APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: 50-313/87-17
50-368/87-17

Licenses: DPR-51
NPF-6

Dockets: 50-313
50-368

Licensee: Arkansas Power & Light Company (AP&L)
P. O. Box 551
Little Rock, Arkansas 72203

Facility Name: Arkansas Nuclear One (ANO)

Inspection At: Russellville, Arkansas, and Region IV Offices, Arlington, Texas

Inspection Conducted: May 10-26, 1987

Inspectors: D M Hunnicutt
D. M. Hunnicutt, Chief, Operations Section — 6/9/87 Date

for D M Hunnicutt
H. W. Kerch, NRC, Region I, Lead Reactor Engineer — 6/9/87 Date

Approved: for R. E. Ireland
T. F. Westerman, Chief, Reactor Safety Branch — 6/9/87 Date

Inspection Summary

Inspection Conducted May 10-26, 1987 (Report 50-313/87-17)

Areas Inspected: No inspection of Unit 1 was conducted.

Results: Not applicable.

Inspection Conducted May 10-26, 1987 (Report 50-368/87-17)

Areas Inspected: Reactive, special announced inspection of licensee's procedure and personnel qualifications in the areas of welding and NDE, observations of welders and NDE personnel qualifying to specific procedures, observations of weld repairs and NDE examinations of weld repairs, and verification of licensee evaluations and inspections at a mockup and the Unit 2 pressurizer area.

Results: Within the area inspected, no violations or deviations were identified.

## DETAILS

1. Persons Contacted

ANO

*D. B. Lomax, Plant Licensing Supervisor
*E. C. Ewing, General Manager, Plant Support
*#P. Michalk, Plant Licensing Supervisor
*D. Provencher, QA Supervisor
*#D. Howard, Special Project Manager
*#R. Lane, Manager, Engineering
*L. Humphrey, General Manager, Nuclear Quality
*J. Taylor-Brown, QC Superintendent
#B. Baker, Operations Manager
#L. Taylor, Plant Licensing Engineer

NRC

#E. H. Johnson, Director, Division of Reactor Safety and Projects
#C. C. Harbuck, Resident Inspector
*#D. M. Hunnicutt, Chief, Operations Section
*H. W. Kerch, Lead Reactor Engineer, Region I

*Denotes attendance at the May 14, 1987, exit interview.
#Denotes attendance at the May 15, 1987, exit interview.

The NRC inspectors also held discussions with other station and contractor personnel.

2. Identification of Pressurizer Leakage

On April 22, 1987, an entry was made into ANO-2 containment to assess a possible small leak on one of the safety injection tanks. During the walkdown, leakage in the area of the pressurizer was detected. Entries into the ANO-2 containment were made on April 23 and 24, 1987, to further evaluate the leakage in the vicinity of the pressurizer. Two small leaks were detected. One from the high point vent above the pressurizer (about 100 drops per minute) and the second leak was from the area of the pressurizer lower head (about 60 drops per minute or about 0.002 gallon per minute). ANO-2 was shut down on April 24, 1987, as required by the Technical Specifications. The licensee issued a 10 CFR Part 50.72 report on the assumption that the leakage from the lower head area was through the pressure boundary.

The licensee removed the insulation from the lower head area and determined that the leakage source was from the pressurizer heater sleeve in position X1. The licensee attempted unsuccessfully to remove the heater element from the X1 sleeve. The heater element in position T4

could not be removed. The upper head pressurizer manway was then opened for visual inspection of the pressurizer heaters. Visual inspection revealed that these two heater elements had ruptured. The rupture of heater element in position X1 had caused damage to the heater sleeve that resulted in leakage through the sleeve to the outside of the pressurizer. Rupture of the heater element in position T4 had not damaged the sleeve and no leakage had occurred.

