

In an August 14, 1987, letter to the NRC, the District indicated that an AC Voltage Drop Analysis had been performed by Burns and Roe and NPPD personnel. The analysis covering the segment of the distribution system from the offsite power lines to the MCC terminals on the 480 VAC system had been performed using Burns and Roe's Computer Program ELO 110. At that time, NPPD personnel were performing the voltage drop analysis for the remainder of the AC Distribution System at CNS.

The Burns and Roe study indicated the following:

- 1) For the 161KV line supplied via the 345/161KV transformer at CNS, the electrical distribution system powered via the startup transformer can withstand a simultaneous start of Emergency Core Cooling System (ECCS) equipment with the normal auxiliaries (essential and non-essential) remaining energized, provided the 161KV system voltage is maintained above a lower limit of 165KV.

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- 2) For the 69 KV line supplied from the Omaha Public Power District (OPPD) system, the emergency offsite supply, the electrical distribution system powered via the emergency station transformer can withstand a sequential starting of ECCS equipment as well as a phased start of two Service Water pumps with all non-essential equipment de-energized, provided the 69KV system voltage is maintained above a lower limit of 65.55KV.

The above cases meet the design requirements of the offsite power supply criteria for CNS: two independent power supplies in addition to the Emergency Diesel Generators (EDGs).

Subsequent to the August 14, 1987, and followup correspondence from the District to the NRC, dated November 14, 1987, NPPD completed a voltage drop study on the 480 VAC and 120 VAC systems, NPPD Calculation 87-132. As part of that effort, voltage and current measurements were taken to establish the margin between the calculation and the field conditions for a number of the 120 VAC components analyzed. The readings taken indicated there was a considerable margin of conservatism in the calculation.

The results of the study verified adequate voltage to all safety-related components provided the grid voltages specified previously were satisfied.

With regard to the Inspection Team's comments on the first level undervoltage relays, the first level of undervoltage are electro-mechanical relays which utilize an inverse time-voltage characteristic. It has been determined by NPPD that first level undervoltage relays would not actuate during the accelerating period of the ECCS motors when powered from either offsite supply.

Also, as a followup to the contract action associated with OPPD that had been noted by the SSFI Team, NPPD analyzed the 69KV line contract with OPPD to determine the feasibility of raising the minimum contract voltage to greater than 66.7KV. The configuration of the line, possible contingencies, and the past history of the 69KV line were reviewed to determine if operability problems currently are a viable concern. As a result of the review, the 69KV line was evaluated as being a reliable power supply with high availability and capable of supporting ECCS operation. Therefore, modifications to the line were not necessary. However, the review indicated that an alarm annunciation circuit should be installed that would alert the operator if the 69KV line voltage dropped below the minimum safe operating voltage for the ECCS loads. This annunciation will be installed during the 1989 Outage.

The following will prevent a recurrence of similar events in the future:

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- 1) A Special Order is in effect which provides the voltage limits for offsite power supplies. As a result, Operations is able to determine operability.
- 2) During the 1988 Outage, the Residual Heat Removal (RHR) and Core Spray (CS) System logic circuitry was modified to provide for a sequential, vice simultaneous, start when powered from the Startup Transformer. The effect of this change was twofold:
 - a) Provided for reducing the lower operability limit for the 161KV incoming line voltage from 165KV to 159.4KV.
 - b) Reduced the severity of the calculated voltage dip that had been projected to be experienced upon simultaneous start of the ECCS loads.
- 3) NPPD Calculation 87-132A will be maintained and updated whenever new loads are added or modifications are performed on the electrical system to verify that all safety-related components have adequate voltage.
- 4) Design Change 88-263 will install annunciation on the 69KV line to alert the operator if the 69KV line voltage cannot support ECCS equipment operation for a LOCA.

H. Similar Events

None.