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SUBJECT: LER 89-006-01:on 890224,isolation of RCIC & HPCI due to broken thermocouple lead & poor perf of test switches.
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Iowa Electric Light and Power Company

November 10, 1989
DAEC-89-0792

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 #89-006, Rev 1

Gentlemen:

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

Very truly yours,

Rick Hannen 11-10-89

Rick L. Hannen
Plant Superintendent - Nuclear

RLH/JRP/gt

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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 0 9

TITLE (4) Isolation of RCIC and HPCI Due to a Broken Thermocouple Lead and Poor Performance of Test Switches in Steam Leak Detection System Logic

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 2	2 4	8 9	8 9	0 0 6	0 1	1 1	1 0	8 9	None	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	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 R. Probst, Technical Support Engineer	AREA CODE 3 1 9 8 5 1 - 7 3 0 8

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

On February 24, 1989, an isolation of the Reactor Core Isolation Cooling System (RCIC) occurred due to a signal from the Steam Leak Detection System (SLDS). Troubleshooting determined the cause to be a nearly broken thermocouple (TC) wire on a temperature detection module in the SLDS logic. The root cause was a combination of the natural properties of the solid core TC wire, 1970's surveillance testing methodology, and final wire damage during recent replacement of the module with an upgraded model. The wire was re-terminated. A time delay in the SLDS isolation logic was raised from one to three seconds for the RCIC and High Pressure Coolant Injection (HPCI) SLDS logic. RCIC was returned to service on March 2, 1989, after several days of monitoring the RCIC SLDS logic for further problems.

On March 2, 1989, an isolation of HPCI occurred due to a signal from the SLDS logic. Troubleshooting revealed an internal problem within test switches between the TC's and SLDS temperature detection modules was resulting in simulated open TC wire signals, which were being detected by upgraded modules installed in 1988. Following removal of the test switches from its SLDS circuitry, HPCI was returned to service on March 3, 1989. The test switchs were removed from the RCIC and Reactor Water Cleanup SLDS logic shortly thereafter. Long-term corrective actions include modification of the test circuitry and examination of the test switches.

This revised Licensee Event Report is being submitted to note a change in corrective action three, completion of other corrective actions, and to clarify the Riley Panalarm model numbers.

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		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Duane Arnold Energy Center	0 5 0 0 0 3 3 1	8 9	- 006	- 01	2 OF 9

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

This Licensee Event Report documents steam supply isolations of the Reactor Core Isolation Cooling system (RCIC, EIIS System BN) and the High Pressure Coolant Injection system (HPCI, EIIS System BJ) due to signals from the Steam Leak Detection System (SLDS, EIIS System JM). These isolations constitute actuation of an Engineered Safety Function (ESF), and are being reported in accordance with 10 CFR 50.73(a)(2)(iv).

As part of the SLDS, thermocouples monitor area temperatures and differential temperatures in the HPCI, RCIC, Reactor Water Cleanup (RWCU, EIIS System Code CE) and suppression pool areas. These thermocouples provide signals to temperature detection modules. If above normal temperature is sensed, a module will signal for an isolation in the appropriate system to contain the potential steam leak. A full description of the SLDS is provided in Section III, Analysis, and Figure I.

I. DESCRIPTION OF EVENT:

A. February 24, 1989 RCIC Isolation:

On February 24, 1989, with the reactor at 100% power, at 1420 hours the RCIC outboard steam supply isolation valve automatically closed. The RCIC system was declared inoperable at that time. This placed the plant in a seven day Limiting Condition for Operation (LCO) in accordance with the plant Technical Specifications, which also required the operability of HPCI be demonstrated. Due to turbine governor problems, HPCI was considered inoperable at 1645 hours and per the Technical Specifications a twenty-four hour LCO was entered. The HPCI operability was discussed in-full in LER 89-07. HPCI was declared operable at 0529 hours on February 25, 1989, thus exiting the twenty-four hour LCO.

A review of the RCIC isolation by control room staff indicated the isolation signal had originated within the SLDS, which provides inputs into the RCIC logic. Review of the RCIC system status indicated the isolation signal was short-lived (a few seconds at most) and not warranted. The RCIC system was repressurized and RCIC unisolated at 1446 hours, but was still considered inoperable pending further investigation of the isolation. A RCIC isolation due to troubleshooting activities occurred at 2035 hours, with the system repressurized and unisolated soon afterwards.

