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U-602296
L45-94(06 - 03)LP
2C.220

Docket No. 50-461

10CFR50.73
JGC-089-94
June 3, 1994

Document Control Desk
Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Clinton Power Station - Unit 1
Licensee Event Report No. 94-005-00

Dear Sir:

Enclosed is Licensee Event Report No. 94-005-00, Technological Advancements in Controlling Electrical Load Additions Result in Identification of Improper Second-Level Undervoltage Relay Setpoint. This report is being submitted in accordance with the requirements of 10CFR50.73.

Sincerely yours,

J. G. Cook
Vice President

RSF/csm

Enclosure

cc: NRC Clinton Licensing Project Manager
NRC Resident Office, V-690
Regional Administrator, Region III, USNRC
Illinois Department of Nuclear Safety
INPO Records Center

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NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), 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.

LICENSEE EVENT REPORT (LER)

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

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Clinton Power Station	05000461	1 OF 5

TITLE (4) Technological Advancements in Controlling Electrical Load Additions Result in Identification of Improper Second-Level Undervoltage Relay Setpoint

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
									None	05000
04	08	92	94	005	00	06	03	94	FACILITY NAME: None	DOCKET NUMBER

OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)							
			20.402(b)		20.405(c)		50.73(a)(2)(iv)		73.71(b)
POWER LEVEL (10)	000		20.405(a)(1)(i)		50.36(c)(1)	X	50.73(a)(2)(v)		73.71(c)
			20.405(a)(1)(ii)		50.36(c)(2)		50.73(a)(2)(vii)		OTHER
			20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(Specify in Abstract below and in Text, NRC Form 366A)
			20.405(a)(1)(iv)	X	50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		
			20.405(a)(1)(v)		50.73(a)(2)(iii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
A. B. Haumann, Project Engineer	(217) 935-8881, Extension 4078

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)			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)

In 1992, electrical design engineers raised a concern that the setpoints for second-level undervoltage relay in the auxiliary power (AP) system may not be correctly set to provide adequate voltage for proper equipment operation. A plan to address the concern included installing an alarm to alert operators if bus voltage decreases to 3940 volts, providing an annunciator procedure for operator guidance in response to the alarm, training operators on the alarm and proper response, determining the minimum voltage required, and developing design change options to restore the plant to the design basis regarding degraded voltage. In 1994, an extensive study of the AP system response under Loss of Coolant Accident (LOCA) conditions identified the minimum voltage required by engineered safety features equipment at all levels from the 4160-volt to the 120-volt levels and concluded that the second-level undervoltage relay minimum reset point of 3799 volts would not ensure sufficient voltages for all equipment fed from the 120-volt motor control center distribution panels following a postulated LOCA scenario. The cause of the event is attributed to an initial design error in second-level undervoltage relay setpoint and reset point, which was identified by technological advancements in analyzing electrical load. Corrective actions included those actions discussed above, new computer tools for improved analytical modeling, and improved configuration controls.

DESCRIPTION OF EVENT

On May 6, 1994, after an extensive study, the condition described in this LER was determined to be reportable under the provisions of 10CFR50.73.

On April 8, 1992, the plant was in Mode 5 (REFUELING), reactor [RCT] temperature was about 86 degrees Fahrenheit, reactor pressure was atmospheric and the third refueling outage (RF-3) was in progress. Electrical design engineers were reviewing calculations developed in response to Electrical Distribution System Functional Inspection (EDSFI) degraded voltage issues identified at other nuclear power plants. The calculation being reviewed (calculation 19AQ-2, Revision 3) was recently enhanced to evaluate the voltages at various levels following automatic initiation of safety systems during a postulated Loss of Coolant Accident (LOCA) scenario (i.e., LOCA block-start).

At about 1330 hours, while reviewing the calculations, an engineer raised a concern that the setpoints for the second-level undervoltage relay [27] in the auxiliary power system [EC] may not be correctly set to provide adequate voltage for proper operation of all required equipment. The second-level undervoltage relay is designed to transfer safety-related electrical load to the associated emergency diesel generator [EK][DG] in the event of a sustained degraded voltage condition of the normal offsite electrical source(s). Adequate voltage could not be assured if the installed circuits were in the worst case configuration allowed by the bounding design specifications (for example, cable lengths). The engineer initiated Condition Report (CR) 1-92-04-031 to track the continuing investigation and resolution of the concern.

