Iowa Electric Light and Power Company

May 15, 1992
NG-92-2392

Mr. A. Bert Davis
Regional Administrator
Region III
U. S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License DPR-49
Licensee Event Report #92-006

Gentlemen:

In accordance with 10 CFR 50.73 please find attached a copy of the subject Licensee Event Report.

Very truly yours,

David L Wilson

David L. Wilson
Plant Superintendent - Nuclear

DLW/JP/eah

cc: Director of Nuclear Reactor Regulation
Document Control Desk
U.S. Nuclear Regulatory Commission
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NRC Resident Inspector - DAEC

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NRC Form 366A (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO 3150-0104

EXPIRES 4/30/92

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Duane Arnold Energy Center	0 5 0 0 0 3 3 1	1 OF 0 8

TITLE (4) Emergency Safety Feature Actuation During Modification Acceptance Testing Due To Damaged Switchyard Cable

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	DOCKET NUMBER(S)
0 4	1 6	9 2	9 2	— 0 0 6 —	0 0	0 5	1 5	9 2	None	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): N

POWER LEVEL (10): 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

[ ] 20.402(b)	[ ] 20.405(c)	[X] 50.73(a)(2)(iv)	[ ] 73.71(b)
[ ] 20.405(a)(1)(i)	[ ] 50.36(c)(1)	[ ] 50.73(a)(2)(v)	[ ] 73.71(c)
[ ] 20.405(a)(1)(ii)	[ ] 50.36(c)(2)	[ ] 50.73(a)(2)(vii)	[ ] OTHER (Specify in Abstract below and in Text, NRC Form 366A)
[ ] 20.405(a)(1)(iii)	[ ] 50.73(a)(2)(i)	[ ] 50.73(a)(2)(viii)(A)	
[ ] 20.405(a)(1)(iv)	[ ] 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
James Probst, Technical Support Engineer	AREA CODE 3 1 9 8 5 1 - 7 3 0 8

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
X	E A	C B L		N					

SUPPLEMENTAL REPORT EXPECTED (14)

[ ] YES (If yes, complete EXPECTED SUBMISSION DATE) [X] NO

EXPECTED SUBMISSION DATE (15): MONTH | DAY | YEAR

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

On April 16, 1992, with the plant in cold shutdown for a refueling outage, a test of a newly installed 161 KV breaker resulted in several unanticipated Primary Containment Isolation System actuations and the automatic starting of the "B" Emergency Diesel Generator (EDG). The cause of the event was a momentary drop in voltage on one essential (Class 1E) bus during the process of transferring power supplies. The severity of the voltage drop was increased by a "slow-transfer" of the bus between sources, rather than the expected "fast-transfer". The slow-transfer occurred because of a damaged cable in the plant switchyard. The root cause of the damaged cable was poor work practices at the time of the initial cable installation. A contributing cause was an untimely approach to continuing a program of testing switchyard cables, given the occasional cable problems that were being experienced. The damaged cable was replaced, and a schedule for further testing of switchyard cables is being developed. Additional testing found that EDGs may start on any essential bus transfer, depending on bus conditions.

I. DESCRIPTION OF EVENT

On April 16, 1992, with the plant in cold shutdown, a test of a newly installed 161 KV breaker resulted in several Emergency Safety Feature actuations, including automatic starting of an Emergency Diesel Generator. At the time of the event, the Duane Arnold Energy Center (DAEC) was in the final stages of a refueling outage, with all fuel in the vessel and the "A" side of the Residual Heat Removal System in service to provide hutdown cooling for the vessel inventory. A Modification Acceptance Test was in progress for a new 161 KV circuit breaker, Breaker K, which had been installed in the site switchyard during the outage. The breaker had been installed to eliminate the possibility of a single breaker failure after a line fault resulting in a loss of offsite power to the plant. Breaker K operates in parallel with a previously existing breaker, Breaker J. Each breaker can connect an offsite line to the transformer normally used to supply offsite power to the plant. (See Figure 1).

During the Modification Acceptance Test, both the J and K breakers were to be opened (de-energized) to simulate a failure of the primary source of offsite power to the plant's 4160 V essential buses (a transformer connected to the switchyard). Per design, the essential (Class 1E emergency) buses, 1A3 and 1A4, were each expected to "fast-transfer" within a few cycles to the alternate offsite power supply source (another transformer). A second design feature, an automatic "slow-transfer" which occurs over approximately 4.5 seconds, is also available. (See II. Cause, and III. Analysis, for more discussion of "slow" and "fast" transfers).