3. Pressurizer Repair Procedure

The licensee requested NRC approval to utilize the temper bead weld repair technique as described in paragraph NB-4622.9 of the Winter 1985 Addenda of the 1983 Edition of Section III of the ASME B&PV Code for temporary repair of the ANO-2 pressurizer. Permanent repair to the pressurizer as specified in 10 CFR Part 50.55a, with current tooling limitations, would require excessive radiation exposure to workers, a prolonged outage (estimated up to 22 weeks), and other related problems.

The proposed pressurizer repair technique was described in a meeting between the licensee and NRC staffs on May 8, 1987. The proposed repairs consisted of cutting and boring out the damaged sleeves (positions X1 and T4), verifying by nondestructive testing (NDE) that flaws were removed, mapping each cavity and fabricating a carbon steel plug of compatible SA-533, Gr. B, Cl.1 (P3) material, and completing a weld repair with pre-heat and post-heat treatment.

4. Full Scale Mockup for Personnel and Material Qualification

The licensee prepared a full scale mockup to qualify personnel, procedures, and equipment. The mockup consisted of a plate of carbon steel (C/S) (P3 material) approximately 4 inches thick and 30 inches in diameter. This C/S plate was fitted into a confined area with dimensions similar to those encountered in the pressurizer lower head area. This mockup area was constructed of light gage metal formed into an area approximately 9 feet in diameter. The 4-inch thick, 30-inch diameter C/S plate with heater extension tubes on centerlines and other related obstructions found below the pressurizer was installed into the full scale mockup. The mockup was very similar to the conditions experienced under the pressurizer as related to confined spaces, heater tube extensions, and physical obstructions. The physical obstructions in the mockup area were in place to impair the welders ability to perform; thus simulating conditions similar to those encountered by welders and NDE personnel during welding and NDE examinations under the pressurizer. The mockup for qualification of personnel required the following actions:

- Welders were originally qualified to the procedure prior to qualifying at the mockup assembly.

- Welders were fully dressed in protective clothing and respirators as required by the radiation work permit (RWP) for the repairs during welder qualification on the mockup.

- Welding was performed according to weld procedure (DWPS SMA-3.3-914) requirements, including preheat conditions of 350°F for the C/S plate and the plug.

- The temperature recording instrumentation was calibrated in accordance with the procedure.

- The temperatures were monitored at eight locations during preheat, welding, interpass waiting periods, post weld heat treatment (PWHT), and controlled cooldown during welding operations on the mockup. Four locations were monitored during welding operations on installation of plugs in locations X1 and T4 on the Unit 2 pressurizer. Four positions adequately monitored welding operations at the X1 and T4 positions.

- Magnetic particle (MT) examinations were performed on the base metal weld joint, the temper bead layer (second weld bead layer), and each succeeding layer of weld metal, including the finished weld surface.

- Welder qualification as required by ASME B&PV Code.

- Weld procedure qualification test assembly to be same material (P3), pre-heat and PWHT at equivalent time and temperature as the pressurizer material (P3).

- Dimensional requirements of weld procedure qualification test assembly, including depth of cavity.

- Minimum 4-hour PWHT holding time for P3 material after weld repair.

- NDE and visual examinations verified sound weld deposit metal in the X1 and T4 heater positions and in the pressurizer shell near the X1 heater position.

- Remote visual examination of the heater diameter and area immediately above the heater (pressurizer inside diameter) including the nozzle area, cladding, and seal weld area could be accomplished with the boroscope/video; remote dye penetrant (PT) could be done and evaluated.

The NRC inspectors observed portions of the above procedure and personnel qualifications.

No violations or deviations were identified.

5. Welder Qualification

The welders were qualified at the mockup in accordance with ASME B&PV Code, Section III, 1983 Edition with Addenda through Winter 1985, Sections NB-4300, NB-3337.3, and paragraph NB-4622.9(g) and Section XI, paragraph IWB-4322.2. The full scale mockup demonstrations by each welder

and the subsequent NDE results of the weld examinations were adequate to determine that these welders were fully qualified to ASME B&PV Code, Sections III and XI, and the appropriate licensee procedures. The NRC inspectors observed portions of the procedure and welder qualifications at the mockup on May 10-13, 1987.