A corrective action plan was developed to address the concern. Since the investigation was expected to be lengthy due to the need to evaluate individual circuits and components, a plant modification was implemented on May 15, 1992, to ensure sufficient bus [BU] voltage for equipment operability during the investigation. The modification added an alarm [ALM] on the 4.16 kilovolt (KV) buses of electrical divisions 1, 2, and 3 to monitor bus voltage. The alarm is designed to actuate in the main control room when bus voltage decreases to 3940 volts alternating current (VAC), thereby alerting operators to a potential degraded voltage condition. The 3940 VAC value was selected because it is about one percent above the minimum voltage which would be expected at the 4 KV engineered safety feature buses under LOCA loading. In preparation for implementing the modification, annunciator procedure CPS 5009, "Alarm Panel 5009 Annunciators," was revised on May 12, 1992, to advise operators that, if the alarm activates, Class 1E buses could be experiencing degraded voltage due to low grid voltage at the reserve auxiliary transformer [XFMR] or the emergency reserve auxiliary transformer. The procedure identifies actions the operators should take in response to the alarm, including monitoring the bus voltages, attempting to increase the grid and/or bus voltages, and starting the emergency diesel generators and

transferring the buses to the emergency diesel generators if bus voltage falls below 3890 VAC (the original calculated minimum required voltage at the 4 KV bus with LOCA loading). Each emergency diesel generator is capable of providing sufficient voltage for proper equipment operation. Operators were briefed on the second-level undervoltage scheme and the symptoms they could expect to see during a degraded voltage condition. In addition, the operators received training on the new undervoltage alarm, possible causes for alarm actuation, and automatic actions and operator actions in response to the alarm. Long-term actions were established to determine the minimum voltage required for safety-related loads and develop design change options for restoring the plant to the design bases.

On May 6, 1994, the Nuclear Station Engineering Department (NSED) completed an extensive voltage study of the auxiliary power system under LOCA conditions. The study identified the minimum voltage required by engineered safety feature equipment at all levels from the 4.16 KV to the 120 VAC levels. The results of the study concluded that the present second-level undervoltage relay minimum reset point of 3799 volts would not ensure sufficient operating voltages for the equipment fed from the 120 VAC motor control center (MCC) distribution panels [PL] following a LOCA block-start. This condition is contrary to the design basis of the plant and is a condition that alone could have prevented fulfillment of the safety function of at least four 120-VAC instrumentation and control circuits. However, the investigation verified that the interim actions implemented on May 15, 1992, to provide a main control room alarm if 4.16 KV bus voltage decreases to 3890 VAC, as well as the subsequent operator actions, continue to provide adequate operating voltage to all required equipment.

Motor-operated valves, pump and fan motors, damper actuators and the MCC contactors would receive adequate voltage within ten seconds following a LOCA block-start if the 4.16 KV bus voltage recovers above the minimum second-level undervoltage relay reset point of 3799 VAC. However, voltage at or just above the current relay reset point would not be sufficient at the MCC bus to ensure that all the devices fed from the 120-VAC distribution panels will operate. Identified circuits that would not receive adequate voltage are AB MCC 1A1 circuit 9B-4A, CB MCC E2 circuit 2B-7, CB MCC E2 circuit 2B-24, AB MCC 1C1 circuit 4B-5. These four circuits affect the instrumentation and control functions for the Control Room Heating Ventilating and Air Conditioning (HVAC) system [VI], the Standby Gas Treatment system [BH], the Diesel Generator Room HVAC system [VJ], the Drywell Cooling HVAC system [VB], the Containment Building HVAC system [VA], the Drywell Purge HVAC system, the Switchgear Heat Removal system, and the Containment Monitoring system [IK].

No automatic or manually initiated safety system responses were necessary to place the plant in a safe and stable condition. Other equipment or components may have been inoperable at the start of this event to an extent that their inoperable condition could have contributed to the consequences of an undervoltage condition; however, Illinois Power has determined that further investigation is not of significant benefit in either understanding or correcting this condition. The interim corrective action bounds those other components. The permanent corrective action, when established and implemented, will ensure adequate voltage for all required equipment.

CAUSE OF EVENT

The cause of this event is attributed to an initial design error which could only be identified through the use of technological advancements in analyzing electrical loads. In 1984, when the degraded voltage calculations were prepared, the engineering tools and techniques used were not as sophisticated as they are today. The old tools and techniques were incapable of providing analyses at the depth that can now be provided. Therefore, the 1984 analysis required the use of assumptions which have since been refined using today's technology.