Troubleshooting identified a poor connection at the back of a SLDS temperature detection module. This was determined to be the cause of the isolation signal. The connection was reterminated. Additional monitoring of the SLDS was undertaken due to recent short, spurious SLDS isolation signals. Because of a one-second time delay within the logic, these signals had not resulted in actual isolations. In order to make the SLDS logic more immune to short-lived spurious signals, the time delay in both the HPCI and RCIC logic was increased from one to three seconds. Following this, the RCIC system was declared operable at 1752 hours on March 2, 1989.

B. March 2, 1989 HPCI Isolation:

At 1757 hours on March 2, 1989, with the reactor at 100% power, the HPCI system outboard steam supply isolation valve automatically closed due to a signal from the SLDS. A HPCI room high temperature signal remained in for approximately one minute. After reviewing conditions in the HPCI system, it was determined the signal was unwarranted, and HPCI was unisolated at 1800 hours. HPCI was formally declared inoperable at 1835 hours. The HPCI inoperability test was initiated to demonstrate the operability of other required safety systems, and was successfully completed. A second HPCI isolation occurred from the same source at 1935 hours. HPCI remained isolated for most of the period from this time until the completion of corrective actions on March 3.

Troubleshooting of the SLDS revealed an internal problem with test switches in the SLDS circuitry for HPCI, RCIC and the RWCU system. On March 3 at 2317 hours, following bypassing of the test switches in the HPCI portion of the SLDS logic, HPCI was declared operable. Corrective actions were completed for the RCIC and RWCU portions of the SLDS logic early the following day.

II. CAUSE OF EVENT:

The cause of the isolation signals from the SLDS on February 24 and March 2, 1989, were problems in the electrical path from thermocouples monitoring area temperature to temperature detection modules in the control room which signal for isolations when a setpoint is exceeded. These problems were loose connections and poor test performance which resulted in erroneous temperature signals being sensed by the SLDS modules. The following paragraphs provide further detail on the investigation and cause of the isolation signals. It should be noted the SLDS temperature detection modules were replaced with upgraded models in the latter half of 1988 in an effort to improve system reliability. These upgrades feature a reduced heat load power supply, and include the optional thermocouple burnout protection. Should an open circuit appear in the thermocouple inputs, the instrument would signal for an isolation.

A. Troubleshooting Activities:

1. February 24, 1989 RCIC Isolation.

Troubleshooting of the SLDS inputs into the RCIC system began soon after the isolation on February 24 occurred. At the time of the isolation control room staff had noted that the "Steam Leak Detection High Differential Temperature" annunciator had briefly come in. A review of the SLDS panel with the control room found that there was no current isolation signal from this system. No other RCIC system isolation signal was present, nor were there any indications that a condition which should result in an isolation existed.

There was a known response characteristic within the SLDS of short duration isolation signals being generated due to unidentified system noise. One second time delays built into the SLDS isolation logics in 1985 and 1986 reduced the number of isolation signals. Periodically an SLDS annunciator, which does not have a time delay, would momentarily come in but system isolations were not occurring.

From the initial event review a preliminary determination was made that the RCIC isolation had been due to a short, spurious signal from a temperature detection module in the SLDS, TDS2445A (EIIS Component Code JM-TS). Calibration checks were performed on TDS2445A. The switch was found within calibration. It's thermocouples were examined and found to be in satisfactory condition.

Troubleshooting then focused on items outside the thermocouple to temperature detection module interface which might cause a spurious signal. The stability of the power supply for the RCIC temperature detection modules which could signal for the valve closure was examined and no problems were found. During an examination of the RCIC and HPCI temperature detection modules in the SLDS cabinet, touching of a thermocouple input wire on TDS2445A resulted in a RCIC isolation signal which remained in. Further examination found the wire to be nearly broken where it was bent at the terminal screw of TDS2445A. (The wire broke off during examination). It appears this wire had simulated an open thermocouple lead earlier in the day when RCIC had isolated. In the event of a sensed open thermocouple lead, the temperature detection module will signal for an isolation. The input wire was reterminated.

As a conservative measure following the repair, RCIC was still considered inoperable so that the RCIC SLDS logic could be monitored for several hours to provide adequate assurance that the problem had been corrected. Additional momentary SLDS annunciators, with no isolation signals, occurred soon after repair of TDS2445A. The instrument source of these signals could not be determined. Loose connections on the test switches could also simulate an open thermocouple signal, and several were tightened.

