

**Virginia Electric and Power Company  
North Anna Power Station  
P. O. Box 402  
Mineral, Virginia 23117**

March 20, 2003

U. S. Nuclear Regulatory Commission  
Attention: Document Control Desk  
Washington, D. C. 20555-0001

Serial No.: 03-179  
NAPS: MPW  
Docket No.: 50-339  
License No.: NPF-7

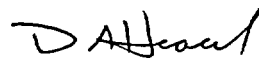
Dear Sirs:

Pursuant to 10CFR50.73, Virginia Electric and Power Company hereby submits the following Supplemental Licensee Event Report applicable to North Anna Power Station Unit 2.

Report No. 50-339/2001-003-01

This report has been reviewed by the Station Nuclear Safety and Operating Committee and will be forwarded to the Management Safety Review Committee for its review.

Very truly yours,



D. A. Heacock, Site Vice President  
North Anna Power Station

Enclosure

Commitments contained in this letter: None

cc: United States Nuclear Regulatory Commission  
Region II  
Sam Nunn Atlanta Federal Center  
61 Forsyth Street, SW, Suite 23 T85  
Atlanta, Georgia 30303-8931

Mr. M. J. Morgan  
NRC Senior Resident Inspector  
North Anna Power Station

IE22

**LICENSEE EVENT REPORT (LER)**

(See reverse for required number of digits/characters for each block)

Estimated burden per response to comply with this mandatory information collection request. 50 hours Reported lessons learned are incorporated into the licensing process and fed back to industry Send comments regarding burden estimate to the Records Management Branch (T-6 E6), US Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503 If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection

FACILITY NAME (1) <b>NORTH ANNA POWER STATION , UNIT 2</b>		DOCKET NUMBER (2) <b>05000 - 339</b>	PAGE (3) <b>1 OF 6</b>
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TITLE (4)  
**Reactor Vessel Head Nozzle Through-Wall Leakage Due to Lack of Weld Fusion During Original Fabrication**

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 NAME	DOCUMENT NUMBER
11	13	2001	2001	-- 003 --	01	03	20	2003	FACILITY NAME	05000-
									FACILITY NAME	05000-

OPERATING MODE (9) <b>6</b>	<b>THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)</b>			
	20.2201(b)	20.2203(a)(3)(ii)	50.73(a)(2)(ii)(B)	50.73(a)(2)(ix)(A)
POWER LEVEL (10) <b>0 %</b>	20.2201(d)	20.2203(a)(4)	50.73(a)(2)(iii)	50.73(a)(2)(x)
	20.2203(a)(1)	50.36(c)(1)(i)(A)	50.73(a)(2)(iv)(A)	73.71(a)(4)
	20.2203(a)(2)(i)	50.36(c)(1)(ii)(A)	50.73(a)(2)(v)(A)	73.71(a)(5)
	20.2203(a)(2)(ii)	50.36(c)(2)	50.73(a)(2)(v)(B)	OTHER
	20.2203(a)(2)(iii)	50.46(a)(3)(ii)	50.73(a)(2)(v)(C)	Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)	50.73(a)(2)(i)(A)	50.73(a)(2)(v)(D)	
	20.2203(a)(2)(v)	X 50.73(a)(2)(i)(B)	50.73(a)(2)(vii)	
	20.2203(a)(2)(vi)	50.73(a)(2)(i)(C)	50.73(a)(2)(viii)(A)	
	20.2203(a)(3)(i)	X 50.73(a)(2)(ii)(A)	50.73(a)(2)(viii)(B)	

LICENSEE CONTACT FOR THIS LER (12)

NAME <b>D. A. Heacock, Site Vice President</b>	TELEPHONE NUMBER (Include Area Code) <b>(540) 894-2101</b>
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COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	AB	RPV	R380	Yes					