No violations or deviations were identified.

6. Remote PT Examinations

The licensee requested Babcock and Wilcox (B&W) to develop a technique for remote PT examination of the pressurizer heater channels and the inside diameter regions of the pressurizer shell in and near the X1 and T4 positions. The procedure (B&W ISI-246) and personnel were qualified on the mockup. The procedure was approved for use prior to start of the pressurizer repairs by the AP&L staff.

The NRC inspector questioned the inservice inspection (ISI) requirements for the repairs to the X1 and T4 channel areas. The licensee requested Combustion Engineering (CE) to establish an ultrasonic (UT) baseline and applicable ISI requirements. The completed temporary repairs will be monitored by AP&L staff members until permanent repairs are affected. These actions and commitments answered the NRC questions.

The NRC inspector discussed the weld repair procedure, NDE procedures, personnel qualifications, and ASME B&PV Code requirements with the Authorized Nuclear Inspector (ANI). The ANI approved these procedures subsequent to qualification and prior to start of repairs on the pressurizer.

No violations or deviations were identified.

7. NRC Review of Licensee and Licensee Contractor Procedures

| Procedure Number | Title of Procedure | Revision Number | Date Approved |
|---|---|---|---|
| 99770078-007 | Engineering Requirements for Removal and Reinstallation of Heaters at ANO-2 | 0 | 05/10/87 |
| 9977078-003 | Engineering Requirements for Repair of X1 Penetration at ANO-2 | 0 | 05/10/87 |
| 1000.12 | Control of Site Contractors | 9 | 12/05/86 |
| 1009.003 | Contract Administration Procedure | 0 | 11/05/86 |

| | | | |
|---|---|---|---|
| 1032.07 | ISI Program Requirements | 6 | 07/14/86 |
| 1032.016/ 202F20 | Field Change Notice Pressurizer Heater #T-4 Repair Modifications | 8 | 05/12/87 |
| 1000.23 | Quality Control Program | 9 | 10/28/86 |
| Dwg. WDB-3898 | Pressurizer Heater | A | 06/19/82 |
| St. No. 99779150-007 | Pressurizer Heater T-4 Penetration Repair | 8 | 05/12/87 |
| 9977078-008 | Engineering Requirements for Repair of T-4 Penetration at ANO One, Unit 2 | 0 | 05/11/87 |
| DWPS SMA-3.3-914 | Welding Procedure Specification | 2 | 05/08/87 |
| | Welder Performance Qualification for the X-1 and T-4 Heater Penetration Repairs to the ANO Unit 2 Pressurizer | 0 | 05/12/87 |
| 99770078-004 | C.E. Mockup Engineering Requirements | 0 | 05/12/87 |
| DCP #87-2044A | Design Change ALARA Review Checklist | 8 | 05/12/87 |
| DCP #87-2044A FCN #2 | B&W ISI Procedure 246, "Remote PT Examination" | 0 | 05/14/87 |
| Dwg (Contract 73370) 99770077 | Heater Sleeve-Elevation Arkansas Pressurizer | 0 | 05/07/87 |
| STD-CFS-089 | Set-up and Operation of Heat Treat Equipment | 1 | |
| C-E Manual No. 73370 | Combustion Engineering Pressurizer Instruction Manual | 1 | 09/78 |
| DSG-87-096 | Evaluation of Loose Heater Parts in ANO-1, Unit 2 Pressurizer | N/A | 05/03/87 |
| 2CAN058704 | ANO-2 Pressurizer Heater Repair 10 CFR 50.55a(2)(3) Request and Attachments A and B | N/A | 05/12/87 |

The NRC inspectors determined that the above referenced procedures contained the information required to perform the stated functions.

