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SUBJECT: LER 88-013-00:on 881026,inadequate sealing of level switch electrical housing results in core spray & EDG actuations.

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NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

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

TITLE (4)
Inadequate Sealing of Level Switch Electrical Housing Combined with Cognitive Personnel Error results in Core Spray and Emergency Diesel Generator Actuations

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)
1 0	2 6	8 8	8 8	0 1 3	0 0	1 1	2 5	8 8	None	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
N		20.402(b)	20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10)	0 0 0	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 R. 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	

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 fifteen single-space typewritten lines) (16)

On October 26, 1988, with the reactor defueled, the spurious actuation of a Yarway level switch combined with actuation of a second level switch as part of a surveillance procedure resulting in an inadvertent injection into the flooded-up refueling cavity by the "B" Core Spray System, and automatic startup of the two Emergency Diesel Generators (EDGs). Core Spray injection was terminated after approximately thirty seconds by Operator action. The reactor cavity was not over-filled. The root cause of the spurious switch initiation was improper sealing of the switch, which allowed moisture intrusion after instrument venting. The root cause of the inappropriate actuation of the second level switch was personnel error. Ongoing Control Room outage activities may have also been a factor. A cognitive personnel error and a training deficiency resulted in two additional auto-starts of the EDGs.

Corrective actions to be taken are 1) sealing of moisture intrusion area on Yarways, 2) training on lessons learned, and 3) development of a procedure to disable automatic start signals to safety systems which are not required.

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

I. DESCRIPTION OF EVENT:

On October 26, 1988, at 0353 hours, with the reactor in cold shutdown and defueled with the refueling cavity flooded, an inadvertent reactor vessel low water level signal resulted in the injection of water into the refueling cavity by the "B" Core Spray System (EIIS System Code BM) and the automatic startup of the two Emergency Diesel Generators (EIIS System Code EK).

At 0350 hours on October 26, 1988, routine surveillance testing of four reactor vessel level switches was in progress. These switches actuate at either of two different low vessel levels, designated "lo-lo" and "lo-lo-lo". Two switches are in the "A" logic side and two are in the "B" logic side. Actuation of one "A" logic switch and one "B" logic switch at either vessel low level setpoint can result in initiation of emergency systems if other various logic requirements are also fulfilled. One of the four switches, LIS4531 ("A" logic side, EIIS System Code BM-LIS), had been successfully calibrated earlier that morning. Approximately one and one-half hours later, after notification of the Control Room, calibration of another switch, LIS4532 ("B" logic side, EIIS System Code BM-LIS), was initiated.

LIS4532 was successfully calibrated at the "lo-lo" level setpoint. At 0353 hours, the simulated vessel level signal at LIS4532 was reduced to the "lo-lo-lo" level. Actuation of LIS4532 at the "lo-lo-lo" level setpoint resulted in the unanticipated automatic starting of both Emergency Diesel Generators (EDGs), and the "B" Core Spray subsystem. A Control Room Operator recognized the EDG's were starting and after determining they were not required, secured them by taking the Control Room spring-return handswitches to the STOP position and releasing, which returned the switches to AUTO. As the essential buses remained powered from offsite sources, the EDG's would not have loaded onto the buses. The "B" Core Spray system was secured by Operator action after having injected water into the flooded-up refueling cavity for approximately thirty seconds.

One minute after the EDGs were stopped, they auto-started a second time. An Operator quickly secured both by placing their handswitches to the "Pull-to-Lock" position. One minute after this the two EDGs automatically started a third time. Shortly thereafter an Operator who had been dispatched from the Control Room to the EDG's location secured them for the final time by means of isolating their fuel source. At no time did the EDG's load onto the essential buses.

The Instrument Technicians testing LIS4532 noted that when the switch actuation occurred equipment in the plant began to start. They promptly contacted the Control Room Operators, who had already identified that the

level switch testing might have been a factor in the incident. On instructions from the Control Room, the Instrument Technicians removed the "lo-lo-lo" signal from LIS4532 approximately two minutes after actuation.

A preliminary investigation revealed that the level switch calibrated earlier in the evening, LIS4531, was providing a spurious actuation signal to the "lo-lo-lo" logic. This completed both the "A" and "B" sides of the logic, which resulted in the safety system initiations. Following calibration earlier that morning, LIS4531 had been left in the operable, unactuated condition.