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
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ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On October 28, 2001, North Anna Unit 2 was shutdown to perform a qualified, visual barehead inspection of the reactor vessel head penetrations for evidence of leakage as required by NRC Bulletin 2001-01. On November 13, 2001, with Unit 2 in Mode 6, an apparent through-wall leak on penetration number 63 was identified based on the presence of boric acid deposited at the base of the penetration and the results of a subsequent liquid penetrant examination of the associated J-groove weld area. A non-emergency 8-hour notification was made to the NRC, at 0859 hours, on November 13, 2001, in accordance with 10CFR50.72(b)(3)(ii)(A). The event is also reportable in accordance with 10CFR50.73(a)(2)(i)(B). The cause of the event was hot-short cracking, which occurred during original fabrication of the reactor vessel head. Repairs to the welds were performed in accordance with NRC verbally approved relief requests to eliminate any leakage path. No significant safety consequences resulted from this event since RCS unidentified leakage was well below TS limits. An evaluation also determined that a complete lack of fusion in the zone between the weld and the head would not result in rod ejection accident because the weld to the tube would prevent it. The health and safety of the public were not affected at any time during this event.

**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

FACILITY NAME (1)  NORTH ANNA POWER STATION	DOCKET  05000 - 339	LER NUMBER (6)			PAGE (3)  2 OF 6
		YEAR 2001	SEQUENTIAL NUMBER --003 --	REVISION NUMBER 01	

NARRATIVE (If more space is required, use additional copies of NRC Form 366A) (17)

**1.0 DESCRIPTION OF THE EVENT**

On October 28, 2001, North Anna Unit 2 was shutdown to perform a qualified, visual barehead inspection of the reactor pressure vessel (EIS-RPV) head penetrations (EIS-PEN) for evidence of leakage as required by NRC Bulletin 2001-01, Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles. On October 31, 2001, with Unit 2 in Mode 5, this inspection resulted in three penetrations (51, 62 and 63) being identified as rejectable due to existence of boric acid on the reactor pressure vessel barehead surface. The other 62 penetrations were determined to be acceptable based on this inspection. On November 13, 2001, with Unit 2 in Mode 6, further review identified an apparent through-wall leak on penetration number 63 due to evidence of boric acid deposited at the base of the penetration and a liquid penetrant indication near the J-groove weld for that penetration. A portion of the J-groove weld, approximately two and three-fourths (2 3/4) inches long, containing the indication, was excavated to a depth of approximately one (1) inch. A liquid penetrant examination of this excavation on penetration 63 showed that the indication located in the outside edge of the weld almost the full length of the excavation remained and that it turned into the weld at the uphill and downhill ends of the excavation. Based on the apparent through-wall leak, a non-emergency 8-hour notification was made to the NRC, at 0859 hours, on November 13, 2001, in accordance with 10CFR50.72(b)(3)(ii)(A), any event or condition that results in the condition of the nuclear power plant, including its principal safety barriers, being seriously degraded. This event is reportable per 10 CFR 50.73(a)(2)(ii)(A), for any event or condition that resulted in the condition of the nuclear power plant, including its principal safety barriers, being seriously degraded.

In addition, Technical Specification (TS) 3.4.6.2 prohibits reactor coolant system (RCS) (EIS-AB) pressure boundary leakage in Modes 1 through 4. Although the apparent leakage was identified in Mode 6, it is reasonable to assume that the leakage occurred during Modes 1 through 4. Therefore, this event is also reportable in accordance with 10CFR50.73(a)(2)(i)(B) for a condition prohibited by TS.

A summary of NDE inspection results for penetration 63 and penetrations 51 and 62 that also had rejectable indications due to existence of boric acid on the reactor barehead surface is provided below.

Penetration # N2-63:

LP: Liquid Penetrant (LP) examination of the entire weld surface revealed twelve indications at the toe of the weld, which appeared to be contained in the cladding material. No indications were noted on the weld surface. Six of the recorded indications were parallel to the weld, and six were transverse.

E/C ID: The thermal sleeve was removed to facilitate inspection of the tube. Eddy Current (E/C) inspection on the inside diameter (ID) of the penetration in the area

LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION

FACILITY NAME (1)  NORTH ANNA POWER STATION	DOCKET  05000 - 339	LER NUMBER (6)			PAGE (3)  3 OF 6
		YEAR 2001	SEQUENTIAL NUMBER --003 --	REVISION NUMBER 01	

NARRATIVE (If more space is required, use additional copies of NRC Form 366A) (17)

of the attachment weld under the vessel head was performed, and one 31 millimeter (mm) long axial indication was reported.