No violations or deviations were identified.

8. NRC Inspector Review of Combustion Engineering Operating Manual

| Procedure Title | Section Number | Revision Number | Date Approved |
|---|---|---|---|
| Job Site Indoctrination and Training Requirements | OP-1.1 | 6 | 09/01/86 |
| QA/QC Interface with Authorized Inspection Agency | OP-2.1 | 8 | 02/16/87 |
| Procurement Control | OP-4.1 | 9 | 09/01/86 |
| Approved Products Procedure | OP-4.2 | 7 | 02/16/87 |
| QC Review and Preparation of Quality Documentation | OP-5.3 | 9 | 02/16/87 |
| Drawing and Document Control | OP-6.1 | 7 | 02/16/87 |
| General Housekeeping for Construction Work at Nuclear Power Plants | OP-8.2 | 2 | 09/01/86 |
| Personnel and Material Accountability for Controlled Access Areas | OP-8.3 | 6 | 09/01/86 |
| Visual Examination for Completed Weld Surfaces | OP-9.1 | 6 | 09/01/86 |
| Magnetic Particle Examination | OP-9.2 | 6 | 09/01/86 |
| Liquid Penetrant Examination | OP-9.4 | 10 | 09/01/86 |
| Visual Examination Defined as VT-1, VT-2, VT-3 | OP-9.5 | 8 | 09/01/86 |
| Welder Performance Testing Procedure | OP-9.7 | 9 | 02/16/87 |
| Heat Treating | OP-9.9 | 8 | 09/01/86 |
| Weld Inspection Records | OP-10.4 | 8 | 02/16/87 |

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|---|---|---|---|
| Hydrostatic Test | OP-11.1 | 6 | 09/01/86 |
| Control of Measuring and Test Equipment | OP-12.1 | 11 | 01/05/87 |
| Quality Assurance Records Control | OP-17.1 | 11 | 02/16/87 |

The NRC inspector review determined that the above referenced procedures contained the required elements for appropriate completion of repair work on the pressurizer heater channels.

No violations or deviations were identified.

9. Repairs to Channels X1 and T4

The plugs installed in the pressurizer heater channels and the surfaces repaired in positions X1 and T4 are non-clad SA-533, Grade B, Cl. 1, carbon steel (P3) material. The corrosion effect for the remainder of the current fuel cycle (until approximately March 1988) was assessed. These evaluations considered aerated and deaerated operating and shutdown conditions. The evaluations determined that corrosion effects were within acceptable limits and no deleterious effects were identified.

Stress corrosion cracking and hydrogen embrittlement were evaluated by AP&L and their contractor personnel. The results of these evaluations indicated that the repair of the X1 and T4 pressurizer heater channels should not contribute to weld failure at either of these locations during the remainder of the current fuel cycle.

10. Postulated Failure Identification Safeguards

The licensee has installed a temporary sampling line to the containment atmosphere monitor (CAM) to continuously sample the area immediately above the pressurizer. The CAM system continuously monitors airborne particulate and gaseous radioactive isotopes using an air particulate detector (APD) and a radioactive gas detector.

A containment entry will be made for the specific purpose of leak detection and assessment on a once-per-month schedule.

Refresher training of the reactor operators for a small break LOCA will be completed prior to restart of Unit 2.

The licensee will continue to be alert for parameter changes that could indicate primary leakage (example: higher than normal makeup rate to the safety injection tanks).

No violations or deviations were identified.

11. Pressurizer Shell Repairs

The licensee removed the heater sleeve from heater position T4. No damage to the pressurizer heater channel was observed. A plug was machined to the dimensions (1.181-inch diameter) of the final heater channel diameter, buttered in accordance with the repair procedure, and installed in the channel in accordance with the weld procedure. NDE examination verified that the weld was acceptable.

