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May 9, 2005

U.S. Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington, DC 20555-0001

Subject: Licensee Event Report 50-368/2005-001-00  
Arkansas Nuclear One – Unit 2  
Docket No. 50-368  
License No. NPF-6

Dear Sir or Madam:

In accordance with 10CFR50.73(a)(2)(ii)(A), enclosed is the subject report concerning reactor coolant system pressure boundary leakage.

There are no new commitments contained in this submittal.

Sincerely,

for Dale E. James  
Manager, Licensing

DEJ/dh

enclosure

IE22

cc: Dr. Bruce S. Mallett  
Regional Administrator  
U. S. Nuclear Regulatory Commission  
Region IV  
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**LICENSEE EVENT REPORT (LER)**

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

Estimated burden per response to comply with this mandatory 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 and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by Internet e-mail to infocollects@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 an 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.

|  |                                      |                          |
|--|--------------------------------------|--------------------------|
| <b>1. FACILITY NAME</b><br>Arkansas Nuclear One – Unit 2 | <b>2. DOCKET NUMBER</b><br>05000 368 | <b>3. PAGE</b><br>1 OF 5 |
|--|--------------------------------------|--------------------------|

**4. TITLE**  
Reactor Coolant System Pressure Boundary Leakage Due To Primary Water Stress Corrosion Cracking Of Pressurizer Heater Sleeves

| 5. EVENT DATE |     |      | 6. LER NUMBER |                   |         | 7. REPORT DATE |     |      | 8. OTHER FACILITIES INVOLVED |               |
|---------------|-----|------|---------------|-------------------|---------|----------------|-----|------|------------------------------|---------------|
| MONTH         | DAY | YEAR | YEAR          | SEQUENTIAL NUMBER | REV NO. | MONTH          | DAY | YEAR | FACILITY NAME                | DOCKET NUMBER |
| 03            | 09  | 2005 | 2005          | - 001 -           | 00      | 05             | 09  | 2005 |                              | 05000         |
|               |     |      |               |                   |         |                |     |      | FACILITY NAME                | DOCKET NUMBER |
|               |     |      |               |                   |         |                |     |      |                              | 05000         |

|  |   |   |  |   |  |  |  |  |  |  |
|--|---|---|--|---|--|--|--|--|--|--|
| <b>9. OPERATING MODE</b><br><br>3          | <b>11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: (Check all that apply)</b> |   |  |   |  |  |  |  |  |  |
| <b>10. POWER LEVEL</b><br><br>000          | <input type="checkbox"/> 20.2201(b)   | <input type="checkbox"/> 20.2203(a)(3)(i)   | <input type="checkbox"/> 50.73(a)(2)(i)(C)             | <input type="checkbox"/> 50.73(a)(2)(vii)     |  |  |  |  |  |  |
|  | <input type="checkbox"/> 20.2201(d)   | <input type="checkbox"/> 20.2203(a)(3)(ii)  | <input checked="" type="checkbox"/> 50.73(a)(2)(ii)(A) | <input type="checkbox"/> 50.73(a)(2)(viii)(A) |  |  |  |  |  |  |
|  | <input type="checkbox"/> 20.2203(a)(1)  | <input type="checkbox"/> 20.2203(a)(4)      | <input type="checkbox"/> 50.73(a)(2)(ii)(B)            | <input type="checkbox"/> 50.73(a)(2)(viii)(B) |  |  |  |  |  |  |
|  | <input type="checkbox"/> 20.2203(a)(2)(i)   | <input type="checkbox"/> 50.36(c)(1)(i)(A)  | <input type="checkbox"/> 50.73(a)(2)(iii)              | <input type="checkbox"/> 50.73(a)(2)(ix)(A)   |  |  |  |  |  |  |
|  | <input type="checkbox"/> 20.2203(a)(2)(ii)  | <input type="checkbox"/> 50.36(c)(1)(ii)(A) | <input type="checkbox"/> 50.73(a)(2)(iv)(A)            | <input type="checkbox"/> 50.73(a)(2)(x)       |  |  |  |  |  |  |
|  | <input type="checkbox"/> 20.2203(a)(2)(iii)   | <input type="checkbox"/> 50.36(c)(2)        | <input type="checkbox"/> 50.73(a)(2)(v)(A)             | <input type="checkbox"/> 73.71(a)(4)          |  |  |  |  |  |  |
|  | <input type="checkbox"/> 20.2203(a)(2)(iv)  | <input type="checkbox"/> 50.46(a)(3)(ii)    | <input type="checkbox"/> 50.73(a)(2)(v)(B)             | <input type="checkbox"/> 73.71(a)(5)          |  |  |  |  |  |  |
| <input type="checkbox"/> 20.2203(a)(2)(v)  | <input type="checkbox"/> 50.73(a)(2)(i)(A)  | <input type="checkbox"/> 50.73(a)(2)(v)(C)  | <input type="checkbox"/> OTHER                         | Specify in Abstract below<br>of NRC Form 366A |  |  |  |  |  |  |
| <input type="checkbox"/> 20.2203(a)(2)(vi) | <input type="checkbox"/> 50.73(a)(2)(i)(B)  | <input type="checkbox"/> 50.73(a)(2)(v)(D)  |  |   |  |  |  |  |  |  |

