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INDIANA MICHIGAN POWER

March 23, 2000

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Operating Licenses DPR-58 and DPR-74
Docket Nos. 50-315 and 50-316

Document Control Manager:

In accordance with the criteria established by 10 CFR 50.73 entitled Licensee Event Report System, the following revised report is being submitted:

LER 315/1999-022-01, "Electrical Bus Degraded Voltage Too Low For Safety Related Loads."

The commitment identified in LER 315/1999-022-00 dated September 17, 1999, is superceded in its entirety and replaced by the following commitments:

- A 34.5 kVAC switchyard breaker will be installed prior to Mode 4 to allow the plant electrical auxiliary load to be split between 34.5 kVAC transformers TR4 and TR5.
- Transformer TR5 taps will be changed prior to Mode 4 to obtain a 2.5 percent higher voltage when compared to the tap position when CNP was last producing power.
- The Containment Hydrogen Skimmer Ventilation Fan motor cables will be replaced prior to Mode 4 with larger cables to improve motor terminal voltage.
- One voltage regulating transformer per safety train, as required, will be installed in the plant prior to Mode 4 to feed 120 VAC safety loads to ensure adequate voltage to these loads.
- A working agreement between American Electric Power (AEP) System Operations and Donald C. Cook Nuclear Plant Operations will be developed prior to Mode 4 to establish how System Operations will operate the system to improve the minimum projected voltage during sustained degraded voltage conditions.
- AEP is evaluating long-term solutions, such as installing automatic load tap changing transformers during a future unit outage in place of the existing reserve auxiliary transformers, to improve bus voltage conditions. The evaluation will be completed by October 1, 2000.
- AEP will perform a review of the degraded voltage relay setpoint and time delay against the requirements of Generic Letter (GL) 6/2/77, "NRC Request for Evaluation of Safety Related Equipment with Regard to Sustained Degraded Voltage Conditions at the Offsite Power Sources and Interaction Between Offsite and Onsite Emergency Power Systems," and GL 8/8/79, "Adequacy of Station Electric Distribution Systems Voltages," to identify whether changes are needed. This review will be completed within one year following the restart of CNP Unit 1. Upon completion of this review, AEP will initiate any required licensing activities.

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Should you have any questions regarding this correspondence, please contact Mr. Robert C. Godley, Director, Regulatory Affairs, at 616/465-5901, extension 2698.

Sincerely,

M. W. Rencheck
Vice President – Nuclear Engineering

/srd
Attachment

c: J. E. Dyer, Region III
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Records Center, INPO
NRC Resident Inspector

NRC Form 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503

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TITLE (4)

Electrical Bus Degraded Voltage Could Be Too Low For Safety Related Loads

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 NAME	DOCKET NUMBER
											Cook Plant Unit 2	05000-316
06	09	1999	1999	--	022	--	01	03	23	2000	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)			
POWER LEVEL (10)	0	20.2201 (b)	20.2203(a)(2)(v)	50.73(a)(2)(i)	50.73(a)(2)(viii)
		20.2203(a)(1)	20.2203(a)(3)(i)	50.73(a)(2)(ii)	50.73(a)(2)(x)
		20.2203(a)(2)(i)	20.2203(a)(3)(ii)	50.73(a)(2)(iii)	73.71
		20.2203(a)(2)(ii)	20.2203(a)(4)	50.73(a)(2)(iv)	OTHER
		20.2203(a)(2)(iii)	50.36(c)(1)	X 50.73(a)(2)(v)	Specify in Abstract below or on NRC Form 366A
		20.2203(a)(2)(iv)	50.36(c)(2)	50.73(a)(2)(vii)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
M. B. Depuydt, Regulatory Affairs	616 / 465-5901, x1589

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If Yes, complete EXPECTED SUBMISSION DATE).	X NO				

Abstract (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

This LER was revised in its entirety to provide the results of electrical load flow calculations and engineering evaluations performed as corrective actions for LER 315/99-022-00. These evaluations resulted in a better understanding of the degraded grid voltage setpoint basis and the safety related electrical system analytical limit, and new corrective actions.