The licensee removed the heater sleeve from heater position X1. An area about 1/4-inch wide and 1/2-inch long on the downhill side of the channel indicated slight surface damage from either steam cutting or boric acid corrosion. This area was easily blended out to clean metal. No repairs were required to the inside of the pressurizer heater channel. A plug was machined to the final hole diameter (1.188-inch) and installed as described for heater channel T4. The NDE examination verified that the weld was acceptable.

An area near the X1 heater channel indicated a boric acid wastage (corroded/erroded) volume about 1 1/2-inch in diameter and about 3/4-inch deep in the pressurizer shell. This volume was ground out to clean metal. The ground out volume was approximately 1 1/2-inch in diameter and 1 inch in depth. The pressurizer shell in the vicinity of the ground out area to be repaired was examined by NDE methods and verified to be free from deleterious defects. The void was repaired in accordance with the welding procedure. NDE examination verified that the weld repair was acceptable. The welders had been qualified on the mockup, using the approved repair weld procedure. The NDE procedure and NDE personnel had been qualified on the mockup prior to examination of the pressurizer shell repairs.

No violations or deviations were identified.

12. Pressurizer Heater Removal and Replacement

The licensee determined that the root cause of the through wall pressurizer leak (60 drops per minute or about 0.002 gallons per minute) was a failure through the sleeve at heater position X1. The root cause of the sleeve degradations at heater positions X1 and T4 was related to two Watlow heaters that had ruptured sometime subsequent to the installation of these heaters in 1982. In 1982, 23 out of the 96 originally installed General Electric design pressurizer heaters were replaced with unannealed Inconel, 600 Watlow design heaters. During this outage 21 of these Watlow heaters were removed without problems. Visual inspection by licensee personnel determined that no apparent failure or damage to any of these 21 heaters had occurred during service. Six spare General Electric design pressurizer heaters were installed in selected positions. Fifteen pressurizer channels were plugged in accordance with qualified and approved procedures.

Later in this outage during heatup prior to achieving criticality, testing revealed that two General Electric designed heaters had failed with open circuits. These two heaters were removed from the respective pressurizer channels. The channels were plugged in accordance with the qualified and approved procedures, previously implemented in the plugging of the 15 other channels.

At startup on May 27, 1987, subsequent to completion of removal, repair, and replacement of pressurizer heaters, there were 77 operable pressurizer heaters. This number of pressurizer heaters is greater than the minimum number of pressurizer heaters required by the Technical Specifications for control of plant transients, natural circulation cooldown, and safety requirements.

No violations or deviations were identified.

13. Inspection of Pressurizer Lower Head Area

Licensee personnel completed an inspection of the pressurizer lower head area following completion of pressurizer heater repairs. The pressurizer heater cables were found to be in good condition. During the inspection, no visual evidence of damage from steam, boric acid, or physical abuse during welding and/or inspection operations was identified. An NRC inspector was present during selected portions of the pressurizer heater repair activities. No indications of damage to cables or other components were observed during these inspections.

No violations or deviations were identified.

14. Loose Pressurizer Heater Parts

The licensee completed an evaluation of loose parts in the Unit 2 pressurizer. The evaluation and analyzed consequences of loose parts from these heaters indicated that no significant damage to components or operating problems will occur through continued operation of the facility with the known loose heater parts in the pressurizer. The NRC inspector reviewed the evaluation.

No violations or deviations were identified.

15. Metallurgical Examination of Failed Pressurizer Heaters

The licensee packaged the two failed pressurizer heaters, T4 and X1, and forwarded one to Combustion Engineering and one to Babcock and Wilcox metallurgical laboratories for detailed examination. The results of these metallurgical examinations will be reviewed by the NRC inspector when these examinations have been completed.

16. Exit Interviews

The NRC inspectors held an exit interview with licensee personnel designated in paragraph 1 on May 14, 1987. A second exit interview was held on May 15, 1987. The resident inspector attended the exit interview on May 15, 1987.