**12. LICENSEE CONTACT FOR THIS LER**

|   |  |
|---|--|
| FACILITY NAME<br>Arkansas Nuclear One / Dee Hawkins | TELEPHONE NUMBER (Include Area Code)<br>479-858-5589 |
|---|--|

**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**

| CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX | CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX |
|-------|--------|-----------|---------------|--------------------|-------|--------|-----------|---------------|--------------------|
|       |        |           |               |                    |       |        |           |               |                    |

|  |                                     |       |     |      |
|--|-------------------------------------|-------|-----|------|
| <b>14. SUPPLEMENTAL REPORT EXPECTED</b><br><input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE) <input checked="" type="checkbox"/> NO | <b>15. EXPECTED SUBMISSION DATE</b> | MONTH | DAY | YEAR |
|  |                                     |       |     |      |

**ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)**

On March 9, 2005, following shutdown for a scheduled refueling outage, a visual inspection of the reactor coolant system pressurizer revealed indications of leakage below the insulation around three pressurizer heater sleeves. On March 12, 2005, with the insulation removed from the heater sleeves and bottom head of the pressurizer, a total of eight heater sleeves and one pressurizer heater penetration containing a plug were found to be leaking. Leakage was identified by small amounts of boron discovered at the sleeve penetration interfaces. On March 15, 2005, with the pressurizer filled with water, one additional leaking pressurizer heater sleeve was identified by visual observation of moisture on the sleeve. Leakage was confirmed in nine pressurizer heater sleeves and one plugged penetration. The failure mechanism for the ten leaking pressurizer penetrations was primary water stress corrosion cracking of Alloy 600 material. Non-destructive examination of the penetrations confirmed the presence of axially oriented flaws. Inspection of the pressurizer base material surrounding each penetration indicated that no boric acid wastage had occurred. The leaking heater sleeves were repaired using NRC approved ASME Code-qualified mechanical nozzle seal assemblies. The leaking plugged penetration was replaced with an Alloy 690 sleeve and plug. The pressurizer will be replaced during the refueling outage scheduled for the fall of 2006.

NRC FORM 366AU.S. NUCLEAR REGULATORY COMMISSION  
(1-2001)

## LICENSEE EVENT REPORT (LER)

| 1. FACILITY NAME              | 2. DOCKET | 6. LER NUMBER |                   |                 | 3. PAGE |  |
|-------------------------------|-----------|---------------|-------------------|-----------------|---------|--|
| Arkansas Nuclear One – Unit 2 | 05000368  | YEAR          | SEQUENTIAL NUMBER | REVISION NUMBER | 2 OF 5  |  |
|                               |           | 2005          | 001               | 00              |         |  |

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

## A. Plant Status

At the time this condition was discovered, Arkansas Nuclear One, Unit 2 (ANO-2) was in hot shutdown, Mode 3, preparing for a scheduled refueling outage.

## B. Event Description

Nine pressurizer [AB] heater sleeves and one pressurizer heater penetration containing a plug were found to have been leaking.

On March 9, 2005, following shutdown for a scheduled refueling outage, visual inspections of the reactor coolant system (RCS) [AB] 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" and NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors." The initial inspection was conducted with the insulation remaining on the pressurizer lower head. Indications of leakage were discovered below the insulation around three pressurizer heater sleeves.

The insulation was removed from the heater sleeves and bottom head of the pressurizer and a bare-metal visual inspection of the head and heater sleeves was performed. On March 12, 2005, a total of eight heater sleeves were identified with evidence of boric acid leakage at the annulus where the sleeve exits the lower pressurizer head. One plug was also discovered with evidence of boric acid leakage. The penetration at this location had been plugged in the late 1980s using Alloy 600 materials. Inspection of the pressurizer base material surrounding each penetration showed no evidence of boric acid wastage.

On March 15, 2005, with the pressurizer full of water, one additional leaking pressurizer heater sleeve was identified. While installing temporary shielding on the bottom of the pressurizer in preparation for making repairs to the heater penetrations previously identified as leaking, two sleeves appeared to be wet at the sleeve-vessel interface. The first sleeve had previously been identified as leaking during the bare-metal visual inspection. The second sleeve, however, had been inspected previously, and had shown no indications of leakage.

Non-destructive examination (NDE) confirmed the presence of axially oriented flaws in the leaking pressurizer heater penetrations.