On June 9, 1999, during performance of preliminary electrical load flow analyses, it was thought that the Technical Specifications (TS) 4160 VAC electrical bus degraded voltage lower allowable limit may be too low to ensure adequate voltage for some of the 600 VAC and 120 VAC safety related loads during a design basis accident (DBA). On August 21, 1999, a four-hour prompt notification to the NRC was made, and LER 315/99-022-00 was subsequently submitted for a condition that alone could have prevented the fulfillment of the safety function of safety related systems. Additional reviews determined that the degraded voltage relay setpoint is not related to ensuring adequate voltage to safety related equipment during a DBA. However, a postulated sustained worst case offsite degraded grid voltage condition, above the relay setpoint, could have resulted in some electrical equipment terminal voltages below that required for starting or continuous operation during a DBA.

The cause of the condition was a lack of understanding of the design and licensing basis, and a lack of control of design basis supporting documentation. These issues are symptoms of a programmatic issue related to inadequate design and licensing basis control. Corrective actions include establishment of an analytical limit for low 4160 VAC bus voltage, plant modifications to improve equipment terminal voltage, a working agreement with system operations to improve grid low voltage conditions when they occur, evaluation of long-term solutions, and a review of the basis for the degraded voltage relay setpoint and time delay. Programmatic design control issues are being addressed through the Donald C. Cook Nuclear Plant Restart Plan and Corrective Action Program. The safety significance of the condition described in this LER is low, due to the small likelihood of this scenario to occur.

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TEXT *(If more space is required, use additional copies of NRC Form (366A)* **(17)**

Conditions Prior to Event
Unit 1 was in Mode 5, Cold Shutdown.
Unit 2 was in Mode 5, Cold Shutdown.

Description of Event
On June 9, 1999, during performance of preliminary electrical load flow analyses, it was thought that the Technical Specifications (TS) 4160 VAC electrical bus (EIIS: EB) degraded voltage lower allowable limit may be too low to ensure adequate voltage for some of the Donald C. Cook Nuclear Plant (CNP) 600 VAC (EIIS: ED) and 120 VAC (EIIS: ED) safety related loads during a design basis accident (DBA). The voltage at the terminals of certain 600 VAC safety related loads on buses 11A/B/C/D (EIIS: BU) and 21A/B/C/D (EIIS: BU), and certain 120 VAC loads, may have been too low to allow starting the loads or the loads may have failed while operating.

Additional reviews determined that the degraded voltage relay (EIIS: 27) setpoint is not related to ensuring adequate voltage to safety related equipment during a DBA (see Analysis). However, a postulated sustained worst case offsite degraded grid voltage condition, above the relay setpoint, could have resulted in some equipment terminal voltages below that required for starting or continuous operation during a DBA.

The scenario whereby some 600 VAC and 120 VAC safety related loads may not receive adequate voltage is postulated to occur during an analytically determined worst case offsite American Electric Power (AEP) degraded grid voltage condition. Sustained worst case offsite power grid voltage could result in inadequate voltage to some safety related loads, their control circuitry, and the associated electrical components required for performing safety functions. The voltage needed for equipment operation has typically been determined to be 90 percent of nameplate voltage. During the postulated degraded grid voltage scenario, 600 VAC bus voltage may be reduced from its nominal value of 600 VAC to as low as 460 VAC, which may not be high enough to start or operate some of the safety related 600 VAC or 120 VAC loads.

On August 21, 1999, the degraded voltage vulnerability was determined to be reportable, and a four hour prompt notification to the NRC was made at 1618 hours Eastern Daylight Time in accordance with 10 CFR 50.72(b)(2)(i) as a degraded condition identified while shutdown. Subsequently, it was determined that the prompt notification should have referenced 10 CFR 50.72(b)(2)(iii) for a condition that alone could have prevented the fulfillment of the safety function of systems needed to shutdown the reactor, remove residual heat, control the release of radioactive material, or mitigate the consequences of an accident, instead of 10 CFR 50.72(b)(2)(i). LER 315/99-022-00 was submitted on September 17, 1999, in accordance with the corresponding 10 CFR 50.73(a)(2)(v) reporting requirement, as a condition that alone could have prevented the fulfillment of the safety function of safety related systems. The gap in time between the discovery date of June 9, 1999, and the reporting date of August 21, 1999, was due to the need for evaluation by CNP staff and management to validate whether the preliminary finding by the consultant performing the electrical load flow analyses was accurate.

