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U. S. Nuclear Regulatory Commission
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Subject: Arkansas Nuclear One - Unit - 1
Docket No. 50-313
License No, DPR-51
Licensee Event Report 50-313/2001-002-00

Gentlemen:

In accordance with 10CFR50.73(a)(2)(ii)(A), enclosed is the subject report concerning leakage through the Reactor Coolant System pressure boundary. The enclosure contains no commitments.

Very truly yours,

Jimmy D. Vandergrift
Director, Nuclear Safety

JDV/tfs

enclosure

IE22

cc: Mr. Ellis W. Merschoff
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NRC FORM 366 (1-2001) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

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TITLE (4) Reactor Coolant System Pressure Boundary Leakage Due To A Crack In A Control Rod Drive Mechanism Nozzle Reactor Vessel Head Penetration

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
03	24	2001	2001	002	00	05	08	2001	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	N
POWER LEVEL (10)	000

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (Check one or more) (11)

	20.2201(b)		20.2203(a)(3)(i)		50.73(a)(2)(i)(C)		50.73(a)(2)(vii)
	20.2201(d)		20.2203(a)(3)(ii)	X	50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(A)
	20.2203(a)(1)		20.2203(a)(4)		50.73(a)(2)(ii)(B)		50.73(a)(2)(viii)(B)
	20.2203(a)(2)(i)		50.36(c)(1)(i)(A)		50.73(a)(2)(iii)		50.73(a)(2)(ix)(A)
	20.2203(a)(2)(ii)		50.36(c)(1)(ii)(A)		50.73(a)(2)(iv)(A)		50.73(a)(2)(x)
	20.2203(a)(2)(iii)		50.36(c)(2)		50.73(a)(2)(v)(A)		73.71(a)(4)
	20.2203(a)(2)(iv)		50.46(a)(3)(ii)		50.73(a)(2)(v)(B)		73.71(a)(5)
	20.2203(a)(2)(v)		50.73(a)(2)(i)(A)		50.73(a)(2)(v)(C)		OTHER
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(B)		50.73(a)(2)(v)(D)		Specify in Abstract or NRC Form 366A

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
T. F. Scott, Nuclear Safety and Licensing Specialist	501-858-4623

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	AB	NZL	B015	Y					

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED SUBMISSION DATE (15)	MO	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE)	X	NO				

ABSTRACT (16)

Indication of boric acid crystals were noted in the area of one Control Rod Drive Mechanism nozzle on the Reactor Vessel (RV) head during routine visual inspection at the start of a scheduled refueling outage. The other nozzles did not exhibit indications of leakage. Non-destructive examinations confirmed that a crack in the nozzle had resulted in Reactor Coolant System (RCS) pressure boundary leakage. The cause of the crack was determined to have been Primary Water Stress Corrosion Cracking. The crack was repaired before the unit was returned to service. The RCS unidentified leak rate before the shutdown did not indicate any significant leakage. A safety assessment concluded that the crack did not pose any risk for catastrophic failure of the nozzle or boric acid damage to the RV head. Routine visual inspections were determined to be adequate to detect future similar cracks before any significant impact on safe operation can occur.

NARRATIVE (17)

A. Plant Status

At the time this condition was determined to be reportable, Arkansas Nuclear One Unit 1 (ANO-1) was in refueling shutdown conditions with the Reactor Vessel (RV) [AB] head on the storage stand.

B. Event Description

Reactor Coolant System (RCS) [AB] pressure boundary leakage occurred from a crack in a Control Rod Drive Mechanism (CRDM) [AA] nozzle that penetrates the RV head.

On March 18, 2001, following shutdown for a scheduled refueling outage, routine visual inspections of the RCS were conducted for evidence of boron in accordance with NRC Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants." This inspection revealed an increase in the amount of boric acid crystals in the area of one CRDM nozzle over the amount that had been present during the previous inspection. The previous inspection had concluded that the boron buildup was due to leakage from the CRDM flange mechanical joint. The results of the inspection on March 18 were inconclusive regarding the source of the leakage. The other CRDM nozzles did not exhibit indications of boric acid leakage.

After the RV head was placed on the storage stand, additional inspections were conducted. On March 23, liquid penetrant (PT) examinations of the face of the J-weld, the outside diameter (OD) of the CRDM nozzle below the J-weld, and the bottom eight inches of the inside diameter (ID) of the CRDM nozzle were performed. No linear indications were identified in the J-weld. One circumferential linear indication was identified on the downhill side of the CRDM nozzle OD below the J-weld. This linear indication was rejectable. No indications were identified in the nozzle ID.

On March 24, a second PT examination was performed. Four rounded indications and one possible divot were identified in the J-weld. All indications were removed and determined not to be associated with the leak mechanism. A circumferential crack approximately 0.7 inch long was identified below the J-weld on the downhill side of the OD of the nozzle. The crack branched twice like a "Y" with each branch extending off-axial (nearly axial) to the toe of the J-weld, but it did not appear that any of the segments propagated into the weld material. PT identified no indications in the ID of the nozzle.