The performance of the RCIC SLDS was further evaluated over the next several days. The RCIC temperature detection modules which could provide an isolation signal after a one second delay were continuously monitored by a recorder for over two days and no abnormalities were noted. The momentary spurious signals which did occur did not originate at these instruments. Following the increase of the time delay from one to three seconds (see Corrective Actions), RCIC was declared operable.

2. March 2, 1989 HPCI Isolation.

On March 2, immediately following the HPCI isolation at 1757 hours, a review of the event determined the isolation signal had originated with TS2261B (EIIS Component Code JM-TS), a HPCI area high ambient temperature detection module. The module remained actuated for approximately one minute. Recording equipment monitoring SLDS instrumentation as part of a troubleshooting effort noted the signal. The HPCI room temperature was verified as normal, indicating the signal was not warranted. A second isolation signal was received from TS2261B at 1935 hours.

Wiring on the back of TS2261B was examined and no problems were noted. TS2261B was tested and found to be within calibration. The thermocouple cables for TS2261B were meggered and time domain relfectometry was performed with no discrepancies found. A general check of the wiring in the SLDS temperature switch panel discovered that light tapping of the input and output leads for the test switches would result in switch actuation. It was then noted that light tapping on the test switches for several temperature detection modules within the SLDS panel, or on the panel itself, would induce short, spurious switch actuations.

The cause of the HPCI isolations on March 2 was determined to be a poor connection of test switch internal contacts within the circuitry between TS2261B and it's thermocouple. The test switches are General Electric Type CR2940 (EIIS Component Code JM-HS) two position keylock switches.

B. Root Cause:

1. February 24, 1989 RCIC Isolation.

The intermediate cause of the RCIC isolation on February 24, 1989, due to a SLDS signal was a broken wire on the back of a temperature detection module. The cause was a combination of the following:

(1) Natural properties of solid core thermocouple wire, which made it susceptible to breaking due to bending-induced shear stresses.

(2) Early surveillance test methodology and circuit design. Prior to 1977, these wires were removed for every surveillance test.

(3) Replacement of the switch in October, 1988 likely resulted in the final wire damage. Over time the wire began to slip out from beneath the terminal screw.

2. HPCI Isolation on March 2, 1989.

The root cause of the SLDS isolation signal for the HPCI system on March 2, 1989 was poor performance of test switches within the SLDS circuitry. This poor test switch performance came to light as a result of an effort to improve the reliability of the SLDS.

Upgraded models of the SLDS temperature detection modules were purchased and installed as a corrective action for a number of items, including unit overheating. Burnout protection was included in most of the units received. The added burnout protection feature provides increased reliability for the SLDS, as thermocouple failure is now readily detectable.

Test switches identical to those in the SLDS logic were slated for replacement due to high resistance problems in another temperature monitoring system which used Resistance Temperature Detectors (RTDs). High line resistance can have a substantial effect on RTD system accuracy, but this is not the case for thermocouple systems, which feature a very high input resistance. Problems with the open contacts within the test switches had not been noted. Within the SLDS circuitry, this problem would have remained undetected had not the system upgrade been accomplished.

III. ANALYSIS OF EVENT:

A. Description of the SLDS - Area Temperature and Differential Temperature Monitoring

As detailed in Figure I, there are four discrete signals which can result in a HPCI or RCIC isolation: HPCI or RCIC room high ambient temperature, HPCI or RCIC room high differential temperature, suppression pool area high ambient temperature, and suppression pool area high differential temperature. All four signals are subject to a one second time delay. This time delay was installed in 1986 to aid in prevention of spurious isolations in the one-out-of-one isolation signal logic. The suppression pool signals must also remain in for fifteen minutes (HPCI) or thirty minutes (RCIC) prior to an isolation signal occurring. (See LERs 84-28 Revision 1, and 86-007 for details). RWCU will also isolate on high area room temperatures and differential temperatures, and has had a one second time delay installed since 1985. (See LER 85-023).