The calculations prepared in 1984 to establish the second-level undervoltage relay setpoint were performed using the Sargent & Lundy (S&L) Auxiliary Block mainframe computer program. This program was limited by the number of buses it could model. The model only evaluated the voltage down to the 480 VAC substations. From the substation down to the 120-VAC level, a voltage drop was assumed. The acceptable voltage at the 120 VAC level was established through the analysis of a sample of circuit types. Furthermore, the analysis modeled continuous loads. These loads were generally classified as continuously running motors over 50 horsepower and other large loads. The analysis did not evaluate the LOCA block-start transient in detail. In addition, the 1984 model did not consider the influence of motor-operated valves nor did it evaluate in detail the voltage at the end device.

In 1991, NSED initiated a review to update the electrical system loading and voltage drop calculations in response to industry EDSFI issues. The calculations reviewed included those associated with the direct current [EJ](DC) and the emergency diesel generator loading system as well as the LOCA block-start. The review resulted in the development of a new LOCA block-start voltage drop model and transient calculation. The results of the new calculation identified a potential problem with the second-level undervoltage relay setpoint (reset point). On that basis, CR 1-92-04-031 was issued in response to the identified condition.

CORRECTIVE ACTION

The immediate corrective action was installation of a low bus voltage alarm and establishment of an operator action in response to the alarm to ensure adequate voltage to the required equipment. Operators were briefed and received training on the second-level undervoltage scheme, the symptoms of degraded voltage conditions, the new undervoltage alarm, and the actions to take in response to the alarm.

In the meantime, NSED Electrical Design began a detailed review of the equipment and collected data concerning the equipment load and voltage requirements. This information was used to evaluate the voltage required at the 4.16 KV bus to ensure that adequate voltage is available for required equipment down to the 120 VAC level. Several design change options have been proposed to resolve the degraded voltage relay setting condition and are currently being evaluated. Illinois Power plans to select an appropriate design change by August 31, 1994, and will communicate that information to the NRC Resident Inspector.

NSED Electrical Design has improved its analytical modeling ability over the past few years. New computer tools have been purchased to evaluate and track electrical system loads. These new tools are being used in design calculations to evaluate the potential effects of design changes on system voltage. In addition, the configuration controls in place today are much more detailed than they were in 1984. Other design areas where similar problems could have existed (that is, the DC system loading and the DG loading) have been reviewed and no other voltage problems have been found.

ANALYSIS OF EVENT

This event is reportable under the provisions of 10CFR50.73(a)(2)(ii)(B) and 10CFR50.73(a)(2)(v) because the current second-level undervoltage setpoint (and reset point) is not in accordance with the plant's design basis and is a condition that alone could have prevented the fulfillment of the safety functions of at least four 120-VAC instrumentation and control circuits.

Assessment of the safety consequences and implications of this event identified that it has potential nuclear safety significance. From initial plant startup on September 29, 1986, until May 15, 1992, if a LOCA had occurred while grid voltage was low, sufficient voltage may not have been available for proper safety system equipment operation. Although the emergency diesel generators automatically start in response to a LOCA signal, they do not automatically pick up loads unless a loss-of-voltage or degraded voltage condition exists. For a degraded bus voltage condition, and for each affected bus, the undervoltage relay will trip at the associated setpoint and cause a timer circuit to initiate. Bus transfer to pick up the loads occurs automatically only if voltage fails to recover above the degraded voltage reset point prior to timer timeout or if a total loss of voltage occurs. However, the condition described in this LER would have caused the degraded undervoltage relay to reset at a voltage too low to ensure proper operation of all required equipment. Nevertheless, main control room operators can manually initiate a bus transfer to the diesel generator if they recognize the need to do so. Operators have been trained since May 15, 1992, to recognize the symptoms of a degraded voltage condition; therefore, only since then have plant safety-related components been assured sufficient voltage to perform their required functions in the event of a degraded voltage condition following a LOCA block-start, as operators would take appropriate action in response to such an event.

ADDITIONAL INFORMATION

No equipment or components failed during this event.

Clinton Power Station has not reported similar events in the past.

For further information regarding this event, contact A. B. Haumann, Project Engineer at (217) 935-8881, extension 4078.