ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-313/95-14
50-368/95-14

Licenses: DPR-51
NPF-6

Licensee: Entergy Operations, Inc.
1448 S.R. 333
Russellville, Arkansas

Facility Name: Arkansas Nuclear One, Units 1 and 2

Inspection At: Russellville, Arkansas

Inspection Conducted: October 2-6, 1995

Inspectors: C. A. Clark, Reactor Inspector, Plant Support Branch
Division of Reactor Safety

I. Barnes, Technical Assistant
Division of Reactor Safety

Approved: C.A. VanDenburgh 11-9-95

Chris A. VanDenburgh, Chief, Engineering Branch
Division of Reactor Safety

Date

Inspection Summary

Areas Inspected (Units 1 and 2): Routine, announced inspection of the licensee activities associated with the Unit 2 Refueling Outage 2R11 eddy current examination of steam generator tubing. The inspection also reviewed open items identified in both units during a previous inspection of steam generator tubing eddy current examination activities.

Results (Units 1 and 2):

Engineering

- The licensee identified that the predominant degradation mode of the Unit 2 steam generators continued to be circumferential stress corrosion cracking at the tube expansion transition areas and axial stress corrosion cracking at the eggcrate supports. From commercial service through Refueling Outage 2R11, the licensee had repaired a total of 1559 (675 plugged, 884 sleeved) in Steam Generator A and 788 (504 plugged, 284 sleeved) in Steam Generator B (Section 3).

- The licensee had performed an initial scope of eddy current examinations that was consistent with the scope of prior examinations and appeared appropriate for identification of potential degradation. The licensee had continued the commendable practice of using two separate companies to perform independent primary and secondary analysis of eddy current data, and had implemented eddy current program oversight surveillance activities of appropriate scope and depth (Section 4.1, 4.2, and 4.3).

- The licensee had adequately addressed previous weaknesses noted in approved vendor procedures with respect to requirements for position verification during eddy current data acquisition (Section 4.4).

- The licensee had developed complete and well-written, nondestructive examination procedures. The inspectors identified one minor exception involving inadequate procedural documentation of the conformance of the motorized rotating pancake coil examination technique to Appendix H of Electric Power Research Institute NP-6201, Revision 3 (Section 4.2).

- The inspectors concluded that the licensee and contractor nondestructive examination personnel were knowledgeable and competent (Section 4.4).

- In response to the inspector's previous concern, the licensee had developed a new procedure to track loose parts in the steam generators. However, the eddy current testing program had not been modified to require a specific evaluation for loose parts in the steam generators. Additional licensee action is needed to resolve this concern (Section 5.1).

Summary of Inspection Findings:

- Inspection Followup Item 313;368/9417-01 was reviewed and remained open (Section 5).

Attachments:

- Attachment 1 - Persons Contacted and Exit Meeting
- Attachment 2 - List of Documents Reviewed

DETAILS

1 Plant Status

During this inspection, Arkansas Nuclear One, Unit 2, was in Refueling Outage 2R11 performing scheduled examinations of steam generator tubes.

2 STEAM GENERATOR TUBE INTEGRITY FOLLOWUP REVIEW - ENGINEERING (92903)

The main objective of this inspection was to assess the effectiveness of licensee Unit 2 programs in detection and analysis of degraded tubing, and repair of defects. A similar inspection was performed of Unit 2 in the summer of 1994, documented in NRC Inspection Report 50-313/9417; 50-368/94-17.

3 UNIT 2 STEAM GENERATOR MATERIALS AND TUBE DEGRADATION HISTORY

Following the identification of the existence of outside diameter stress corrosion cracking in the spring of 1992, the licensee implemented a comprehensive eddy current examination program of the Unit 2 steam generators. A previous Unit 2 steam generator tube integrity review (NRC Inspection Report 50-313/92-26; 50-368/92-26) documented the degradation history through Refueling Outage 2R9. This information was updated in NRC Inspection Reports 50-313/93-22; 50-368/93-22 and 50-313/94-17; 50-368/94-17 to include the repair information through Refueling Outage 2R10. Table 1, below, provides the plugging and sleeving repair history for the two steam generators through Refueling Outage 2R11 as a function of effective full-power years of operation at the time of repair. The data included for Refueling Outage 2R11 reflects information provided as of October 23, 1995. The licensee had not completed the steam generator tube repair activities at the completion of this inspection; therefore, final repair numbers may change.

Based on this information, the inspectors confirmed that hot-leg side circumferential outside diameter stress corrosion cracking at tube expansion transition areas continued to be the predominant defect indication type detected by eddy current examinations in Steam Generator A. The licensee identified 482 tubes with circumferential cracks of a total tube repair population of 643 in Refueling Outage 2R11. The licensee also detected 37 circumferential cracks in the tube expansion transition areas on the cold-leg side of Steam Generator A. This was the first identification of this defect type at this steam generator location. The licensee identified other tube defect indications in Steam Generator A at the eggcrate supports, the batwing supports, and in the sludge pile region above the tube sheet. The licensee attributed these indications to be axial stress corrosion cracking at the eggcrate supports, wear at the batwing supports, and volumetric intergranular attack-like defects in the sludge pile. The licensee also detected similar types of defect in Steam Generator B, but with a lower tube repair population of 341 tubes.

