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December 22, 1999
NG-99-1798

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station 0-P1-17
Washington, D. C. 20555-0001

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49
Licensee Event Report #1999-007
File: A-120

Dear Sirs:

Please find attached the subject Licensee Event Report submitted in accordance with 10CFR50.73. There is one new commitment being made in this letter:

> A rigid support will be installed to protect the flexible conduit for solenoid valve SV-4402. This action will be completed by the end of Refuel Outage 17 and will be tracked by Action Request number 18176.

Should you have any questions regarding this report, please contact this office.

Sincerely,

Richard L. Anderson

Richard L. Anderson
Plant Manager - Nuclear

cc: Mr. James Dyer
Regional Administrator
Region III
U. S. Nuclear Regulatory Commission
801 Warrenville Road
Lisle, IL 60532

NRC Resident Inspector - DAEC
DOCU

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PDR ADOCK 05000331

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

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 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Forward comments regarding burden estimate to the 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. If an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

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TITLE (4)

Safety Relief Valve Opened During 125VDC Ground Troubleshooting Due to Two Faults in the Solenoid Valve DC Circuit.

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
11	27	1999	1999	-- 007 --	00	12	22	1999		05000
									FACILITY NAME	DOCKET NUMBER
										05000

OPERATING	2	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)			
POWER LEVEL (10)	1	20.2201(b)	20.2203(a)(2)(v)	50.73(a)(2)(i)(B)	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)	X 50.73(a)(2)(iv)	OTHER
		20.2203(a)(2)(iii)	50.36(c)(1)	50.73(a)(2)(v)(C)	Specify in Abstract below or in RC 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)
John W. Karrick, Principal Licensing Specialist	319-851-7901

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
X	SB	RV	T020	Y					

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE	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)

On November 27, 1999, during a plant startup following Refuel Outage 16 with reactor pressure at 100 psig, a Safety Relief Valve (SRV) opened resulting in reactor pressure dropping and a reactor water level fluctuation. Troubleshooting to locate a ground on a 125 VDC bus was in progress at the time of the event. Once the troubleshooting efforts were ceased, the SRV closed. Plant equipment and parameters responded as expected for the opening of an SRV.

Subsequent testing and repair efforts revealed an open circuit in the SRV's solenoid valve Grayboot connector and a positive ground in the same circuit. Given those conditions, when the troubleshooting efforts introduced a high enough current into the circuit, the solenoid valve energized, resulting in the SRV opening. The root cause of the event was personnel traffic in the area of the solenoid valve's flexible conduit located inside the plant's drywell. Corrective actions included repair of the damaged connection, testing of the SRV, briefing personnel about the event, and issuance of an industry Operating Experience report. Follow-up actions include installation of protective material over the conduit and reviewing industry information pertaining to DC ground troubleshooting. There was no impact on safe operation of the plant as a result of this event.

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

I. DESCRIPTION OF EVENT:

On Saturday, November 27, 1999, the plant entered Mode 2 (Startup) at 1459 hours while coming out of Refuel Outage (RFO) 16. The reactor reached criticality at 1731 hours. Throughout the day, and for the previous two days, troubleshooting efforts had been in progress to locate a ground on the 125 VDC bus. Based on available indications, the ground was classified as a negative, intermittent, high resistance ground on Division I of the 125 VDC bus. Electrical maintenance and engineering personnel were performing the troubleshooting under Troubleshooting Instruction Forms (TIFs) with concurrence from the control room operators.

A D.C. Scout instrument was connected to the positive side of the 1D10 bus and was pulsing the circuit to locate the ground. Efforts to locate the ground using a small (5 milliamp) output from the D.C. Scout were unsuccessful. In accordance with the D.C. Scout Operation Manual, the output signal was increased in increments while pulsing the ground path. At 2235 hours, upon raising the output of the D.C. Scout to 50 milliamps, PSV-4402, an Automatic Depressurization System (ADS) Safety Relief Valve (SRV), opened. Reactor pressure went from approximately 100 psig to 85 psig. Reactor water level swelled from 190 to approximately 198 inches. Operators contacted personnel performing the troubleshooting and directed them to stop. PSV-4402 went closed after the output of the D.C. Scout was lowered. Reactor water level shrank to approximately 178 inches and was quickly restored to 186 inches (in the normal range). All troubleshooting was halted and the test equipment was disconnected.

