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SUBJECT: LER 88-019-00:on 881120,external chloride contamination results in transgranular stress corrosion cracking of CRDP.
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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	1 OF 0 5

TITLE (4): External Chloride Contamination Results in Transgranular Stress Corrosion Cracking of Control Rod Drive Piping

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 1	2 0	8 8	8 8	— 0 1 9	— 0 0	1 2	2 0	8 8	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)	0 0 0	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
Kenneth S. Putnam, Technical Support Engineer	AREA CODE 3 1 1 9 8 5 1 1 - 7 6 0 2

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	
B	J D	P S P		N							

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 November 20, 1988, with the plant in cold shutdown for refueling, workers in the drywell observed leakage in the area of Control Rod Drive (CRD) piping. Investigation of the leakage revealed a region of CRD piping with a significant deposition of a substance on the surface. Analysis of the corroded piping revealed that the piping had experienced transgranular stress corrosion cracking as a result of high concentration chloride surface contamination. The source of chlorides was traced to apparent leaching from electrical cable insulation jackets in a conduit directly above the affected CRD piping tube bundle. The leaching of chlorides from the insulation jacket is believed to have been permitted by thermal aging of the material which broke down the chemical bonding of the material. Inspection of other potentially affected equipment found some chlorides associated with cable installation but no instances of piping deterioration. Thirty-three pipe sections in the affected tube bundle were replaced. At no time was the ability to shutdown the reactor impaired.

This event is being reported for information.

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NRC Form 366
(9-83)

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER(6)			PAGE(3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Duane Arnold Energy Center	0 5 0 0 0 3 3 1	8 8	- 019	- 00	2 OF 5

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

I. DESCRIPTION OF EVENT:

With the plant in cold shutdown for refueling, on November 20, 1988 workers in the Drywell observed a small amount of leakage from a section of piping associated with the Control Rod Drive (CRD) system. Inspection of the pipe in the area of the leak revealed significant deposition of a substance on the surface of the piping. The CRD piping involved included both withdrawal and insertion lines communicating between the Hydraulic Control Units and the control rod drive mechanisms. The function of the piping is to supply motive force to the control rod drive mechanism piston for control rod positioning and rapid insertion (scram). Each control rod has one withdrawal and one insertion line associated with it. A total of 89 withdrawal and 89 insertion lines are needed to supply the 89 control rods. The pipes are split into 4 separate tube bundles for penetration into the drywell. The area of surface contamination was limited to one tube bundle.

II. CAUSE OF THE EVENT:

Analysis of the failed CRD piping indicate conclusively that the cause of the piping failure was Transgranular Stress Corrosion Cracking (TGSCC). The analysis further showed the presence of chlorides near the tip of the crack and in corrosion product on the outer surface of the piping. The chlorides likely induced the corrosion process. Investigation into the source of the chlorides revealed high levels of chloride orginating in the area of an electrical field option box directly above the affected CRD piping. The cable running through this conduit and field option box historically had a short life expectancy. In 1985 an Environmental Qualification evaluation limited the approved life of the cable such that replacement is required every cycle. Residue of previously replaced degraded cable insulation found in the field option box was analysed and showed extremely high concentrations of free chlorides (170,000 ppm). Corrosion products on the bottom of the field option box had chloride concentrations of 240,000 ppm. Consultation with individuals knowledgeable in cable insulation properties indicate that many cable insulation jacket materials, when broken down by exposure to excessive temperature, are susceptible to water leaching of chlorides. It is known that the cable associated with the field option box above the CRD piping experienced temperatures sufficiently high to result in deterioration of the insulation. The precise correlation between insulation jacket deterioration and its ability to allow chloride leaching is not known at this time. It is believed that water condensed from a steam leak in the area of the electrical conduit at some time during past operation may have dripped through the deteriorated insulation jacket and leached out free chlorides. The water, then contaminated with chlorides, is thought to have dripped down onto the exposed CRD piping and, over time, built up a significant deposition of high chloride concentration residue.

The chloride contamination then induced the Transgranular Stress Corrosion Cracking of the CRD piping.

III. ANALYSIS OF EVENT:

The corrosion of the CRD piping led to the potential for leakage from either withdrawal or insert lines. A total of three lines contained defects that penetrated through the wall. An additional 30 lines were replaced to ensure that all CRD piping was free of all indications of TGSCC. At no time were any CRD pipes in a condition which would have prevented control rod insertion. The control rods were shown to stroke during friction and functional testing during the outage. The cable involved is in the environmental qualification program but is not safety-related.

