Palo Verde Nuclear
Generating Station

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**10CFR50.73**

192-01090-WEI/SAB/REB
May 24, 2001

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-37
Washington, DC 20555-0001

Dear Sirs:

**Subject: Palo Verde Nuclear Generating Station (PVNGS)**
**Unit 1**
**Docket No. STN 50-528**
**License No. NPF-41**
**Licensee Event Report 2001-001-00**

Attached please find Licensee Event Report (LER) 50-528/2001-001-00 that has been prepared and submitted pursuant to 10CFR50.73. This LER reports the findings and corrective actions taken as a result of reactor coolant system pressure boundary leakage caused by a degraded Inconel alloy 600 instrument nozzle. The degraded nozzle was modified prior to Unit 1 entering Mode 4 following the refueling outage.

In accordance with 10CFR50.73(d), a copy of this LER is being forwarded to the NRC Regional Office, NRC Region IV and to the Resident Inspector. If you have questions regarding this submittal, please contact Daniel G. Marks, Section Leader, Regulatory Affairs, at (623) 393-6492.

Arizona Public Service Company makes no commitments in this letter.

Sincerely,

WEI/SAB/REB/kg

Attachment

cc: E. W. Merschoff (all with attachment)
J. H. Moorman
L. R. Wharton

IE22

NRC FORM 366 (1-2001)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 6-30-2001

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), U.S. 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.

# LICENSEE EVENT REPORT (LER)

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

| FACILITY NAME (1) | DOCKET NUMBER (2) | PAGE (3) |
|---|---|---|
| Palo Verde Nuclear Generating Station-Unit 1 | 05000528 | 1 OF 4 |

TITLE (4)

## RCS PRESSURE BOUNDARY LEAKAGE CAUSED BY DEGRADED ALLOY 600 INSTRUMENT NOZZLE

| EVENT DATE (5) | | | LER NUMBER (6) | | | REPORT DATE (7) | | | OTHER FACILITIES INVOLVED (8) | |
|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REV NO | MONTH | DAY | YEAR | FACILITY NAME | DOCKET NUMBER |
| | | | | | | | | | | 05000 |
| 03 | 31 | 2001 | 2001 | – 001 | – 00 | 05 | 24 | 2001 | FACILITY NAME | DOCKET NUMBER |
| | | | | | | | | | | 05000 |

| OPERATING MODE (9) | 4 |
|---|---|
| POWER LEVEL (10) | 000 |

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20.2201(b) | | 20.2203(a)(3)(ii) | | 50.73(a)(2)(ii)(B) | | 50.73(a)(2)(ix)(A) |
| | 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 Specify in Abstract below or in NRC Form 366A |
| | 20.2203(a)(2)(iii) | | 50.46(a)(3)(ii) | | 50.73(a)(2)(v)(C) | | |
| | 20.2203(a)(2)(iv) | | 50.73(a)(2)(i)(A) | | 50.73(a)(2)(v)(D) | | |
| | 20.2203(a)(2)(v) | | 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 | TELEPHONE NUMBER (Include Area Code) |
|---|---|
| Daniel G. Marks | 623-393-6492 |

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 | C490 | 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 15 single-spaced typewritten lines) (16)

On March 31, 2001 with Unit-1 operating in Mode 4, Hot Shutdown, and cooling down to Mode 5, Cold Shutdown, for a refueling outage engineering personnel discovered boric acid on a reactor coolant system hot leg instrument nozzle. The cause of the boric acid accumulation was primary water stress corrosion cracking of alloy 600 Inconel material in the instrument nozzle. The amount of boric acid found demonstrates the crack was small and the leakage rate low. The nozzle was visually inspected during the last refueling outage in 1999 with no leakage identified. Visual inspections of other alloy 600 hot leg nozzles did not identify other degraded components.

As corrective action the nozzle was modified during the refueling outage and prior to the Unit entering Mode 4. In addition, the current Palo Verde Alloy 600 strategy is to modify all alloy 600 hot leg nozzles during future outages.

A similar previous condition was reported in LER 50-528/1999-006-00.

## LICENSEE EVENT REPORT (LER)

| FACILITY NAME (1) | DOCKET (2) | LER NUMBER (6) | | | PAGE (3) |
|---|---|---|---|---|---|
| | | YEAR | SEQUENTIAL NUMBER | REVISION NUMBER | |
| Palo Verde Nuclear Generating Station 1 | 05000528 | 2001 | -- 001 | -- 00 | 2 OF 4 |

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

I. REPORTING REQUIREMENT(S):

This LER is being submitted pursuant to 10CFR50.73(a)(2)(ii).

Specifically, on March 31, 2001, engineering personnel discovered boric acid residue on a reactor coolant system (RCS) (EIIS:AB) hot leg instrument nozzle (EIIS:NZL). Technical Specifications (TS) Limiting Condition for Operation (LCO) 3.4.14 permits no RCS pressure boundary leakage and, therefore, the discovery of leakage (boric acid residue) from the nozzle was a degradation of a principal safety barrier. Upon notification of the discovery, Operations personnel entered LCO 3.4.14 Condition B at 1058 Mountain Standard Time (MST). Notification of the event (ENS# 37878) was made in accordance with 10CFR50.72(b)(3)(ii) at 1505 MST. The TS condition was exited on March 31, 2001 at 2103 MST when the plant entered Mode 5, Cold Shutdown, and the LCO was no longer applicable.