II. ROOT CAUSE:

Four areas of root cause determination were performed with respect to the event at 0353 hours on October 26, 1988: 1) The root cause of the spurious LIS4531 actuation, 2) The root cause of the inappropriate actuation of LIS4532, 3) Additional factors which contributed to a full "lo-lo-lo" signal being initiated, and 4) The root causes of the second and third EDG actuations.

1. Root Cause of the Spurious Actuation of LIS4531

The cause of the unanticipated "lo-lo-lo" signal trip on LIS4531 was moisture on the contacts of microswitch no. 1 within the switch. When LIS4531 was examined later in the day, no moisture was noted, but both the chronology of the switch actuation and other factors indicates a high probability that there was moisture on the microswitch contacts. LIS4531 is a Yarway Corporation model 4418C.

The switch's unanticipated actuation came at 0158 hours, several minutes after the Instrument Technicians had completed its testing. The signal remained in for approximately five hours, after which the switch reset on its own. This would be consistent with moisture on the microswitch. The microswitch contacts have a gap of approximately one millimeter. Other possible causes, such as a valving error or contact degradation (some was noted when the switch was examined), were eliminated during the root cause review.

(Refer to Figures One, Two and Three for the following). LIS4531 has four microswitches arranged in two rows, with the small microswitch contact arms hanging downward. On the top of the electrical switch housing above the microswitches is a conduit penetration to provide a pathway for field wiring to the overhead junction box, and two unused penetrations currently plugged by plastic stoppers. One of the plastic stoppers is about six inches directly overhead of the microswitches within the switch housing.

Instrument line water leaves a white residue upon evaporation. Upon inspection, a small amount of similar residue was identified on the microswitch no. 1 contacts and contact arms. This residue is also apparent on the outside of the LIS4531 electrical switch housing, around the conduit plugs, and on the inside cover of the housing. An examination of the surroundings overhead revealed some evidence of water in the past dripping onto a junction box directly over the switch housing, but no source for such water was apparent. There was no evidence of leakage from the mechanical housing of LIS4531, which contains the switch's water-filled sensing unit, into the electrical switch housing.

The most likely source of water was from LIS4531 itself, via instrument vents on top of the mechanical housing, which is side by side with the electrical switch housing. LIS4531 is vented at the end of each surveillance test to insure no air is trapped within the switch's water-filled sensing unit. The two small vents on top of the mechanical housing are wrapped with cloth to catch the small overflow of water, but at some time during a recent calibration or instrument check, some water may have migrated to the top of the switch housing, and subsequently down through the edges of the conduit plugs or conduit. Water clinging to the underside of the switch housing could then have been disturbed by the work being performed on the instrument, and subsequently dripped onto the microswitch. The switch had been vented a week prior to October 26, 1988. It was also vented at the end of the October 26 calibration, and although excessive water discharge during venting was not noted, the water intrusion into the electrical switch housing could have occurred at that time. The root cause of the moisture intrusion therefore was inadequate sealing of conduit and conduit plugs on the top of the LIS4531 electrical switch housing.

2. The Root Cause of the Inappropriate Actuation of LIS4532

With LIS4531 already providing a spurious "lo-lo-lo" signal, actuation of LIS4532 as part of the same surveillance procedure resulted in the initiation of the "B" Core Spray system and EDGs. This inappropriate actuation occurred primarily because of miscommunication between the Instrument Technicians and the Control Room regarding the testing of LIS4531, as described in the following paragraphs.

Actuation of LIS4531 results in Control Room annuciation. The alarms received on the initial LIS4531 surveillance test actuation and reset were noted by the Control Room and the Instrument Technicans performing the test were informed that they had occurred. During the next

twenty-five minutes four additional cycles of LIS4531 were performed for calibration purposes by the Instrument Technicians (one utility, one contract). A step at the end of the LIS4531 test called for verification that all alarms had been reset following the disconnection of the test equipment. Based on the notification given following the first cycling of LIS4531, the Instrument Technicians performing the test considered this step as having been completed. The Control Room was not asked to verify resetting of all alarms and therefore did not know the testing of LIS4531 had been completed.