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On March 24, ultrasonic testing (UT) was performed. Scanning for both axial and circumferential reflectors, the examination confirmed a crack in the location of the linear PT indication. It indicated that the subsurface dimensions of the crack extended in a circumferential direction below the weld and in an axial direction through the weld-to-CRDM nozzle fusion zone and to a termination point 1.3 inches above the weld. The flaw depth dimension was estimated to be a maximum of 0.2 inch into the nozzle wall. (The nozzle wall thickness is approximately 1.24 inches.)

Also on March 24, Eddy Current (ECT) examination of the nozzle ID indicated two shallow clusters of crazing and a scratch near the uphill side of the nozzle bore. Otherwise, no significant ID oriented flaws were identified. Because the crazing was indicated by ECT but not detectable by PT or UT, their shallow nature was confirmed.

C. Root Cause

The CRDM nozzle crack was caused by Primary Water Stress Corrosion Cracking (PWSCC). Previous industry experience with PWSCC in Alloy 600 components was evaluated as part of NRC Generic Letter 97-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Closure Head Penetrations." Fatigue stresses on the OD of the nozzle below the weld are believed to be too low to initiate a fatigue crack, and the plant's water chemistry controls preclude stress corrosion cracking from contaminants such as sulfur.

The root cause evaluation identified a potential contributing cause. During the RV head fabrication process, the CRDM nozzle OD was ground in order to achieve an interference fit between the nozzle and penetration. This grinding increased the residual stresses and thereby enhanced the susceptibility to PWSCC.

D. Corrective Actions

On March 26, excavations to remove the axial crack in the CRDM nozzle were initiated. An in-process PT examination was performed during excavation and a final PT examination of the repair cavity verified that the flaw was removed from the weld butter. On March 28, an embedded flaw repair was performed in accordance with the ASME Section XI program and welded per ASME Section III requirements. The repair was progressively examined in accordance with NB-5000. After completing the weld repair, UT

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and ECT examinations of the nozzle were conducted per the repair plan. An OD originated embedded axial flaw was sized by UT as 0.20 inch deep with a length of 1.3 inches above the weld in the nozzle. A limit load analysis was performed and indicated that fatigue crack growth for the design life of the plant (including life extension) is well within the acceptance criteria prescribed by the ASME Code Section XI.

A video inspection of the RV head was completed after decontamination activities to provide a baseline for future visual inspections.

Other than the routine visual inspections for boron buildup, additional CRDM nozzle inspections were not conducted. The basis for this decision included a consideration that bounding fracture mechanics and flaw growth predictions show that adequate safety margin exists to ensure structural margin between operating cycles even with an assumption of significant initial flaws. Based on a conservative safety assessment, sufficient opportunities (three refueling outages) exist to detect leakage before structural integrity of a CRDM nozzle would be challenged.

ANO plans to continue to participate in industry activities regarding PWSCC.

E. Safety Significance

The total unidentified RCS leakage measured on March 16, 2001, just before shutdown for the refueling outage was 0.087 gallons per minute (gpm), a small fraction of the one gpm allowed by Technical Specifications. While the contribution of the CRDM nozzle crack to this total cannot be quantified, the measurement provides a bounding value.

A safety assessment of PWSCC cracking of CRDM nozzles determined that flaws with the as-found configuration do not promote catastrophic failure of the nozzle. Leak rates from these cracks are low and can be detected by visual examination before there is a risk of failure. Crack growth into the low alloy steel RV head is not expected due to the low susceptibility of this material to stress corrosion cracking. Boric acid corrosion rates of the RV head are so low that safe operation of the plant would not have been affected before the leakage was detected by routine visual inspection. The safety assessment also concluded that it is improbable that complete failure of the CRDM nozzle weld could result in a small break LOCA or control rod ejection accident.

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Therefore, the overall safety significance of this condition was determined to be minimal. There was no actual impact on the public health and safety due to this condition.

F. Basis for Reportability

The crack in the CRDM nozzle resulted in RCS pressure boundary leakage and constituted a degradation of one of the plant's principal safety barriers. This condition is being reported pursuant to 10CFR50.73(a)(2)(ii)(A). This condition was reported to the NRC Operations Center pursuant to 10CFR50.72(b)(3)(ii)(A) at 1824 CST on March 24, 2001.

G. Additional Information

ANO has previously reported as Licensee Event Reports (LERs) four conditions involving RCS pressure boundary leakage attributed to PWSCC of Alloy 600 material. In LER 50-313/90-021-00 (letter 1CAN019112) dated January 21, 1991, ANO-1 reported leakage from an Alloy 600 Pressurizer level sensing nozzle. Also, in LER 50-313/2000-003-00 (letter 1CAN030001) dated March 16, 2000, ANO-1 reported leaking welds for RCS hot leg level instrumentation nozzles. In LER 50-368/87-003-01 (letter 2CAN088801) dated August 12, 1988, ANO-2 reported leaking Pressurizer heater sheaths. In LER 50-368/2000-001-00 (letter 2CAN080011) dated August 29, 2000, ANO-2 reported leaking Pressurizer heater sleeves and an RCS resistance temperature detector nozzle. Corrective actions for these conditions were not intended to prevent recurrence of PWSCC in Alloy 600 material that is subject to this failure mechanism.

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].