Iowa Electric Light and Power Company

April 21, 1992
NG-92-2090

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 #90-010,Rev.01

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/SA/eah

cc: Director of Nuclear Reactor Regulation
Document Control Desk
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D. C. 20555

NRC Resident Inspector - DAEC

IE22
1/1

280059

NRC Form 366A (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED OMB NO 3150-0104

EXPIRES 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530) U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Duane Arnold Energy Center	0 5 0 0 0 3 3 1	1 OF 0 7

TITLE (4): Control Rod Drive Insert/Withdraw Line Leakage and Indications at One Bundle Due to High Cycle Fatigue

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)
									None	0 5 0 0 0
0 5	1 9	9 0	9 0	– 0 1 0	– 0 0	0 4	2 1	9 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)	0 8 3	20.402(b)	20.405(c)	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)	X 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 (AREA CODE)
James R. Probst, Technical Support Engineer	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	A A	P S X	C 1 3 0	Y							

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 May 19, 1990, during a video probe inspection of the small (approximately two inch) air gap between the steel drywell shell and the outer concrete radiological shield, a Control Rod Drive (CRD) withdraw line was observed to have a small (pinhole) leak. Subsequent investigation using ultrasonic testing and metallurgical analysis found other indications (cracks) on the insert and withdraw lines at the southwest CRD bundle penetration into the drywell. These indications are circumferential, from the outside diameter in, and at the toe of the drywell shell to CRD pipe fillet weld. They occur both inside and outside the drywell, with the most extensive being outside.

A subsequent survey of the three other CRD insert/withdraw bundle penetrations found no evidence of similar indications. The root cause of the indications at the southwest CRD penetration remains unknown. Based on metallurgical examinations, an unknown forcing function causing high cycle fatigue is suspected. The southwest CRD lines were replaced using a new drywell penetration weld design.

Instrumentation of the CRD Lines over the next cycle found no forcing function or source of excessive vibration. There is no evidence of new degradation. The instrumentation is being removed. Other than routine monitoring, no further action is planned. This report is being filed for information only.

I. DESCRIPTION OF EVENT:

During the past few years, with the reactor in various operational modes, small quantities of water have been observed dripping intermittently from a torus downcomer penetration in the southwest torus area. From the location of the downcomer, it appeared likely that the source of the water was in the air gap (annulus) region between the steel drywell shell and the outer, concrete radiological shield. (See Figure One). At one point the leakage was quantified at approximately one gallon per hour.

An ongoing, long-term effort was conducted to determine the source of the water. During the investigation, water was also observed from time to time in the nearby sand pocket drains. Inspections of the air gap region were conducted, with over twenty penetrations being examined by video probe insertion. A new video probe with articulation capability was purchased in the spring of 1990 to aid in the search.

On May 19, 1990, a Control Rod Drive (CRD, EIIS Code AA) withdraw line with a small (pinhole) leak was found at penetration X- 37C/X-38C. The leak in the pipe was at the toe of fillet weld between the pipe and the drywell shell. (See Figure Two). A second line at this penetration appeared to be weeping at a similar location. Penetration X-37C/X-38C is a bundle of fifty CRD insert and withdraw lines in the southwest quadrant of containment. (There are four CRD bundles in total, each located in a different quadrant). Upon inspection, roughly half of the southwest bundle lines were found to be visibly wet, and others had mineral streaks in evidence, indicating they had been wet in the past. Some corrosion and discoloration was in evidence on the pipes and drywell shell. Visual inspection within the air gap region of the other three CRD insert/withdraw line bundles saw no evidence of leakage, discoloration or notable corrosion. The dripping at the southwest torus downcomer penetration was noted at this time to be on the order of one gallon per hour.

An evaluation was performed which indicated plant operation could continue until the anticipated refueling outage six weeks away. Withdraw line leakage would not affect the control rod's ability to scram, and excessive leakage (greater than 10 gpm) could not occur if the line were to sever. An inspection plan was developed to determine during the outage if any other CRD insert or withdraw lines were affected, and to ascertain if any degradation to the drywell shell had occurred.

The initial inspection of the southwest CRD bundle lines in July, 1990, following the outage shutdown, was performed using an internal ultrasonic probe. This inspection found numerous indications (cracks) in the pipes for both withdraw and insert lines in the air gap region, including four thru-wall indications. Indications just inside the drywell were also present in some pipes, but these were less numerous and less severe with no thru-wall cracks noted.

All indications were circumferential in nature, in the pipes at the toe of the shell to pipe fillet weld, and from the outside diameter in. The indications were very fine and tight. (The withdraw line leak was not visible below 700 psig reactor pressure, and upon removal, its thru-wall crack could not be seen). A sampling of lines at the other three CRD bundle penetrations found no evidence of abnormal indications, indicating the problem was specific to the southwest CRD bundle.

II. CAUSE OF EVENT

To aid in determination of the root cause, examples of insert and withdraw lines from the southwest bundle with indications were sent to an off-site laboratory for metallurgical testing. The results indicated transgranular fracturing at multiple locations from the outside diameter in, with striations present consistent with high cycle fatigue and periodic crack growth. No evidence was found of stress corrosion cracking (chloride-induced or otherwise).