UT ID: A Ultrasonic Test (UT) examination of the ID was performed to confirm and determine the depth of the indication found using E/C. The depth of the indication was <1 mm, and the length was 14 mm.

UT OD: A UT examination using pulse echo probes inside the tube (45° forward/up and 45° backward/down) was performed focusing on the outside diameter (OD) of the tube. There were no reportable indications using this method.

Penetration #N2-51:

LP: LP examination of the entire weld surface revealed twelve indications at the toe of the weld, which appeared to be contained in the cladding material. No indications were noted on the weld surface. Five of the indications were parallel to the weld, and seven were transverse.

E/C ID: This thermocouple penetration does not have a thermal sleeve. E/C inspection on the ID of the penetration in the area of the attachment weld under the vessel head was performed, and six axial indications were reported.

UT ID: UT examination of the ID of the tube was performed to confirm and determine the depth of the indications found using E/C. All indications were <1 mm deep with the exception of #3, that had a depth of <2 mm. The following lengths were determined using UT:

Indications #1 and #2, 24 mm long cluster (craze cracking)

Indication #3, 10 mm long

Indication #4, 6 mm long

Indication #5, 12 mm long

Indication #6, 6 mm long

UT OD: A UT examination using pulse echo probes inside the tube (45° forward/up and 45° backward/down) was performed focusing on the OD of the tube. There were no reportable indications using this method.

Penetration # N2-62:

LP: LP examination of the entire weld surface revealed eight indications at the toe of the weld, which appeared to be contained in the cladding material. No indications were noted on the weld surface. Two of the recorded indications were parallel to

**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

FACILITY NAME (1)  NORTH ANNA POWER STATION	DOCKET  05000 - 339	LER NUMBER (6)			PAGE (3)  4 OF 6
		YEAR  2001	SEQUENTIAL NUMBER  --003 --	REVISION NUMBER  01	

NARRATIVE (If more space is required, use additional copies of NRC Form 366A) (17)

the weld, and six were transverse.

E/C ID: The thermal sleeve was removed to facilitate inspection of the tube. E/C inspection on the inside diameter of the penetration in the area of the attachment weld under the vessel head was performed, and two axial cluster indications (craze cracking) were reported.

UT ID: A UT examination of the ID was performed to confirm and determine the depth of the indications found using E/C. Indication #1 was <2 mm deep, and Indication #2 was <1 mm deep. The following lengths were determined using UT:

Indication #1, 74 mm long

Indication #2, 42 mm long

UT OD: A UT examination using pulse echo probes inside the tube (45° forward/up and 45° backward/down) was performed focusing on the OD of the tube. There were no reportable indications using this method.

**2.0 SIGNIFICANT SAFETY CONSEQUENCES AND IMPLICATIONS**

Reactor Coolant System leakage, including unidentified leakage, is quantified every 72 hours per TS 3.4.6.2. Prior to the Unit 2 shutdown to perform the reactor vessel head inspection, unidentified leakage was measured at 0.04 gpm and containment sump inleakage was measured at 0.06 gpm.

WCAP-14552, "Structural Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: North Anna and Surry Units," was prepared to support determination of appropriate corrective actions. The WCAP documents that as much as 83.9% of the weld may be unfused, and the allowable stress limits can still be met. Even a complete lack of fusion in the zone between the weld and the head would not result in rod ejection because the weld to the tube would prevent it. Therefore, catastrophic failure of a penetration is unlikely. The health and safety of the public were not affected at any time during this event.

**3.0 CAUSE**

The root cause of the reportable PT indication was hot-short cracking, which occurred during original fabrication of the reactor vessel head. The hot-short cracking was due to the presence of low melting point constituents in the weld. The reactor vessel head may not have been sufficiently cleaned prior to welding in the area around penetrations # 51, 62 and 63, which would indicate a lapse in process control. The hot-short cracking was not detected during the final PT of the finished J groove weld, because the indications were likely subsurface prior to startup. The cracking probably did not extend to the wetted weld surface until sometime later in North Anna Unit 2 reactor vessel head's operating

LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION

FACILITY NAME (1)  NORTH ANNA POWER STATION	DOCKET  05000 - 339	LER NUMBER (6)			PAGE (3)  5 OF 6
		YEAR 2001	SEQUENTIAL NUMBER --003 --	REVISION NUMBER 01	

NARRATIVE (If more space is required, use additional copies of NRC Form 366A) (17)

life. Alloy 82/182 welds are prone to cracking when subject to stress at elevated temperatures.