LIS4531 spuriously actuated at 0158 hours after the Instrument Technicians had completed testing on the switch and left the area for break. The Control Room operators acknowledged the alarm assuming the test was still ongoing. This left the annunciator in an alarmed condition.

The root cause of LIS4532 being actuated, with LIS4531 already in a tripped condition, was cognitive personnel error. The Instrument Technicians performing the surveillance test did not call the Control Room at the end of the LIS4531 test to verify resetting of all alarms, as required by the procedure when testing on an instrument is complete. When resuming the test, after one and one-half hours, the preceding steps of the procedure were not reviewed as required by the plant Surveillance Manual.

3. Additional Factors Which Contributed to a Full "Lo-Lo-Lo" Signal Being Initiated

   An additional factor which was a contributing cause in the inadvertent initiation of the "B" Core Spray system and EDGs was the ongoing Control Room outage activities. During normal operations the Control Room operates under the "blackboard" concept so that only the minimum number (or no) annunciators are activated. However, due to outage activities, including painting which required semi-transluscent brown paper over the annunciator, traffic in the area of the panel and the large number of annunicators lit, the LIS 4531 alarm remaining in continuously from 0158 hours through the event at 0353 hours did not draw the attention of the Operators. Had the plant been in a normal on-line situation, the progress of the surveillance would have been more easily followed, and such an abberation would have been noted.

4. The Root Causes of the Second and Third Emergency Diesel Generator Actuations

   The root cause of the second unanticipated start of the EDGs was a cognitive personnel error on the part of a Control Room Operator. The Operator promptly stopped the EDGs upon the initial startup, as a loss

of essential bus power had not occurred and operation of the EDGs under no load conditions is not advisable. After moving the EDG handswitches to STOP, the Operator allowed the spring-return switches to return to AUTO. The Operator did not recall at that time, should the initiation signal remain in, the EDGs would restart after a one minute time delay.

The cause of the third unanticipated startup of the Emergency Diesel Generators is a characteristic of the EDG auto-start logic not covered sufficiently in training. The EDG's are designed to assume bus loads within ten seconds of an auto-start signal. When at full speed the DGs run at 900 rpm and 80 psig oil pressure. After a start signal has been received it seals-in until the EDG attains 250 rpm and 6 psig oil pressure, regardless of what position the Control Room handswitch is taken to. As the EDGs start, this seal-in will normally clear within a few seconds. If a stop signal is given to the EDGs while the seal-in remains in place, the result is a sixty second time delay and another auto-start, even if the switch is placed in the "Pull-to-Lock" position. For the third auto-start of each EDG on October 26; the start signal sealed in and the sixty second time delay began because the Operator reacted very quickly to shut down the EDGs after their previous (second) auto-start. This scenario had not been considered during training. This is not considered a design problem, but rather a characteristic of the logic of which Operators should be cognizant. The root cause can therefore be considered a training deficiency.

III. Analysis of Event:

The unanticipated spurious actuation of LIS4531 microswitch no. 1 was conservative in nature. Actuation of this microswitch and either LIS4532 or LIS4534 (EIIS System Code BM-LIS) microswitch no. 1 will result in an auto-start signal to both EDGs and both Core Spray pumps, and injection will occur if reactor pressure is below 450 psig. In addition, all four Residual Heat Removal (RHR) pumps receive an auto-start signal within fifteen seconds. Subsequent injection into the reactor vessel by the selected RHR Low Pressure Coolant Injection (LPCI, EIIS System Code BO) loop occurs only after a confirmatory level signal and if reactor pressure is below 450 psig.

For the event on October 26, 1988, the "A" Core Spray system and LPCI mode of RHR were inoperable due to ongoing maintenance. The effect on the safety of the plant was minimal. The "B" Core Spray System injected approximately 2500 gallons into the flooded-up and interconnected reactor vessel, steam separator storage pool, and fuel storage pool. The Fuel Pool skimmer surge tanks had the capacity to contain this additional water. Had the reactor been at power when the full "lo-lo-lo" reactor vessel level signal was received, injection would not have occurred due to the reactor pressure being greater than 450 psig.