A subsequent review of the metallurgical analysis, CRD system history and performance, and characteristics unique to the southwest bundle has not resulted in a root cause determination. Evidence points to the existence of a high cycle forcing function, currently unknown, which periodically over time is inducing excessive fatigue in the southwest CRD bundle lines. The predisposition of these lines to high cycle fatigue due to unique, non-cyclic fabrication, construction, environmental and operational factors is also under consideration.

See Section IV, Corrective Actions, for a further, updated discussion.

III. ANALYSIS OF EVENT

The as-found condition of the southwest bundle has been judged not to have had a significant effect on reactivity control or the reactor's ability to shut down in a prompt manner. All evidence suggests the indications found were not propagating rapidly, and of the four thru-wall cracks noted, only two showed any sign of leakage. The leakage was not sufficient to affect rod movement or scram capability.

The CRD insert and withdraw lines provide the mechanism for hydraulic movement of the control rod drives via manual control, and for the high initial acceleration of the rods during an automatic shutdown ("scram", EIIS Code JD). Minor leakage of either line does not affect the ability to move the rod. (No problems were experienced with movement of the control rod which had the small, pinhole leak in its withdraw line). A worst-case rupture of an insert line would not prevent complete insertion of a control rod on a scram signal via reactor pressure during normal power operation (1000 psig). At reactor pressures down to 450 psig, insertion would still occur but scram times would be increased for the affected rod. A worst-case rupture of the withdraw line, or both lines, with the reactor above 450 psig, would result in rod insertion at a speed dependent upon reactor pressure. Primary system leakage due to a ruptured insert line would be limited by the ball check valve on that line. Leakage through a ruptured withdraw line would be limited by the stop piston seals and has been estimated at no greater than 10 gpm with degraded seals. A worst-case rupture of all CRD lines in the southwest bundle would be well within normal and emergency makeup capabilities, and under normal operating conditions would not result in significant radiological releases.

IV. CORRECTIVE ACTIONS

As a corrective action for the extensive indications noted in the southwest CRD bundle, all lines in that bundle have been replaced at the penetration into the drywell. A sleeve has been welded to the CRD pipe and then attached to the drywell shell plate, utilizing a partial penetration groove weld with a cover fillet. This new design provides increased flexibility for thermal transients without sacrificing the carrying capacity needed for mechanical loads. Enhanced leakage monitoring is also under review.

As previously noted, sampling of lines in the other bundles was performed. Ultrasonic testing was considered the preferred method (over other techniques) for determining the extent of the problem. No further indications were found. Currently, efforts are proceeding on identifying the unknown forcing function which appears to have played a role in the southwest bundle degradation. System walkdowns are being performed. The piping and the drywell shell at the southwest and other bundles are being instrumented to provide data on strains, vibrations, and thermal fluctuations during plant operation. This data will be used in determining the root cause and for reviewing the adequacy of the completed repairs.

An examination of the condition of the steel drywell shell in the area of the penetration and the sand pocket region found no evidence of cracking or significant thinning due to moisture-induced corrosion.

Walkdowns of the CRD system within the drywell during the 1990 refueling outage found no sources of vibration which could account for the CRD line indications that had been detected. Monitoring equipment was installed at the southwest bundle prior to plant startup from the 1990 refueling outage to measure pipe strain and acceleration. Sixteen strain gages and five accelerometers were initially used. By year's end, this had been increased to fifty- six strain gauges and fifteen thermocouples spread among all four bundles, and twelve accelerometers total at the southwest and southeast bundles. This instrumentation was located outside the concrete shell, and additionally, for the southwest bundle, in the air gap between the drywell shell and concrete shield. A computerized data collection and analysis system was used to collect and present the data obtained. A system for detecting acoustic emissions caused by pipe leakage or cracking was also placed into service at all four bundles shortly after the refueling outage.

Data gathering from the monitoring equipment continued throughout 1991 and into early 1992, during which a number of plant scrams and other controlled shutdowns occurred. There was no evidence of pipe degradation over this period. No abnormal transients or trends were detected which would have been indicative of a driving force sufficient to have caused the piping degradation discovered at the southwest bundle in 1990. Visual inspection of the air gap region at the southwest bundle in April, 1992 found no evidence of further problems.

As previously noted, a high cycle forcing function was considered the chief cause of the piping indication detected in 1990. Further research into the problem was contingent upon its detection. Given the extensive monitoring that has been completed and the lack of indication of the forcing function at any CRD bundle, it appears unlikely that this phenomena is still in existence or will be detected by further monitoring. Therefore, the monitoring instrumentation is being removed. The torus downcomer areas will continue to be inspected for moisture periodically during each cycle as part of routine surveillance activities. No further action appears necessary at this time to ensure continued CRD piping operability.