The SLDS temperature detection modules are Amtek (formerly Riley) Pan Alarm models 86APTGF-EG Point Temperature Switch, 86AVTFF-EG EG Differential Switch, and 86AVTFF-EGB Differential Temperature Switch without burnout protection. The modules currently in place are upgraded models purchased and installed the latter half of 1988. This was done as a corrective action in response to problems with the SLDS temperature instrumentation, with the goal of making the system more reliable. The upgraded models were received with a "burnout protection" option which

was not contained within most of the previous modules in use. This feature will result in the module signaling for an isolation ("tripping") if it senses an open thermocouple lead. The SLDS temperature detection modules for RCIC, HPCI and RWCU are mounted within one panel in the control room.

B. Effect of Event:

The effect of the unwarranted SLDS isolation signal to the RCIC system on February 24, 1989, was minimal. The worst case effect of RCIC inoperability with the reactor in the Run mode is the loss of this system's ability to maintain reactor vessel inventory after small line breaks that do not rapidly depressurize the vessel. The RCIC system is not considered in the plant accident analysis. Because the HPCI system was declared inoperable during this time period (see LER 89-007), per the Technical Specification the plant entered a twenty-four hour Limiting Condition for Operation, and preparations for shutdown were begun. HPCI was returned to service prior to the completion of the shutdown.

The inoperability of the HPCI system due to the unwarranted SLDS isolation signal on March 2, 1989, had a minimal impact on the safe operation of the plant. Redundant systems were verified to be operable throughout the period of HPCI inoperability. With the reactor in Run mode, the worst case effect of the failure or inability of the HPCI system to operate would be the loos of the ability to maintain reactor vessel inventory after small line breaks that do not rapidly depressurize the vessel. The Automatic Depressurization System, (ADS, EIIS System SB), in conjunction with the Low Pressure Coolant Injection system (LPCI, EIIS System BO) and the Core Spray (CS, EIIS System BM), provides full redundancy for HPCI. The RCIC system was also available to mitigate the loss of HPCI, but is not considered fully redundant to HPCI.

IV. CORRECTIVE ACTIONS:

The immediate corrective action for the unwarranted RCIC SLDS actuation on February 24, 1989 was retermination of the broken thermocouple wire before the break. In addition, the thermocouple leads for the remaining temperature detection modules in the RCIC and HPCI SLDS logic were verified to be making adequate contact both visually and by physical inspection. Reactor Water Cleanup was in service at the time of the troubleshooting for this event, therefore, physical inspection of its thermocouple leads was not performed at that time. Surveillance testing since that time has accomplished this action.

A review determined that raising the minimum time delay for a RCIC or HPCI isolation signal from one to three seconds would have no effect on the ability of SLDS to carry out its design function of isolating the systems at a given leak rate. The minimum time delay was raised from one to three seconds for RCIC on March 2, 1989, prior to that system being declared operable. The same change was made to the HPCI SLDS logic at the same time. A change to

the minimum time delay for the RWCU logic, which would also effect a differential flow isolation signal, is being evaluated. The immediate corrective action for the unwarranted actuation of the HPCI SLDS logic on March 2, 1989, was the bypassing of the malfunctioning test switches in the SLDS circuitry for HPCI, RCIC and RWCU.

The long corrective actions for the above events are as follows:

1. The previously noted change in the minimum time delay for the HPCI and RCIC isolation signals from one to three seconds on March 2, 1989.

2. An evaluation of the effect of a time delay change for the RWCU SLDS was performed, and the time delay has been increased to three seconds.

3. Modified test circuitry for the HPCI, RCIC and RWCU Steam Leak Detection modules will be installed during the 1990 refuel outage.

4. When the old test switches are removed from the SLDS panel, several will be examined to determine why they were susceptible to contact problems. (Currently removal is impractical. It will likely occur during installation of the modified test circuitry noted in item 3.) The result of this study will be provided to the manufacturer (General Electric), and the nuclear industry via NETWORK.

5. A review of other plant applications of this type of test switch was conducted. As a result of this review, four potentially susceptible test switches have been identified and resolution of these concerns are being pursued.

6. A review of the purchasing and acceptance process for the upgraded temperature instrumentation has been performed. It was determined that the method of purchase and the acceptance criteria used were appropriate given the information available.

V. ADDITIONAL INFORMATION:

A. Failed Component Identification

The test switches within the SLDS are General Electric Type CR2940 two position keylock switches.

B. Previous Similar Events

There have been several ESF system isolations due to unwarranted signals originating in the Steam Leak Detection System Since 1985, these have included LERs 85-001, 86-007, 86-012, 86-013, 87-024, and 88-006.