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

There are three other microswitches within LIS4531 and its "A side" and "B side" logic companions. These provide input into the High Pressure Coolant Injection System (HPCI, EIIS System Code BJ), Reactor Core Isolation Cooling System (RCIC, EIIS System Code BN), Auto Depressurization System (EIIS System Code SB), and additional inputs into the RHR logic. Had the moisture resulted in spurious actuation of any of LIS4531's other microswitches, no additional injection into the vessel would have occurred due to the other systems being out of service for maintenance, or because of additional logic requirements for operation.

Based on the nature of the moisture intrusion into LIS4531, the worst case possibility could be considered spurious actuation of all four microswitches with the reactor at full power. This alone would result only in annunciation in the Control Room. Had all the microswitches within LIS4531 spuriously actuated, and the surveillance test been continued as on October 26, complete initiation signals to the HPCI and RCIC systems on "lo-lo" level might have resulted. Such an event would have a minimal safety impact as sufficient time is available for operator action to prevent injection into the reactor vessel (See Section V.b).

IV. CORRECTIVE ACTIONS:

The immediate corrective actions taken for the "B" Core Spray and EDG actuations on October 26 were to secure these systems once it had been verified they were not required. Operations personnel were aware of the possibility of over-filling the refueling cavity, and sought to stop the "B" Core Spray injection as quickly as possible. An inspection of the refueling floor was initiated immediately after the event and revealed no over-flow of the refueling cavity had occurred. Draining of the excess water via the fuel storage pool cooling system was begun shortly thereafter. An Operator dispatched to the EDG area from the Control Room shortly after the first EDG auto-start aided in their shutdown. The brown paper on the annunciator panel was moved aside immediately following the Core Spray initiation. As they were not required to be operable, the "B" Core Spray and EDG startup logics were isolated from their auto-initiation signals soon after the event.

There have been no previous documented instances at the Duane Arnold Energy Center of water intrusion into Yarway electrical switch housings resulting in spurious initiations. The effect of such an intrusion is an inadvertent functioning of the switch and not a failure for function. A spurious actuation of any plant Yarway switch will not result in a safety system initiation.

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As a corrective action to prevent moisture intrusion into Yarway electrical switch housings, all plant Yarway level switches of similar design will have sealant applied to the tops of the switch housing around the conduit and conduit plugs. This action shall be completed by .br December 31, 1988.

This event will be incorporated into site training to emphasize the need to follow procedures as written and to ensure the Control Room is made cognizant of the completion of work on a component, or any temporary halt in such work. This action shall be completed by April 15, 1989.

A procedure will be developed to standardize isolation of safety systems from initiation logic when such systems are not required to be operable. This will help prevent unnecessary challenges, as occurred on October 26. This action shall be completed by June 30, 1989.

Training will incorporate the lessons learned from the auto-starts of the EDGs into the Operator training program. The applicable plant operating procedure will also be modified to note what logic constraints may prevent immediate EDG shutdown after an automatic start. These actions shall be completed by April 15, 1989.

V. ADDITIONAL INFORMATION:

a. Failed Component Information.

LIS 4531 is a Yarway Corporation model 4418C.

b. Previous Similar Events.

The Duane Arnold Energy Center has experienced no previous safety system injections into the reactor vessel as a result of spurious switch operation. On two prior occasions, problems with the LIS4531 surveillance test have resulted in automatic startup of the HPCI system, which was prevented from injecting by prompt Operator action. Neither of these instances were similar in nature to the October 26, 1988 event. A review of Yarway level switch instrument performance documentation indicates no previous spurious actuation due to moisture intrusion.