The potential failure of CRD piping is analyzed in the DAEC Updated Final Safety Analysis Report. At operating pressure failure of a CRD insert line would not prevent the insertion of the control rod as reactor pressure would be capable of providing the motive force for control rod insertion once the withdrawal line was vented via normal scram outlet valve to the scram discharge volume. With the withdrawal line not vented (no scram condition) no control rod movement would occur as no mechanism for retracting the collet fingers would exist.

Failure of the withdrawal line piping could result in unnecessary control rod insertion. This would not have adverse safety significance and the failure would be immediately identified due to rod drift alarms which would sound upon the control rod movement. With the reactor at low or atmospheric pressure, reactor pressure could be inadequate to motivate control rod insertion. Had an actual need for a reactor scram occurred concurrent with a complete failure of a CRD insert line at low reactor pressure, the affected control rod would fail to insert. Under no condition would failure of a single control rod to insert prevent the reactor from being fully shutdown. It is extremely unlikely that gradual deterioration of the CRD piping would result in multiple failures simultaneously occurring. The insert lines are constantly pressurized for CRD cooling water flow. Any significant leakage of CRD cooling water would be readily detectable as an increase in unidentified leakage in the drywell and by a change in cooling water flow rates or control rod drive temperatures.

The CRD piping communicates with the primary system via a tortuous path within the control rod drive mechanism. Leakage of primary system (reactor) coolant would be less than 10 gpm, which would be well within normal makeup capacity.

IV. CORRECTIVE ACTIONS:

The leaking CRD piping and all associated CRD piping in the tube bundle

exposed to corrosive material were examined using visual and liquid penetrant (PT) tests. A total of 33 pipe sections were replaced to ensure that the CRD piping was free of TGSCC. Other CRD piping within primary containment was visually examined for signs of corrosion. Any areas exhibiting any significant corrosion or questionable appearance were further examined using surface PT examinations. No detrimental piping corrosion was found outside the localized area of corrosion on the tube bundle discussed above. Samples taken of various deposits in other areas of CRD piping did not contain appreciable levels of chlorides. Permanent shields were installed over the affected CRD piping and the three equivalent CRD tube bundles to ensure that it is impossible for similar contaminants to reach this piping in the future. The field option box identified as the chloride source was sealed. A visual inspection of other field option boxes in the drywell, heater bay, condensor bay, and steam tunnel was performed including a chemical analysis for chlorides in any notable corrosion deposits associated with the field option boxes. While some of the samples did contain chlorides, no instances of conditions affecting exposed piping similar to the original problem were detected. Any field option box showing any evidence of high temperatures was opened to inspect the cable for deterioration via a bend test for pliability. No significant deterioration was found. In the same general area of the affected CRD piping, there was some evidence of contaminants deposited on insulation of the Recirculation System ring header. The insulation was removed from the Recirculation System and the underlying piping was inspected. No piping deterioration had occurred on the Recirculation System piping.

The results of these inspections indicate that this event is an isolated incident and provide reasonable assurance that the probability of significant deterioration of piping as a result of TGSCC induced by chlorides leaching from electrical insulation is minimal. Other plant programatic enhancements that have recently been implemented which would decrease the probability of recurrence of an event of this nature are an aggressive electrical cable inspection and replacement program and enhanced drywell cooling equipment, which significantly reduced the average ambient temperatures within the drywell. Of all environmentally qualified cable applications, the cable in question had the shortest approved life by a significant margin.

In addition to those actions already taken, the DAEC has initiated an engineering study of existing industry information on the potential for chloride leaching from degraded electrical cable insulation. The study will also determine if supplemental actions, such as cable replacement with cable of lower chlorine content or higher temperature stability is warranted in certain applications. The scope of this study will be finalized by April 15, 1989.

V. ADDITIONAL INFORMATION:

a. Failed Component Identification:

The failed components were 3/4 inch and 1 inch Type 304 IPS stainless steel piping, supplied by Reactor Controls, Inc. The electrical cable that had the degraded insulation jacket was Firewall III 2/C No. 16 AWG coated copper cable manufactured by Rockbestos Company.

b. The affected CRD piping was installed during orginal construction in 1972. No other instances of failures of CRD piping from chloride contamination at the DAEC have been noted.

c. The event is being reported for information.

Iowa Electric Light and Power Company

December 19, 1988
DAEC-88-0921

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 #88-019

Gentlemen:

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

Very truly yours,

Rick Hannen 12-19-88

Rick L. Hannen
Plant Superintendent - Nuclear

RLH/KSP/go

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

File A-118a

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