**4.0 IMMEDIATE CORRECTIVE ACTION(S)**

Based on the qualified, visual barehead inspection results, additional NDE examinations were initiated to characterize the nature of the indications.

**5.0 ADDITIONAL CORRECTIVE ACTIONS**

Evaluations of the eddy current and ultrasonic inspection results for the vessel head penetrations were performed to demonstrate that there is no evidence of a flaw propagating from the OD of the penetration or the penetration to weld fusion zone toward the ID and around the penetration circumferentially. The flaws in the affected penetrations were initially evaluated and reported using WCAP-14552 methodology, which included an assumed flaw aspect ratio of 6:1. However, some of the flaws found at North Anna had aspect ratios larger than 6:1. Subsequently, additional curves were prepared for flaw ratios of 15:1, 20:1, 30:1, 65:1, and 100:1. Using the appropriate bounding aspect ratio, the flaws were reanalyzed for North Anna Units 1 and 2. The revised remaining service life for Unit 2 penetration 51 is 4.16 Y, for Unit 2 penetration 62 is 3.82 Y and for Unit 2 penetration 63 is 4.70 Y.

A boat sample of the weld material from penetration 62 at a location where indications were identified by the LP exam was removed and sent to Westinghouse for laboratory analysis. This sample is considered representative of the indications found in the welds for penetrations 51 and 63 because they all are similarly located at the junction of the J-groove weld and the butter layer. Also, all of the indications are circumferential in nature with a similar appearance from LP. Analysis of the sample confirmed that the indications found using LP were most likely associated with original fabrication.

Relief requests were submitted to the NRC to allow alternative repair techniques for reactor vessel head penetrations that exhibited flaws. During a phone call with the NRC on November 16, 2001, North Anna was given verbal approval to use these repair techniques.

Repairs to the three vessel head penetration welds were performed in accordance with the above mentioned, NRC verbally approved relief requests.

Additional information related to the structural integrity of the reactor pressure vessel head penetration nozzles, including the extent of the leakage and indications, and the inspections and repairs undertaken to satisfy regulatory requirements will be provided in the written response to NRC Bulletin 2001-01.

**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

FACILITY NAME (1)  NORTH ANNA POWER STATION	DOCKET  05000 - 339	LER NUMBER (6)			PAGE (3)  6 OF 6
		YEAR 2001	SEQUENTIAL NUMBER --003 --	REVISION NUMBER 01	

NARRATIVE (If more space is required, use additional copies of NRC Form 366A) (17)

North Anna Unit 2 was returned to service on Saturday, December 15, 2001.

**6.0 ACTIONS TO PREVENT RECURRENCE**

Unit 2 was shutdown on September 8, 2002 for a scheduled refueling outage. Following reactor vessel head inspections the decision was made to replace the existing reactor vessel head. A new crack-resistant reactor vessel head was successfully installed and the unit was returned to service on February 2, 2003.

**7.0 SIMILAR EVENTS**

LER 50-339/94-005-00 documents leakage on a nozzle weld on the seal injection line entering the "B" RCP thermal barrier housing. This line is part of the RCS pressure boundary leakage.

LER 50-338/91-011-001 documents a unit shutdown due to failure of a disc pressurization line for the "B" cold leg stop valve, which exceeded the TS Limit for RCS pressure boundary leakage.

**8.0 MANUFACTURER/MODEL NUMBER**

Rotterdam Dockyard Company/Serial Number 30662

**9.0 ADDITIONAL INFORMATION**

North Anna Unit 1 performed reactor pressure vessel head penetration inspections during the Fall 2001 refueling outage and no through-wall leaks were identified.