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| Arkansas Nuclear One – Unit 2 | 05000368  | 2005          | 001               | 00              | 3       | OF 5 |

**17. NARRATIVE** (If more space is required, use additional copies of NRC Form 366A)**C. Root Cause**

The heaters in the nine leaking sleeves were temporarily removed to perform NDE from the inside of the sleeve. The NDE determined that the leakage was the result of axially oriented flaws at the J-groove weld that attached the sleeve to the cladding on the inside surface of the vessel. These flaws were consistent with primary water stress corrosion cracking (PWSCC) that has been experienced throughout the industry.

The normal operating temperature for the pressurizer (approximately 653 degrees F) increases the susceptibility of Alloy 600 heater sleeves to PWSCC, particularly if other material conditions (reaming, poor microstructure, high yield strength) are present. PWSCC is a failure mechanism that is dependent on time of operation, temperature, stress, and material condition.

All pressurizer penetrations were inspected during the previous refueling outage and no leaks were identified; therefore, the boric acid leakage had developed since April 2002.

**D. Corrective Actions**

The nine leaking pressurizer heater sleeves were repaired using mechanical nozzle seal assemblies (MNSA2) designed to replace the function of partial penetration J-groove welds that attach Alloy 600 nozzles or heater sleeves to the pressurizer. The MNSA2 provides a mechanical seal against leakage and positively captures the nozzle, preventing ejection in the unlikely event of complete 360-degree weld failure. The MNSA2 was designed as an ASME Section III, Class 1, safety-related primary pressure boundary. Material testing has verified compatibility of the MNSA2 with the pressure boundary materials and environment.

The leaking plugged sleeve was replaced with an Alloy 690 sleeve and plug. The Alloy 600 sleeve was cut below the pressurizer and was machined to approximately mid-wall of the pressurizer. The remaining section of the Alloy 600 sleeve was left in place and a new Alloy 690 sleeve was inserted into the pressurizer lower head and welded within the mid-wall region of the pressurizer shell. A new Alloy 690 plug was inserted and welded to the lower portion of the new pressurizer sleeve extending down from the bottom of the pressurizer.

As committed in Entergy letter CRNO-2005-00002 (dated January 24, 2005), the ANO-2 pressurizer will be replaced during the refueling outage scheduled for the fall of 2006.

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(1-2001)**LICENSEE EVENT REPORT (LER)**

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

**E. Safety Significance**

Leakage from the ten pressurizer heater penetrations was determined to be due to axial flaws in the heater sleeve originating from the heat affected zone of the seal weld. Axial cracking will not lead to an axial rupture, due to the cracked area of the sleeve being captured within the vessel wall. Flaws leading to leaks are expected to remain in an axial orientation. Although there exists a possibility for the existence of circumferential flaws, the propensity for these flaws to cause a complete circumferential failure leading to the ejection of a heater sleeve within one operating cycle is remote.

Even though ANO continues to identify the presence of PWSCC cracking on heater sleeves, it is believed that future flaws will remain axial within a given outage cycle and no structurally significant condition will exist. Therefore, there is no imminent need to perform additional repairs of non-leaking nozzles or to conduct more frequent inspections of the nozzles.

For these reasons, the overall safety significance of this condition was determined to be minimal.

**F. Basis for Reportability**

Using the guidance from Section 3.2.4 of NUREG-1022, "Event Reporting Guidelines-10CFR50.72 and 50.73," the identified leaks were considered to be a serious degradation of a principal safety barrier. The discovery of three potentially leaking pressurizer heater sleeves was reported to the NRC Operations Center at 0836 CST on March 9, 2005, in accordance with 10CFR50.72(b)(3)(ii)(A). The report was updated at 2155 CST on March 12, 2005, upon the discovery of additional leaking pressurizer heater sleeves and one leaking plug, and again at 2120 CST on March 15, 2005, upon the discovery of a ninth leaking pressurizer heater sleeve. This report is submitted in accordance with 10CFR50.73(a)(2)(ii)(A).

**G. Additional Information**

ANO has previously reported as Licensee Event Reports (LERs), eight conditions involving degradation of a principal safety barrier 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. 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 50-313/2001-002-00 (letter 1CAN050101 dated May 8, 2001), ANO-1 reported a leaking control rod drive mechanism (CRDM) nozzle. In LER 50-313/2002-003-00 (letter 1CAN120201 dated December 4, 2002), ANO-1 reported a cracked CRDM nozzle reactor vessel head weld. In LER 50-313/2004-002-00 (letter 1CAN060403 dated June 29, 2004), ANO-1 reported a cracked CRDM nozzle reactor vessel

NRC FORM 366A U.S. NUCLEAR REGULATORY COMMISSION  
(1-2001)

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| Arkansas Nuclear One – Unit 2 | 05000368  | YEAR          | SEQUENTIAL NUMBER | REVISION NUMBER | 5 OF 5  |  |
|                               |           | 2005          | 001               | 00              |         |  |

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

weld. 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. In LER 50-368/2002-001-00 (letter 2CAN060201 dated June 13, 2002), ANO-2 reported leaking pressurizer heater sleeves. 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 (EIS) codes are identified in the text as [XX].