V. ADDITIONAL INFORMATION

There have been no previous similar occurrences of this CRD piping problem at the Duane Arnold Energy Center. During the 1988 refueling outage, leakage within the drywell from the northwest CRD bundles insert/withdraw lines, caused by chloride-induced stress corrosion cracking, was detected and repaired. The source of the chlorides was identified as degraded insulation on overhead cabling.

The CRD insert and withdraw lines at the penetration into the drywell are 304 SS, one inch NPS, schedule 160, (nominal wall thickness of 0.25 inches).

The Duane Arnold Energy Center is a General Electric Boiling Water Reactor with a Mark I containment. General Electric has recently issued RICSIL 052 on this concern, and the BWR Owners Group has taken an active interest.

An Intergrated Leak Rate Test is being performed for primary containment during this outage.

This report is being filed for information only.

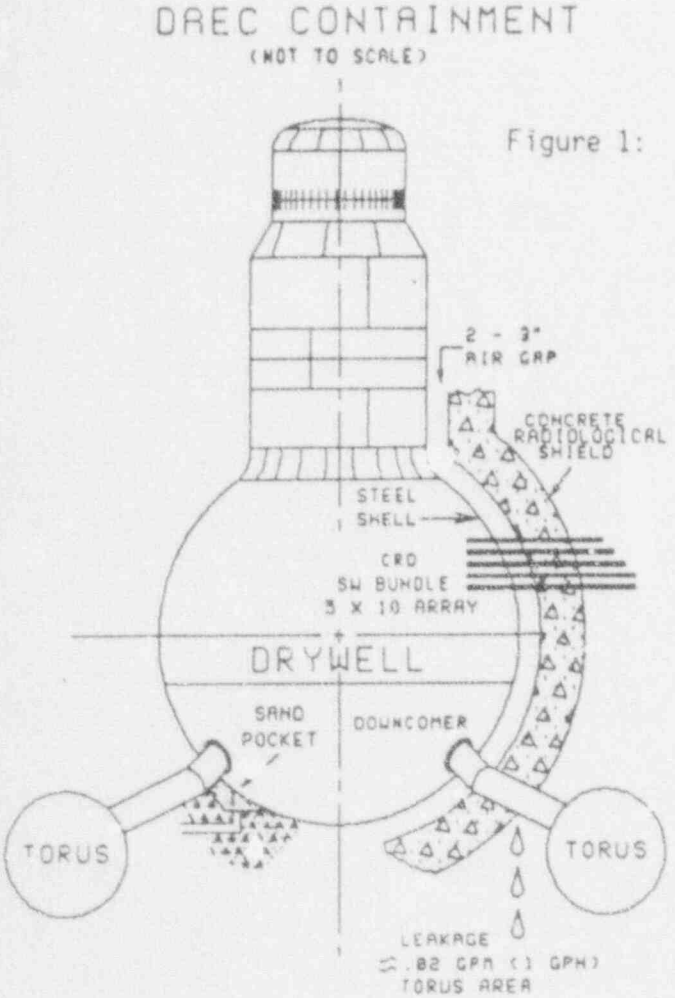

Figure 1: Drywell Shell, With Relative Location of Torus Downcomer and Southwest CRD Bundle

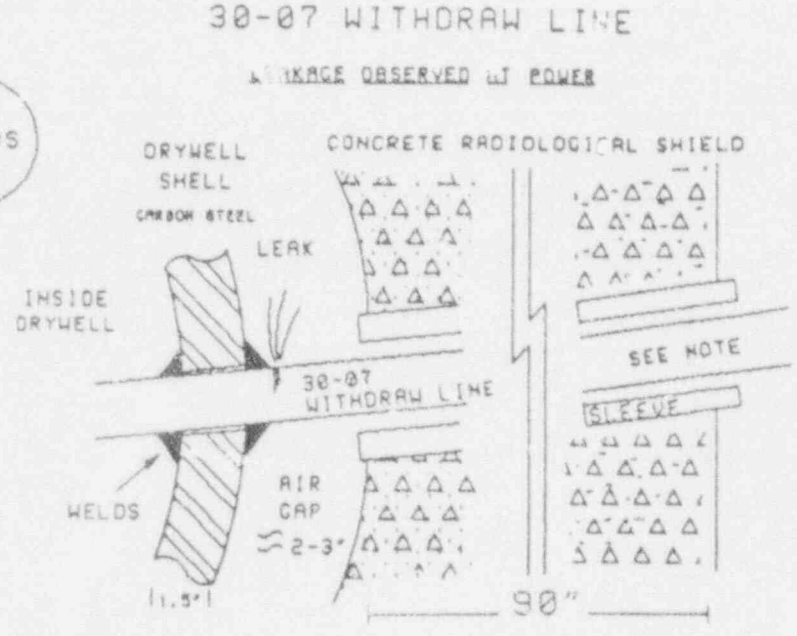

Figure 2: Close-up Perspective of Leaking Southwest Bundle CRD Withdraw Line

THRU-WALL INDICATION NOT VISIBLE UPON REMOVAL

NOTE
1" NPS SCH 160
304 SS
.250 NOM. WALL