

**IES**  
**UTILITIES INC.**

November 2, 1994  
NG-94-3985

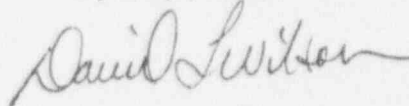
Mr. John B. Martin  
Regional Administrator  
Region III  
U. S. Nuclear Regulatory Commission  
801 Warrenville Road  
Lisle, IL 60532

Subject: Duane Arnold Energy Center  
Docket No: 50-331  
Op. License No: DPR-49  
Licensee Event Report #94-012  
File: A-118a

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  
Plant Superintendent - Nuclear

DLW/JWK/mbm  
n:ler/lerltr doc

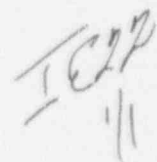
cc: Director of Nuclear Reactor Regulation  
Document Control Desk  
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NRC Resident Inspector - DAEC

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## LICENSEE EVENT REPORT (LER)

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

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.

## FACILITY NAME (1)

Duane Arnold Energy Center

## DOCKET NUMBER (2)

05000-331

## PAGE (3)

1 OF 6

## TITLE (4)

Essential Bus Degraded Voltage Relay Calibration Errors Due to Harmonics

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
10	04	94	94	-- 012 --	00	11	02	94	FACILITY NAME	DOCKET NUMBER 05000
OPERATING		1	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		100	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)			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

Stephen D. Kottenstette, System Engineer

## TELEPHONE NUMBER (Include Area Code)

(319) 851-7353

## 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).

X

NO

## EXPECTED

## MONTH

## DAY

## YEAR

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

On October 4, 1994, with the plant operating at 100% power, during the performance of an increased frequency surveillance test, 4 out of 8 Essential Bus Degraded Voltage relays were found high outside Technical Specification (TS) voltage limits and a fifth high outside the time delay limit. The relays were re-calibrated and returned to service. Analysis of the relay failures led to re-performance of the test using an improved calibration technique. On October 17, 1994 all 8 relays were found low outside the TS voltage limits using the improved calibration method.

The root cause of the event was a failure to use a line corrector on the AC power source during calibration. Corrective actions include procedure revisions, re-calibrating the relays, increased surveillance and trending, and engineering reviews for generic implications.

The effect on plant safety was a reduced margin in the protection against essential motor control center (MCC) trips that can occur at reduced voltage. There were no other systems, components, or structures inoperable at the time that had an effect on the event.

LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION

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FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Duane Arnold Energy Center	05000-331	94	-- 012 --	00	2 OF 6

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

## I. DESCRIPTION OF EVENT:

On October 4, 1994, Surveillance Test Procedure (STP) 42B030-A, the "4KV Emergency Bus Degraded Voltage Annual Calibration", was performed on an increased frequency (quarterly) as a result of recent Electrical Engineering department Instrument Trending Program (ITP) recommendations. The as-found set points of 4 of the 8 relays were high outside the TS allowable setting of  $108.0 \leq V \leq 111.0$  Vac. An additional relay had an as-found time delay above the allowable range of  $8.0 \leq t \leq 8.5$  seconds. The following table provides the as-found values of the out-of-specification relays.

Relay Equipment ID	As-Found Value
127-A1BUS1A3	114.1 VAC
127-A1BUS1A4	111.4 VAC
127-A2BUS1A4	112.0 VAC
127-B2BUS1A4	111.9 VAC
127-A2BUS1A3	8.58 seconds

Each of the relays was re-calibrated and returned to service per the STP within the TS allowed outage time. To perform the calibration adjustments, the STP directed the use of Field Calibration Procedure (FCP) KV-001.

During the engineering review of the surveillance test results, recent industry information was identified involving harmonic distortion effects during calibrations of relays made by the same manufacturer. Engineering investigations revealed potential similar problems at the DAEC. In response to this information, a distortion analyzer was used to measure the distortion on the AC power source used for the relay calibration in the Instruments and Controls (I&C) shop. A 4.7 to 5.1% power source distortion was identified which subsequently equated to approximately 4.0 to 5.0 volt variance in the relay trip set points.

Based on the identified line distortion, prompt actions were taken to re-perform the calibration STP using a line corrector to minimize the distortion. To obtain comparative data, the as-found test of the first relay was performed using the previous calibration setup and also using the improved setup with the line corrector. The results for all eight relays were as follows:

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

Relay Equipment ID	As-Left 10-4-94	As-Found 10-17-94 without line corrector	As-Found 10-17-94 with line corrector	Difference in calibration technique
127-A1BUS1A3	109.3 V	109.5 V	105.10 V	4.20 V
127-A2BUS1A3	109.3 V	N/A	104.15 V	5.15 V
127-B1BUS1A3	109.2 V	N/A	104.47 V	4.73 V
127-B2BUS1A3	110.5 V	N/A	106.96 V	3.54 V
127-A1BUS1A4	109.5 V	N/A	105.38 V	4.12 V
127-A2BUS1A4	109.3 V	N/A	104.68 V	4.62 V
127-B1BUS1A4	111.0 V	N/A	104.93 V	6.07 V
127-B2BUS1A4	109.3 V	N/A	104.24 V	5.06 V

All eight relays were found low outside the allowable values and ranged from 3.5 to 6.1 volts lower than their previous as-left values.