C. This revised Licensee Event Report is being submitted to note a change in corrective action three, completion of other corrective actions, and to clarify the Riley Panalarm model numbers.

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

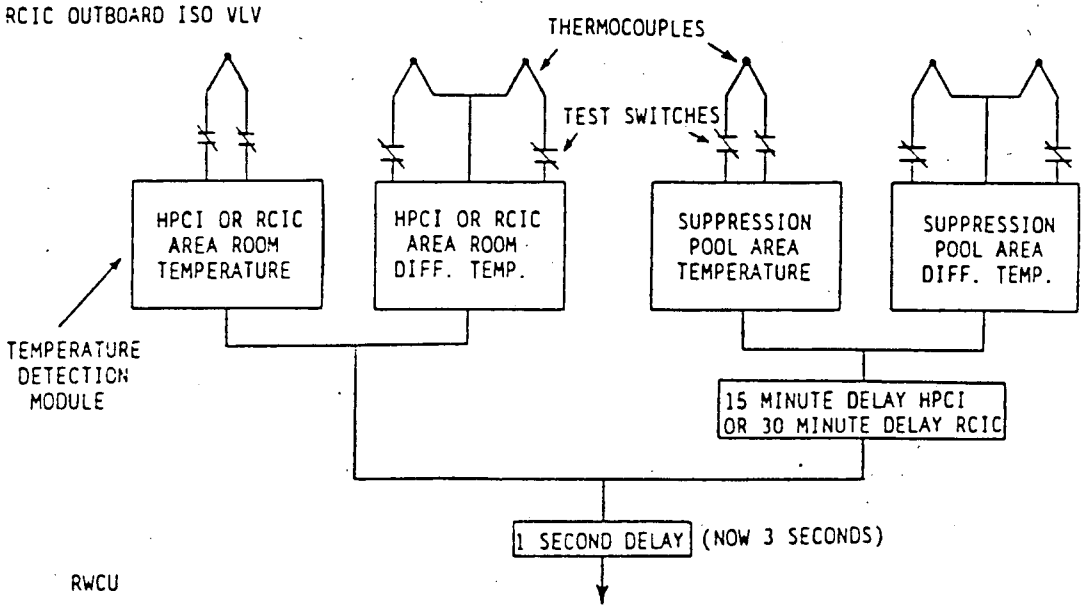
FIGURE I

HPCI, RCIC, AND RWCU
STEAM LEAK DETECTION SYSTEM
TEMPERATURE MONITORING LOGIC

HPCI, RCIC

TYPICAL OF FOUR CHANNELS

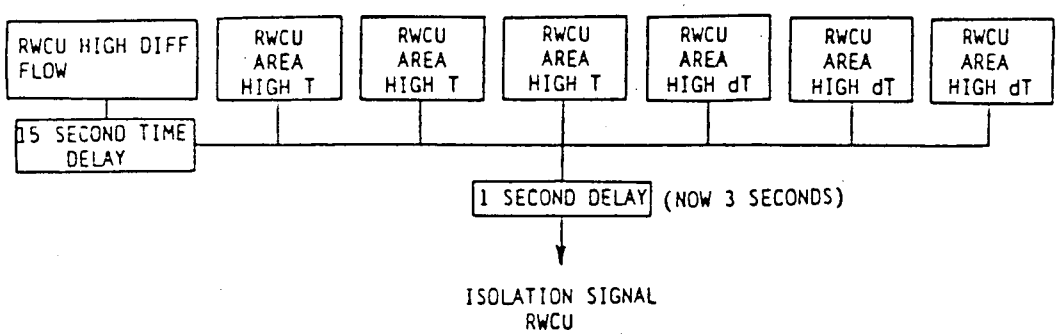
1. HPCI INBOARD ISO VLV
2. HPCI OUTBOARD ISO VLV
3. RCIC INBOARD ISO VLV
4. RCIC OUTBOARD ISO VLV



RWCU

TYPICAL OF TWO CHANNELS

1. RWCU INBOARD ISO VLV
2. RWCU OUTBOARD ISO VLV



NOTE: ANY MODULE ACTUATION MAY RESULT IN AN ISOLATION, IF THE SIGNAL REMAINS IN LONGER THAN THE APPROPRIATE TIME DELAY