Cause of Event
The cause of the identified condition was a lack of understanding of the design and licensing basis of the plant, and a lack of control of design basis supporting documentation. The load flow calculations were determined to be non-conservative such that they lacked rigorous modeling. Specifically, the load flow analyses did not account for the voltage drops of the cabling and interconnections between the safety related buses and the equipment terminal connections, and the analyses did not capture changes to the transmission system over time.

These issues are symptoms of a programmatic issue related to inadequate design and licensing basis control. Maintaining the design basis and providing strong configuration management are vital functions in nuclear power operations. As such, strategic errors, low expectations, and a low commitment in implementing and controlling the CNP design basis caused this programmatic issue.

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Analysis of Event

Previously, it was believed that the degraded voltage relays were in place to ensure that safety related equipment had adequate voltage at the equipment terminals during a degraded voltage condition coincident with a DBA. The 4160 VAC safety related buses are monitored by undervoltage relays (EIIS: 27) connected to a potential transformer (EIIS: XPT). The relays in question are generally referred to as the second level under-voltage relays, or degraded grid voltage relays, and are powered by the 250 VDC (EIIS: EJ) system. When the plant is powered from the preferred offsite source, the degraded grid voltage relays would sense degraded voltage at the 4160 VAC safety related buses and, on a two-out-of-three coincident logic with a two-minute time delay, trip open the reserve feed breakers and start the emergency diesel generators. During normal power operation with the auxiliary power system aligned to the main generators, the degraded voltage relays provide an alarm-only function, and operator action is required to initiate corrective actions should 4160 VAC bus voltage remain degraded for more than two minutes. The degraded voltage relay setpoints were not selected based on ensuring adequate voltage to safety related equipment, but were set below the worst case grid steady state voltage value to prevent spurious engineered safety feature actuations due to short voltage dips. Since the degraded grid voltage relays do not provide a trip function during the time when a DBA is of concern (i.e., during normal operations), the two-minute time delay applied to the relays is not considered as part of the accident analyses time delays.

Due to the discovery of model deficiencies associated with previous load flow analyses, an analytical limit for the minimum 4160 VAC bus voltage has been determined. The analytical voltage limit is determined to be the lowest 4160 VAC safety bus voltage value at which downstream safety related equipment is assured to have adequate voltage for starting and operating during a DBA. The analysis corrects the model deficiencies associated with the previous load flow analyses by evaluating voltage drops from the safety buses to the equipment motor terminals. The analysis also incorporates current and projected transmission distribution system voltage information to ensure that the power grid will support operation of the CNP units and maintain 4160 VAC bus voltage at or above the analytical voltage limit. Finally, the analysis identified the need for certain modifications to the electrical distribution system.

The projected transmission distribution system voltage evaluation identified the worst case minimum transmission grid voltage that would be expected in the CNP area. This worst case minimum voltage was predicted using peak load summer system models with more than 3000 MW of load transfer to adjacent utility transmission systems, with both CNP units offline, a neighboring utility's nuclear unit offline, and an identified single transmission contingency outage. The evaluation showed that the postulated worst case minimum grid voltage should not reach a voltage value low enough to go below the 4160 VAC safety bus analytical limit.

Prior to the new load flow analyses, it was thought that a postulated sustained offsite degraded grid voltage condition could have resulted in some equipment terminal voltages below that required for starting or continuous operation during a DBA. For this postulated condition to occur, electrical grid voltage would have to be degraded to a voltage value which does not provide adequate voltage to electrical equipment (i.e., below the analytical limit) yet does not cause a low voltage relay to actuate, and be sustained at that level. There are two sources of failures for this condition: internal, and external. With respect to internal sources of failures, the breaker and protection scheme at CNP is such that any bus faults or shorts affecting the buses would be cleared in fewer than two seconds. Therefore, internal failures are adequately addressed.

The most credible external event that would produce this offsite power grid low voltage scenario would be system-wide grid degradation. NUREG-1032, "Evaluation of Station Blackout Accidents at Nuclear Power Plants," quotes a generic frequency of 0.0125 events per site-year for a loss of offsite power. NUREG-1032 goes on to say that "... large grid disturbances are relatively infrequent," and, with few exceptions, "... the duration of power outages in power plants as a result of grid disturbances is relatively short."