After the third consecutive relay was found low, the remaining relays were declared inoperable based on expected test results and at 2012 hours on October 17, 1994 the plant entered a 12 hour to Hot Shutdown with a subsequent 24 hour to Cold Shutdown Limiting Condition for Operation (LCO) per TS section 3.8.C.2.b. Each of the remaining relays was re-calibrated successfully and the LCO was exited at 0051 on October 18, 1994. Power reduction was not initiated during the LCO time frame.

## II. CAUSE OF THE EVENT

The cause of this event was the harmonic distortion of the AC power source used during the bench calibration. The root cause was a failure to use a line corrector during the calibration. The following are contributing factors to this root cause:

1. The STP used for the annual relay calibration (STP 42B030-A) did not specify the proper equipment setup or require the use of a line corrector for determining the as-found set points of the relays. The vendor manual for the relay states "if very accurate settings are required for a particular application, say within +/- 3% of a given voltage, a stable, harmonic free test source is required". The Vendor Manual then recommends use of a line corrector to achieve the harmonic free source. This information was partially incorporated into the FCP but not into the STP.

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

2. The FCP was not followed completely during the calibration adjustments that were made on October 4, 1994. In the general instructions of STP 42B030-A, step 4.5 states "only the applicable calibration adjustment section need be performed" when it refers to the FCP. The technicians entered the FCP at step 6.10 for making adjustments. Had they entered at the beginning of section 6.0, step 6.3 would have required calibration equipment to be setup per Figure 1 which included a line corrector. However, the actual calibration step (7.2.1) in the STP that refers to the FCP is ambiguous in that it only states to "perform applicable" adjustments in accordance with the FCP. This is therefore considered a procedural deficiency.

3. The FCP has not been revised since August, 1985 and it is one of only four remaining procedures yet to be converted to the newer Equipment Specific Maintenance Procedure (ESMP) format. ESMPs for Quality Level 1 components are included in the Biennial Procedure Review program. Therefore opportunities to discover the conflict between the FCP and the way the calibrations were being performed were missed.

### III. ANALYSIS OF EVENT

Degraded voltage protection was added to the 4160V essential buses 1A3 and 1A4 in 1978. The output contacts of the four undervoltage relays on each bus form a one-out-of-two-twice logic matrix. When an undervoltage condition of less than 92.2% of nominal voltage exists on the 4160V bus for 8.0 to 8.5 seconds, the undervoltage matrix will cause the 4160V 1A3 and/or 1A4 offsite power supply breakers to trip and the respective Standby Diesel Generator (SBDG) to start and accept the bus once it is up to speed and voltage.

Low voltage motor starters are guaranteed to operate at 86% of nominal bus voltage. This 86% level is conservative in that tests by the MCC vendor indicate that the motor starters are capable of operating down to 67% of nominal control voltage. Assuming a motor starter control power transformer regulation of 5%, the motor starters are operable at 72% of nominal bus voltage.

The lowest as-found relay setpoint was 104.15 VAC. This corresponds to 86.8% (3640 V) at the 4160V level which corresponds to a value of 82.8% at the worst case 480 V MCC (1B36/1B46). For the individual safety related motor, the minimum steady state voltage would be 78.8% for the Offgas Stack Exhaust Fans (1VEF018A and 1VEF018B) which are at the end of long cable runs from 1B34 and 1B44. Therefore, having a nominal bus voltage of 82.8% would be greater than the 72% and the safety related loads would have been capable of performing their safety function.



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The reduction in the margin for safety that existed would not have been affected by changes in plant operating modes.

The essential buses are equipped with separate undervoltage relays designed to sense a Loss of Offsite Power. These separate relays, which are set at 65% and 20% of nominal bus voltage, were not affected by this condition and would have functioned in the event of a complete Loss of Offsite Power to trip open the offsite power supply breakers, start the SBDGs, and allow the SBDGs to accept the bus once it was up to speed and voltage.

IV. CORRECTIVE ACTIONS:

1. STP 42B030-A 4KV Emergency Bus Degraded Voltage Annual Calibration was revised to include use of a line corrector during the as-found checks. This action has been completed.
2. Programs Engineering is determining the generic implication of harmonic distortion to other relay calibrations and in service use. This action will be completed by November 30, 1994.
3. The degraded voltage relays have been put on an increased surveillance frequency to verify that the relays are not drifting excessively as was originally thought. This action has been completed.
4. The four remaining FCPs will be converted into ESMPs or incorporated into existing procedures. This action will be completed by January 31, 1995.
5. A review of the relationship between STPs and ESMPs will be performed to ensure consistency. This review will be completed by January 13, 1995.

V. ADDITIONAL INFORMATION:

A. Component Information

1. The currently installed undervoltage relays are ABB Brown Boveri, Type ITE model ITE-27D. The vendor manual referenced is IB 18.4.7-2 Issue D.

B. Previous Similar Events/Industry Information

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1. A review of LERs since 1984 did not reveal any instances where harmonic distortion effected calibration. DAEC LER 88-016, Rev. 01 involved the same undervoltage relays and their actuation on loss of control power. That event had no direct impact on this LER, nor were the corrective actions applicable to preventing occurrence of this event.
2. The industry information referred to was Comanche Peak's ONE-PIR-94-0722, Dresden LER 94-005 Rev. 00 and a Point Beach NRC Inspection Report.

C. EIIS Codes and Component Identifiers:

1. Medium Voltage Power System - EA
2. Undervoltage Relay - 27
3. Standby Diesel Generators - EK

D. This event is being reported pursuant to 10 CFR 50.73 (a)(2)(v)(d)