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

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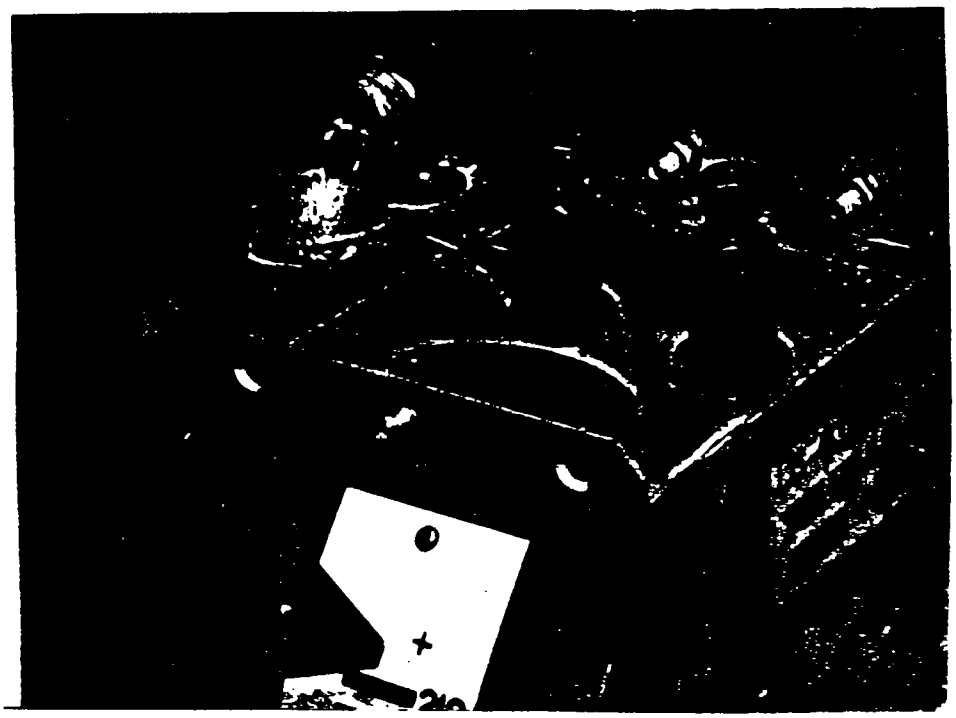
TEXT (If more space is required, use additional NRC Form 366A's) (17)



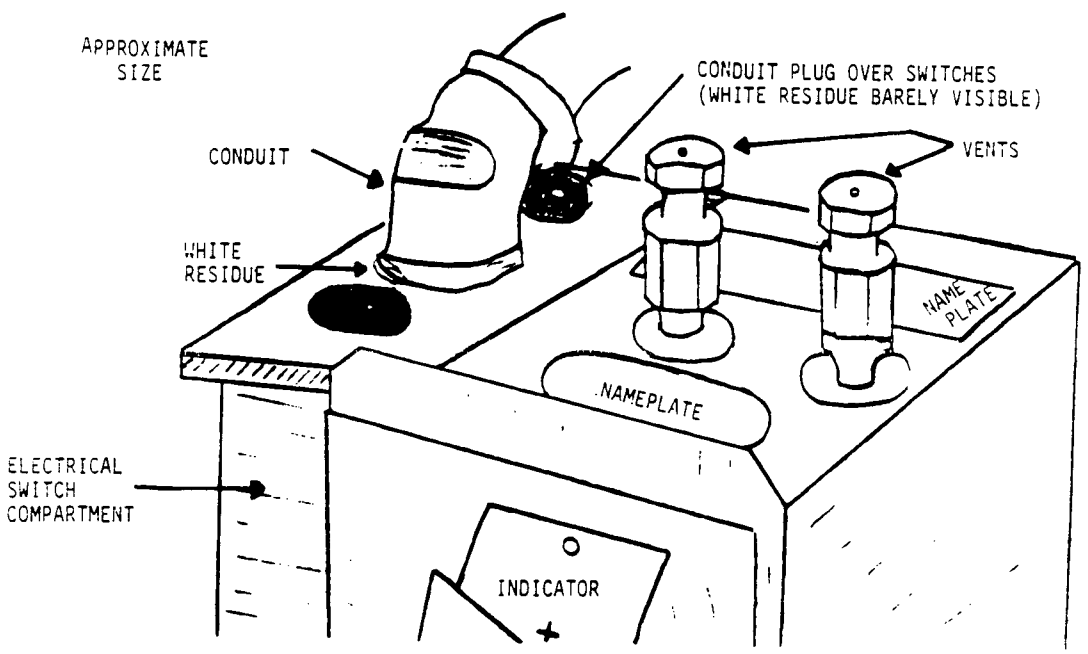


FIGURE 1: TOP OF LIS 4531 (YARWAY 4418C)