Shortly after 1300 hours, the newly installed Breaker K was opened without incident as part of the Modification Acceptance Test. This left Breaker J as the single power source for the essential buses, 1A3 and 1A4. When Breaker J was subsequently opened for the test at 1310 hours, the expected fast-transfer to the alternate offsite power supply occurred for essential bus 1A3. The fast-transfer did not occur for essential bus 1A4. Instead, a slow-transfer took place. The voltage on 1A4 dropped during the transfer process, and in response, the "B" Emergency Diesel Generator (EDG) automatically started. The completion of the slow-transfer of 1A4 to the alternate offsite power supply occurred as designed, therefore the "B" EDG did not assume the bus load when it reached rated speed a few seconds later.

The loss of power to the 1A4 essential bus during the slow-transfer also resulted in other safety system actuations, which occurred when their logic relays were de-energized. Initiation of some Primary Containment Isolation System (PCIS) isolations in Groups I through V occurred. There was limited valve movement due to the shutdown condition of the plant. Shutdown cooling for the vessel inventory was briefly interrupted when an isolation valve to the reactor vessel closed as designed, and fuel pool cooling was also interrupted.

Following the fai re of 1A4 to fast-transfer as expected, the Modification Acceptance Test was suspended pending further investigation. After verifying that the 1A4 essential bus was being powered by an offsite power source, the "B" Emergency Diesel Generator was secured. Shutdown cooling was restored thirty-six minutes after the event, with a minimal rise in inventory temperature from 130 F to 132 F over that time period. Fuel pool cooling was restored with no heatup effect noted.

II. CAUSE OF EVENT

A. Field Investigation

Investigation into the cause of the failure of essential bus 1A4 to fast-transfer began immediately. The problem lay in the fast-transfer permissive logic for 1A4. This logic initiates the fast-transfer of the 1A4 bus to the alternate offsite power source if both the J and K breakers signal that they are open, or there are problems with the primary supply transformer. In addition, the alternate offsite power source must be operable and the "B" Emergency Diesel Generator breaker must not be closed onto the bus. .. slow-transfer to the alternate offsite power supply is initiated if the essential bus voltage has decreased to a great degree (20% of normal), the primary offsite source and EDG are both isolated from the b s, and the alternate offsite source is operable. (See III. Analysis: A. System Design and Requirements for further discussion.)

For the event on April 16, 1992, it was determined that a fast-transfer was not initiated for essential bus 1A4 because the 1A4 fast-transfer permissive logic did not detect that Breakers J and K were open. This was due to an open circuit in the control cable carrying a signal from Breaker J in the plant switchyard to the logic panel in the Control Room. In the plant switchyard this cable runs alone inside an (approximately) 1.5 inch diameter conduit. The conduit is not water-tight, and is exposed to ambient conditions. Inspection of the cable found the open circuit near the J Breaker where the cable made a transition inside the conduit from a long straight run to a series of sharp bends. The cable was found twisted, looped, and bent inside the conduit. A tear or crack was present in the outside cable insulation at this point. The four internal cable wires showed excess wear and aging at the tear, with some portions of three wire cores having rusted away. The outer insulation damage was likely initiated when the cable was first installed, prior to initial plant startup in 1973, and over time the insulation of the wires within the cable degraded. The continuous DC potential on these wires may have contributed to galvanic corrosion.

The fast-transfer circuit this cable serves is not routinely tested because of the potential impact on the plant power supply. It was last called upon in 1984, and it operated successfully at that time. It appears, therefore, that the wires reached a degraded state that would not allow them to function sometime after this date. (See III. Analysis for further discussion).

B. Historical Background

The switchyard at DAEC contains both the high voltage power lines and circuit breakers necessary for DAEC operation, and a substantial number of additional breakers and other system control apparatus used by Iowa Electric. Since the mid 1980's, problems similar to those of the cable examined in April, 1992 had been noted in the switchyard by utility personnel responsible for transmission system protection. These cable problems generally occurred at a rate of one per year. Efforts to inspect the DAEC switchyard cabling due to these problems began in 1990. Roughly 25% of 150 cables have thus far been inspected (meggered), with no problems noted. The cables thus far inspected primarily serve circuit breakers and controls which are important to the operation of DAEC.