Using the generic number to calculate frequency, a large grid disturbance would occur once every 80 years. History shows that the grid at CNP has been more reliable than at the industry average power plant and, therefore, there is reasonable

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expectation that this frequency would be less for the CNP-specific case. The system-wide grid degradation scenario is evaluated as the most frequent credible event to produce the condition here, and any other credible event that would produce this scenario would occur with less frequency.

The safety significance of the condition described in this LER is low, due to the small likelihood of this scenario to occur.

Corrective Actions

No immediate corrective actions were necessary as a result of the condition because bus voltages were being maintained at their nominal values.

The corrective actions to prevent recurrence for the root cause of the programmatic issue related to design control are currently being addressed through the CNP Restart Plan and the Corrective Action Program. The root cause evaluation identified numerous corrective actions to address management, organizational, and programmatic issues. The applicable actions to be completed prior to restart are included in the CNP Restart Action Plan.

Corrective actions specific to the postulated degraded voltage condition include the following:

Based on instrument uncertainty associated with the control room voltage meter (EIIS: MTR) circuitry, administrative limits of 580 VAC were placed on the 600 VAC buses to ensure that the buses remain at a high enough voltage to provide adequate power to the safety related loads until analyses are completed and new limits are proceduralized.

An analytical limit for 4160 VAC safety related bus voltage has been established. This analytical limit ensures that all safety related equipment and downstream components operate satisfactorily during a degraded grid voltage event. The analytical limit determination process also included evaluation of motor operated valve (MOV) operability, which is a change from the previous method of using the degraded voltage relay setpoint. To ensure that the 4160 VAC safety related buses remain at or above the analytical limit when the system grid is at the lowest projected voltage, the following plant modifications will be implemented prior to Mode 4:

1. A 34.5 kVAC switchyard (EIIS: FK) breaker (EIIS: 52) will be installed to allow the plant electrical auxiliary load to be split between 34.5 kVAC transformers (EIIS: XFMR) TR4 and TR5. In the past, TR4 or TR5 individually carried the entire plant load, which resulted in a lower bus voltage due to voltage drop as transformer load increased.

2. Transformer TR5 taps (EIIS: TTC) will be changed to obtain a 2.5 percent higher voltage when compared to the tap position when CNP was last producing power.

Additionally, to ensure adequate voltage to loads that showed the potential to be under-powered during the worst case offsite grid voltage conditions described in this LER, the following plant modifications will be implemented prior to Mode 4:

1. The Containment Hydrogen Skimmer Ventilation Fan (EIIS: BK) motor cables (EIIS: CBL5) will be replaced with larger cables to improve motor terminal voltage because the existing cables were determined to be undersized for the scenario described above.

2. One voltage regulating transformer per safety train, as required, will be installed in the plant to feed 120 VAC safety related loads to address the scenario described above.

A working agreement between AEP System Operations and CNP Operations will be developed prior to Mode 4 to establish how System Operations will operate the system to improve the minimum projected voltage during sustained degraded voltage conditions. AEP System Operations has agreed to monitor grid voltages and routinely project failure scenarios to

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determine the impact on the CNP switchyard voltage. If the projected offsite power source grid voltage with both CNP Units off-line does not meet the established criteria to maintain the analytical limit for the CNP 4160 VAC buses, AEP System Operations will notify CNP Operations and take appropriate measures to improve the available voltage to the CNP 4160 VAC buses. Upon notification of a grid voltage problem from AEP System Operations, CNP Operations will take appropriate actions in accordance with Technical Specifications and CNP station procedures.

AEP is evaluating long-term solutions, such as installing automatic load tap changing transformers during a future unit outage in place of the existing reserve auxiliary transformers, to improve bus voltage conditions.

AEP will perform a review of the degraded voltage relay setpoint and time delay against the requirements of Generic Letter (GL) 6/2/77, "NRC Request for Evaluation of Safety Related Equipment with Regard to Sustained Degraded Voltage Conditions at the Offsite Power Sources and Interaction Between Offsite and Onsite Emergency Power Systems," and GL 8/8/79, "Adequacy of Station Electric Distribution Systems Voltages," to identify whether changes are needed. This review will be completed within one year following the restart of CNP Unit 1. Upon completion of this review, AEP will initiate any required licensing activities.

Previous Similar Events
315/1999-016-00
315/1999-012-00
315/1998-037-01