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

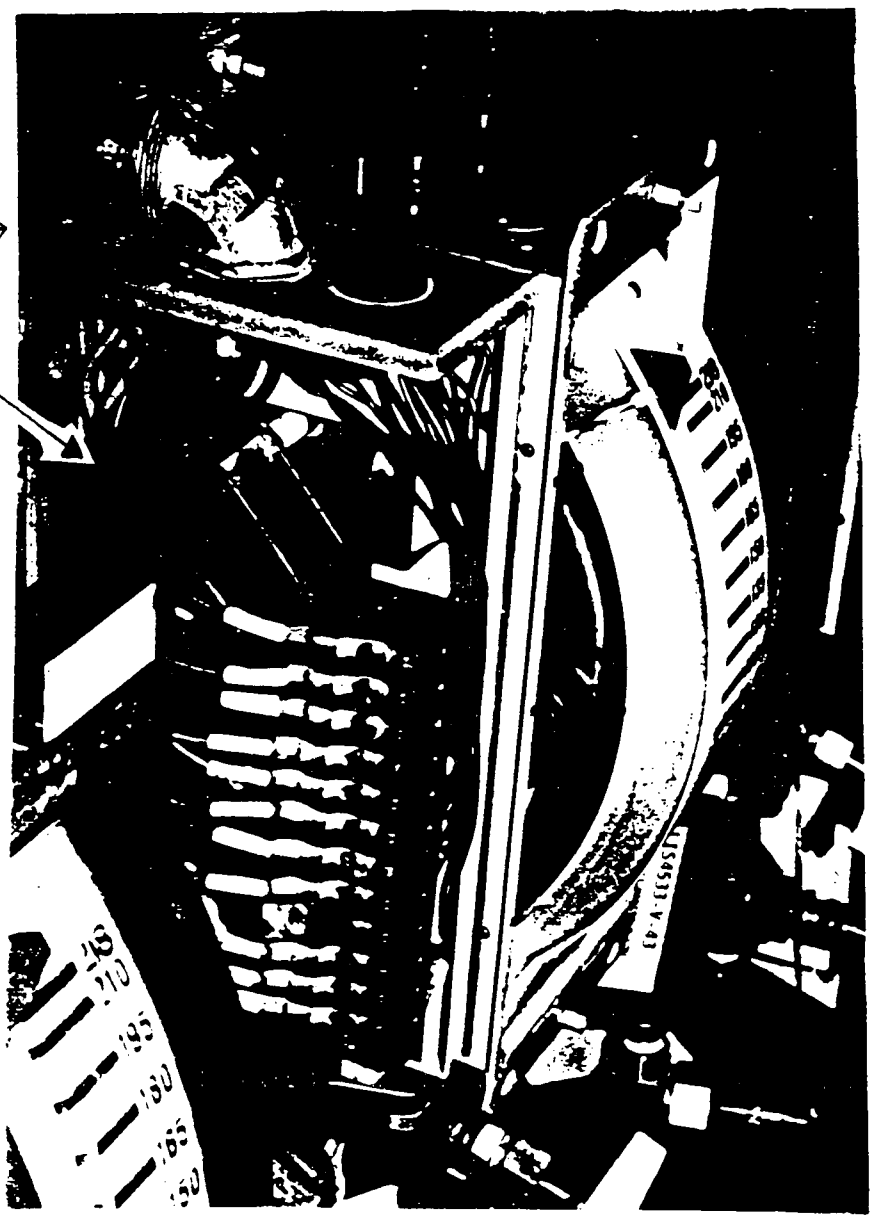
FIGURE 2:

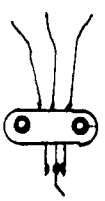
LIS 4531 FROM ELECTRICAL SWITCH COMPARTMENT SIDE

CONDUIT PLUG DIRECTLY OVER SWITCHES

SWITCH LOCATION (HIDDEN FROM VIEW)

APPROXIMATELY HALF SIZE





APPROXIMATE SIZE

FIGURE 3:

LIS 4531 INTERNAL MICROSWITCH

DMB

Iowa Electric Light and Power Company

November 25, 1988
DAEC-88-0893

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 #88-013

Gentlemen:

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

Very truly yours,

Rick Hannen 11-25-88

Rick L. Hannen
Plant Superintendent - Nuclear

RLH/JRP/pl

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