There had been no effect upon DAEC due to the occasional cable problems noted until February, 1992, when a circuit breaker for the alternate power supply to essential bus 1A3 unexpectedly closed. It was determined that a cable serving a fast-transfer logic function for 1A3 was damaged and had caused a ground. This cable served the same function as the 1A4 cable which later caused the April event that is the subject of this report. The two cables run in parallel conduits through the switchyard to the J breaker. The 1A3 cable examined following the February event was damaged in roughly the same place, for the same reason, as the 1A4 cable subsequently examined in April. The damaged section of the 1A3 fast-transfer logic cable was replaced in March during the 1992 refueling outage. The Modification Acceptance Test which was to be performed on the new K breaker following its installation was also designated as a post-maintenance functional check of the repaired 1A3 cable. It was noted that this would also serve to test the functionality of the redundant 1A4 cable.

C. Conclusion

The root cause of the event on April 16, 1992, was poor work practices at the time of the initial 1A4 fast-transfer logic cable installation to Breaker J, which resulted in this cable being damaged. A contributing factor in the event is considered to be an untimely approach to cable testing in the DAEC switchyard once cable degradation had been identified as a potential problem.

III. ANALYSIS OF EVENT

A. System Design and Requirements

At DAEC, the Technical Specifications require that the availability of two offsite power sources be maintained. The UFSAR and Technical Specification Bases note that upon failure of the primary offsite power source there is an automatic transfer to the alternate offsite power source for the plant's essential buses (1A3 and 1A4). The plant design features two types of automatic transfers from one offsite power source to another. In the first, general case, when a low voltage condition has been detected on an essential bus a "slow-transfer" from the primary to the alternate offsite power source occurs for that bus in approximately 4.5 seconds. If the alternate power source is not available, the Emergency Diesel Generator for that bus is called upon. The slow-transfer function is tested once per cycle. For certain cases, a "fast-transfer" of an essential bus to the redundant offsite power supply may occur. This takes place within ten cycles under specific conditions that indicate a fault is not present on the bus. This additional design feature is meant to minimize the impact of a transformer loss or breaker problem and has not been routinely tested because of the possible impact on the plant power supply.

B. Event Analysis

The event on April 16, 1992 involved a failure of the fast-transfer circuitry for essential bus 1A4. The Modification Acceptance Test performed on that date, while noting that a fast-transfer of the two essential buses was expected, also set initial conditions for the test which assumed no fast-transfer, a brief loss of essential bus power, and a slow-transfer of each bus to the alternate offsite power source. The subsequent failure of the 1A4 fast-transfer feature, with the start of the "B" EDG and the initiation of the various PCIS Group Isolations, had a minimal effect on the safe operation of the plant. The EDG and the PCIS Isolations performed as designed, but were not required to mitigate the event. There would be no adverse effect on plant safety system operability in any mode of operation due to the problem experienced.

C. Historical Review

The fast-transfer circuitry for both 1A3 and 1A4 was last verified as operable on December 4, 1984, when a fast-transfer occurred during an event involving one of the site's offsite power transformers. (See LER 84-40). Degradation of the control cable rendered the 1A4 circuitry inoperable at some point after that event. As discussed, the fast-transfer circuitry is not required in order to maintain two offsite power sources. The cable damage noted for 1A4 (and earlier for 1A3) would not have prevented transfer of the essential bus to the backup power supply via the slow-transfer mechanism or manually.

D. System Response

Following repair of the cable which caused the April 16 event, several additional Modification Acceptance Test sequences were performed on April 22. These included again opening the J and K breakers to induce a fast-transfer of both essential buses (1A3 and 1A4). During the first performance of the Modification Acceptance Test on April 22, a fast-transfer of essential bus 1A4 was successfully accomplished, demonstrating the damaged cable which had caused the April 16 event had been successfully replaced. Bus 1A3 also fast-transferred per design. In addition, both EDGs also automatically started. The cause of the EDG starts was promptly reviewed. (The "A" EDG had not started on April 16 when the bus it serves, 1A3, had fast-transferred). The review determined that, even if a fast-transfer did occur, the Emergency Diesel Generators might still automatically start on an essential bus low voltage signal (65% of normal voltage). A fast-transfer is expected to take under ten cycles, but in this time period, the bus voltage can still decay rapidly. (As an example, it was later determined both EDGs had automatically started in 1984 when a fast-transfer had occurred with the plant in normal operation).

The Modification Acceptance Test was annotated to reflect the possibility of the EDGs starting during a successful fast-transfer. Later on April 22, prior to the test being run again, the essential buses, 1A3 and 1A4, were loaded with additional equipment to see if the inductive effect of various large motors on bus voltage would be sufficient to prevent starting of the EDGs. When the Modification Acceptance Test was again performed, only the "B" EDG started (after a short delay). This demonstrated inductive effects may prevent the automatic starting of an EDG on an essential bus fast-transfer.