Plant Management conducted a Fact-Finding Meeting at 2359 hours to investigate the circumstances of the event. It was concluded that no known human performance errors were involved with the troubleshooting. The decision was then made to continue with the plant Startup up to 150 psig reactor pressure in order to be able to conduct surveillance testing (Surveillance Test Procedure (STP) 3.4.3-03) of the SRVs. This surveillance testing verifies each SRV opens when manually actuated and requires adequate reactor steam pressure (150 psig) and flow before it can be performed. At 1111 hours on November 28, 1999, PSV-4402 failed to open during the surveillance test. The valve was declared inoperable and appropriate Technical Specification Limiting Conditions for Operation (LCOs) were entered. The reactor was shutdown at 1422 hours in order to allow for drywell entry to investigate the failure of PSV-4402.

Solenoid Valve (SV) 4402 is a normally de-energized, DC solenoid operated valve that, when energized by the ADS logic, opens and provides nitrogen pressure to open PSV-4402. Inspection of the electrical connections to SV-4402 revealed an open circuit at the field side of the positive Grayboot pin and a ground (to the condulet) on the positive side of SV-4402. The location of these two faults explains why a negative ground had been indicated.

With the D.C. Scout connected to the positive 125 VDC bus (looking for the negative ground), a current path was established through SV-4402 (see Figure 1). Given this current path, once the 50 milliamp output of the D.C. Scout was applied, the current was high enough to energize (open) the normally de-energized SV-4402. Evaluation of the circuit's resistance verified that 50 milliamps was a large enough current to pick up the solenoid.

The damaged Grayboot connection and wiring was repaired, post maintenance testing completed and the valve declared operable at 2250 hours on November 29, 1999. Upon reaching 150 psig during the subsequent plant startup, PSV-4402 successfully passed STP 3.4.3-03 at 0315 on November 30, 1999.

II. CAUSE OF EVENT:

The cause of the event was the damage to the Grayboot connection that created the open circuit and the grounded wire (two separate faults) inside the condulet. The wiring that runs between the junction box and SV-4402 is contained inside a flexible conduit (Sealtite), which is located inside the plant's drywell at a level and location susceptible for personnel to step on. Due to nearby weld repairs inside the drywell during the outage, there was considerable foot traffic over the top of this conduit. Based on these factors and work history from previous outages, it is concluded that the root cause of the damaged connection/wiring is from personnel stepping on the flexible conduit for SV-4402.

A Work Request Card (WRC), A45367, had been written on November 19, 1999 which identified damage to the same flexible conduit on the junction box side of SV-4402. The flexible conduit was repaired and the WRC closed. The electrician that performed that repair did not see any damage on the wires exposed on that end of the connection. The actual faults were later found on the other end (SV side) of the flexible conduit. That end of the flexible conduit did not exhibit signs of damage. The damaged Grayboot connection and grounded wire were enclosed inside the condulet on the SV-4402 end. Neither of them were visible to the electrician who performed the repair. Repairs to damaged conduit are normally performed in a similar manner and have been successful in the past. There are no other instances of grounds caused by conduit damage recorded in the Action Request (AR) system database. The identification of the damaged flexible conduit as documented on the WRC represented an opportunity to have prevented this event. Resistance or continuity checks of that circuit could have detected the damaged connection and eliminated the need for the ground troubleshooting.

From a change analysis perspective, the Grayboot connector was installed on SV-4402 during RFO-15 (April-May, 1998) to simplify the replacement of the SRVs and their solenoid valves each RFO. Prior to the Grayboot installation, the same wires were terminated using butt splices and Environmental Qualification (EQ) tape. The Grayboot connection is not as strong as the former butt splices and EQ tape. Though the Grayboot was installed correctly (based on valve performance during the operating cycle) and remains desirable, this change is considered a contributing factor.

The operation of the D.C. Scout during troubleshooting was conducted in accordance with the D.C. Scout Operation Manual. Several questions arose after this event regarding the manner in which it was used. The type of ground that existed is a significant factor in how the instrument was being used. Specifically, the high resistance this ground created is what required the higher output on the D.C. Scout. Also, the location of the ground with respect to the open connection in the circuit was significant. If there had not been two faults (the ground and the open) in the circuit, SV-4402 would not have changed state. The ground would have been detectable at the lower currents initially used. None of the indications used as input to the troubleshooting were indicative of the open circuit. It was not until PSV-4402 failed its surveillance test that the open circuit was revealed. Therefore, the manner in which the D.C. Scout was used was not a contributor to the event.