II. DESCRIPTION OF STRUCTURE(S), SYSTEM(S) OR COMPONENT(S):

The hot leg instrument nozzle was fabricated from NiCrFe Alloy 600 (Inconel 600). The degraded nozzle is a spare thermowell (EIIS: TW) (1JRCETW0121HB) that penetrates the RCS Loop 2 hot leg piping.

III. INITIAL PLANT CONDITIONS:

On March 31, 2001 Unit 1 was in Mode 4, Hot Shutdown. The RCS was being cooled down in preparation for Unit 1's ninth refueling outage. There were no structures, systems, or components that were inoperable at the time of discovery that contributed to this condition. There were no failures that rendered a train of a safety system inoperable and no failures of components with multiple functions were involved.

IV. EVENT DESCRIPTION:

On March 31, 2001, APS engineering personnel were performing pre-planned visual examinations of RCS piping in accordance with procedure requirements. The purpose of the visual examinations was to identify leakage from pressure retaining components. The examinations are part of APS' systematic measures to ensure that boric acid corrosion does not lead to degradation of the reactor coolant pressure boundary and that there is an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture.

During the visual examinations of the Loop 2 RCS piping, a small amount of boric acid residue was observed around an instrument nozzle that penetrates the Loop 2 hot leg. The boric acid

had accumulated on the exterior of the hot leg piping around the outer perimeter of the instrument nozzle. It was noted that as the RCS was cooled down the nozzle exhibited increased degrees of leakage; first in the form of white boron at the annulus between the outside diameter (OD) of the nozzle and the inside diameter (ID) of the bore, then active drippage as the RCS was cooled.

V. SAFETY CONSEQUENCES:

The cracking of Alloy 600 instrument nozzles both at Palo Verde and industry-wide has been attributed to primary water stress corrosion cracking (PWSCC). Instrument nozzle axially oriented cracks resulting from PWSCC are not considered a significant threat to the structural integrity of the RCS boundary or the instrument nozzle, as this type of cracking typically results only in small leaks.

The bases for this conclusion is that PWSCC that has occurred at Palo Verde has resulted in cracks that were axial in orientation resulting in visibly detectable leakage that was apparent during visual examinations performed as part of routine walkdown inspections before significant damage to the reactor coolant boundary occurred. Eddy current testing (ECT) was conducted on the nozzle at 1JRCETW0121HB and the results confirmed the crack was axially oriented.

The condition would not have prevented the fulfillment of the safety function, and the condition did not result in a safety system functional failure as defined by 10CFR50.73(a)(2)(v).

VI. CAUSE OF THE EVENT:

An investigation of this event was conducted in accordance with the PVNGS Condition Reporting program. PWSCC was concluded to be the mechanistic cause of the instrument nozzle cracking, resulting in axial cracking of the Inconel 600 material. This type of cracking is known to be affected by high temperatures and aging. Industry and Palo Verde specific data demonstrate that these instrument nozzle PWSCC cracks will not result in a complete failure of the pressure boundary but will become evident through small leaks.

Alloy 600 nozzles show significant variability with respect to PWSCC. Forgings and hot worked bar stock may be more susceptible to this form of degradation than cold drawn and annealed pipe material. Nozzles with a wide variety of yield strength levels, from near the specification minimum to very high yield strength, have cracked. Nozzles fabricated from Alloy 600 with a variety of microstructures, including some that steam generator experience indicated should have been resistant to PWSCC, have cracked, as have nozzles fabricated from material with high and low final mill-anneal temperatures.

No unusual characteristics of the work location (e.g., noise, heat, poor lighting) directly contributed to this event. No personnel or procedural errors contributed to this event.

VII. CORRECTIVE ACTIONS:

The degraded hot leg instrument nozzle has been modified. The modification consisted of cutting the existing nozzle off at the outside diameter of the hot leg and installing a plug made of Alloy 690, and welding the plug in place at the outside diameter of the hot leg piping.

To date, APS has replaced all Alloy 600 pressurizer instrumentation nozzles (seven per unit) with corrosion resistant Alloy 690 nozzles and has replaced the Alloy 600 RCS hot leg pressure instrumentation and sampling nozzles in Units 1 and 2 with Alloy 690 nozzles. In addition, all remaining hot leg Alloy 600 instrument nozzles in Units 1, 2, and 3 are currently planned to be modified in future outages.

Any additional corrective actions taken as a result of the investigation of this event will be implemented in accordance with the PVNGS corrective action program. If information is subsequently developed that would significantly affect a reader's understanding or perception of this event, a supplement to this LER will be submitted.

VIII. PREVIOUS SIMILAR EVENTS:

A similar condition was reported in LER 50-528/1999-006-00 in which a different hot leg instrument nozzle was found to have evidence of leakage (boric acid residue). That condition was attributed to PWSCC and the nozzle was repaired. Corrective actions to prevent recurrence from that condition are the same as for this LER with a final completion date currently scheduled for the end of each Unit's 10$^{th}$ refueling outage.