IV. CORRECTIVE ACTIONS

As previously noted, the switchyard cable to the J Breaker, which caused the April 16 failure of the 1A4 bus to fast-transfer, was replaced. The fast-transfer function of the 1A4 bus was successfully tested on April 22.

A schedule for insulation resistance (megger) testing of in-ground cables within the DAEC switchyard will be developed by June 19, 1992 in order to complete testing of all cables in a timely manner. The test schedule will be contingent upon the availability of cables for de-energization and testing. Test results will be reviewed to determine what further actions are required. As previously noted, a number of cables associated with DAEC operation have already been tested.

The appropriate operational procedure has been revised to reflect the possibility of an Emergency Diesel Generator start on an essential bus fast transfer.

V. ADDITONAL INFORMATION

A. Previous Similar Events

As discussed in III. C., during an event in 1984 involving one of the site's offsite power transformers, both essential busses fast-transferred. No other similar events have been identified. Section II. B. discusses previous switchyard cable problems.

B. Component Information

The damaged cable which caused the April 16 event was a 0.7 inch diameter cable with an EPM (ethylene propylene rubber) casing and four #10 stranded copper conductors.

EIIS System and Component CODES

Emergency Diesel Generator	EK
Essential Busses	EB
Switchyard	EA
Primary Containment Isolation System	JM
Residual Heat Removal System	BO

This event is being reported in accordance with 10 CFR 50.73 (a)(2)(iv)

NRC Form 366A (6-89) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
Duane Arnold Energy Center	0 5 0 0 0 3 3 1	92	- 006	- 00	8 OF 8

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

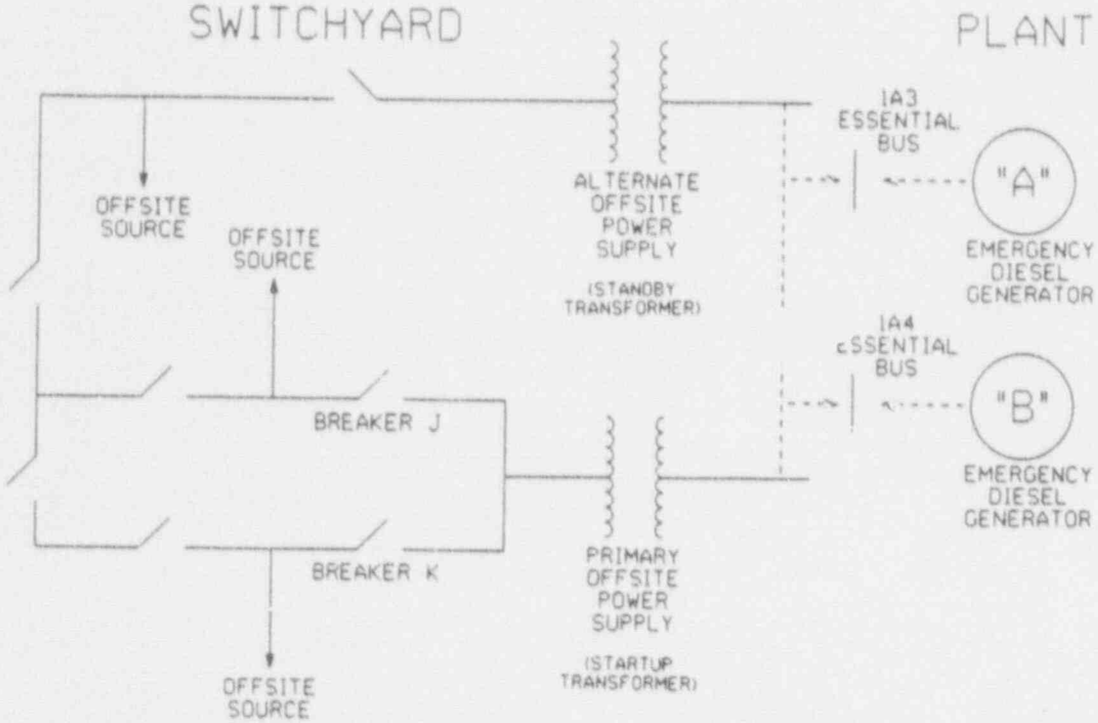

FIGURE 1:

DAEC ESSENTIAL BUS POWER SUPPLIES

(Simplified)