III. ANALYSIS OF EVENT:

Plant parameters responded as expected for the opening of one SRV. Reactor pressure dropped from approximately 100 to 85 psig, reactor water level swelled from 190 to 198 inches, then shrank to 179 inches after PSV-4402 went closed, and was quickly restored to 186 inches (within the normal range). Reactor cooldown rate was not exceeded. Suppression Chamber water level and temperature changes were negligible. There was no noticeable change (decrease) in reactor power associated with the pressure transient. It is estimated that PSV-4402 was open for approximately 60 seconds.

The portion of the ADS logic that actuated was limited to SV-4402, which is what caused PSV-4402 to open. The logic relay for ADS actuation did not change state. There was no direct potential to have lifted all 4 ADS SRVs during the troubleshooting efforts. Given the fact that the valve failed to open (versus failed to close) during its surveillance test, there was no increased risk of PSV-4402 failing open as a result of the electrical faults in the circuit. The remaining 3 ADS SRVs all passed their surveillance testing such that there was no reason to suspect faults in those circuits. Per Technical Specification (TS) Bases section 3.5.1, operation of 3 ADS SRVs is adequate to provide the required depressurization. Therefore, the ADS safety function was not lost. The normal means of coolant makeup, Condensate and Feedwater, were adequate to restore level. All low pressure Emergency Core Cooling Systems (Core Spray and the Low Pressure Coolant Injection mode of Residual Heat Removal) were operable at the time of the event. There were no structures, systems, or components inoperable at the start of the event that contributed to the event.

The plant was at low power and pressure at the time of this event. Had this event occurred at 100% power, the transient would have been more severe than what was experienced. However, the DAEC Updated Final Safety Analysis Report (UFSAR), Section 15.6.2, classifies the inadvertent opening of an SRV as a mild depressurization transient and as a non-limiting transient. Also, the location of the faults in the circuit for PSV-4402 was revealed during startup surveillance testing. Regardless of the troubleshooting, the surveillance testing would have revealed the open in the circuit for SV-4402 during the startup. It is therefore unlikely that the plant would have been operated at 100% power with the circuit in that condition. There was no impact on safe operation of the plant as a result of this event.

IV. CORRECTIVE ACTIONS:

Repairs to the damaged Grayboot connection and wiring were successfully completed on PSV-4402 on November 29, 1999. The ADS surveillance at 150 psig was re-performed satisfactorily on PSV-4402 on November 30, 1999.

A briefing has been conducted with appropriate personnel to review this event to sensitize personnel to the potential for hidden wiring damage when making repairs to conduit and to the difference in strength between Grayboot connections and butt splices with EQ tape.

An industry Operating Experience (OE) report was issued to share lessons learned from this event. This event will be added to the Electrical and Instrument & Controls maintenance shops' OE books to retain the event's lessons learned for future reference. (via LER distribution)

A rigid support will be installed to protect the flexible conduit for SV-4402. This action will be completed by the end of RFO-17 and will be tracked by AR #18176. A search indicated there are 6 installed Grayboot connections inside the drywell, all of them on the SRVs. The remaining SRVs are not located in a vulnerable foot traffic area like PSV-4402. Maintenance history reviews did not identify a trend of similar problems in the other SRVs. Therefore, generic actions to protect the conduit on all of the SRVs are not warranted at this time.

Industry OE or other means will be used to review procedures or instructions from other utilities regarding DC ground troubleshooting and the operation of the D.C. Scout. Based on that review, procedure(s) will be developed and implemented, if considered necessary. (AR# 18177).

This event will be added to outage lessons learned in order to brief workers prior to the next RFO about the consequences of stepping on plant equipment (AR# 18178).

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

V. ADDITIONAL INFORMATION:

A. Previous Similar Events

A review of previous events identified one similar event that occurred on February 7, 1986. PSV-4406 (an ADS SRV) opened for approximately 14 seconds due to two grounds in the 125 VDC circuit. One of the two grounds involved SV-4406, the solenoid valve for PSV-4406, but was associated with an instrument cable's drywell penetration. Therefore, though similar events occurred, the causes were different and the corrective actions are not related (reference: DR 86-082).

B. IEEE System Codes:

EJ – 125VDC Power System
SB – Safety Relief Valves, Main Steam System

This report is being submitted pursuant to 10CFR50.73(a)(2)(iv).

Figure 1: Location of Open and Ground in SV-4402 Circuit