Table 1

Arkansas Nuclear One, Unit 2
Steam Generator Tube Degradation History

UNIT 2 STEAM GENERATORS (SGs) A AND B TUBE REPAIR HISTORY					
Time of Repair Outage No.	Operational Time EFPYs	SG A Repairs		SG B Repairs	
		Plugs	Sleeves	Plugs	Sleeves
Pre-Commercial	0.00	15	0	29	0
2R1 (1981)	0.89	0	0	0	0
2R2 (1982)	1.69	0	0	1	0
2R3 (1982)	2.33	0	0	0	0
2R4 (1985)	3.31	0	0	0	0
2R5 (1986)	4.16	0	0	0	0
2R6 (1988)	5.38	0	0	6	0
2R7 (1989)	6.52	0	0	0	0
2R8 (1991)	7.67	0	0	73	0
2F92 (1992)	8.51	29	392	11	56
2R9 (1992)	8.85	67	-4	132	0
2P93 (1993)	9.36	47	0	3	0
2R10 (1994)	10.20	170	0	77	0
2P95 (1995)	10.85	215	0	85	0
2R11 (1995)**	11.49	147	496	113	228
Total Repairs		1574		814	
Effective Repairs (Plug Equivalent)*		742		547	
% Repairs (Effective, Total)		8.82, 18.71		6.50, 9.68	

* - Based on 17 sleeves being considered thermally equivalent to 1 plug.

** - Planned repairs as of October 23, 1995.

The inspectors noted that the incidence of hot-leg side circumferential stress corrosion cracks in the tube expansion transition area was lower in Steam Generator B (i.e. 213). The licensee did not identify any circumferential cracks in Steam Generator B on the cold-leg side in the expansion transition area. However, the incidence of axial stress corrosion cracking at the eggcrate supports was higher in Steam Generator B than in Steam Generator A. Preliminary tube repair data furnished by the licensee showed that a total of 88 tubes would be repaired in Steam Generator B for axial stress corrosion cracking at eggcrate supports, versus a corresponding total of 46 tubes in Steam Generator A.

4 REVIEW OF STEAM GENERATOR TUBE EXAMINATION PROGRAM REQUIREMENTS AND DATA

4.1 Refueling Outage 2R11 Tube Examination Scope

The inspectors reviewed a September 20, 1995, eddy current examination plan for Unit 2 Refueling Outage 2R11, which identified the following scope of eddy current examinations:

Steam Generator A

- 100 percent top of tube sheet, hot leg, motorized rotating pancake coil — 7480 tubes
- 100 percent Plus point of hot leg sleeves — 387 tubes
- 100 percent bobbin coil, full length, from cold leg — 7867 tubes
- 20 percent top of tube sheet, cold leg, motorized rotating pancake coil in sludge pile area — 1029 tubes
- Row 1 U-bend motorized rotating pancake coil examinations — 12 tubes

Steam Generator B

- 100 percent top of tube sheet, hot leg, motorized rotating pancake coil — 7939 tubes
- 100 percent motorized rotating pancake coil of kinetic welded hot-leg sleeves — 55 tubes
- 100 percent bobbin coil, full length, from cold leg — 7994 tubes
- 20 percent top of tube sheet, cold leg, motorized rotating pancake coil in sludge pile area — 1029 tubes
- Row 1 U-bend motorized rotating pancake coil examinations — 12 tubes

The licensee informed the inspectors that they had performed the Refueling Outage 2R11 motorized-rotating pancake coil examinations with a probe, which included a 0.115-inch pancake coil, a Plus Point coil, and a high frequency Plus Point coil. Experience at other plants had indicated that the use of the Plus Point coil should provide increased sensitivity in the detection of circumferential cracks than was previously achievable using a regular motorized-rotating pancake coil. The inspectors concluded that this initial scope of eddy current examinations was consistent with prior examination scopes and appeared appropriate for the identification of potential degradation.

4.2 Review of Examination Program Requirements

The inspectors reviewed licensee Work Plan 2409.498, "2R11 Steam Generator Maintenance and Inservice Inspection by Combustion Engineering Nuclear Services (CENS)," Revision 0, and found that it appropriately defined the applicable program requirements for eddy current examination and repair of steam generator tubing. The inspectors reviewed portions of various procedures identified in the work plan to identify the latest program requirements. The procedures reviewed are identified in Attachment 2 of this report. With one exception, the inspectors noted that the eddy current examination program requirements were complete and well written. The exception pertained to inadequate documentation of the conformance of the motorized-rotating pancake coil examination technique to Appendix H of Electric Power Research Institute NP-6201, "PWR Steam Generator Examination Guidelines," Revision 3.

In the licensee's June 27, 1995, response to Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes," the licensee committed for Refueling Outage 2R11 to use probes, which were qualified to Appendix H of Electric Power Research Institute NP-6201, Revision 3. This document defines the essential variables that must be addressed in the qualification of a given process. Included as essential variables are the type and length of probe cable and extension cable. The inspectors were concerned that the Refueling Outage 2R11 technical and contractual requirements for eddy current examination did not appear to address the applicability of the use of probes qualified to Appendix H of Electric Power Research Institute NP-6201, Revision 3. In addition, the inspectors did not note any eddy current data acquisition procedural requirements pertaining to the type and length of probe and extension cable to be used.

Based on discussions with licensee personnel and further document review, the inspectors concluded that the eddy current essential variables being used for Refueling Outage 2R11 data acquisition were consistent with the Appendix H of Electric Power Research Institute NP-6201, Revision 3, qualifications. However, the inspectors noted that these requirements had not been fully reflected in formal licensee procedural requirements, and were controlled via informal communications between the licensee and the vendor. The inspectors verified that the special processes used during the steam generator eddy current testing had been adequately controlled by qualified personnel using

qualified procedures as required by 10 CFR 50, Appendix B. The inspectors also concluded that it was unlikely that the licensee would have modified the essential variables from those informally specified. Nevertheless, the inspectors concluded that not including all the applicable Appendix H essential variables in the formal eddy current examination procedure requirements was a weak engineering practice.

The inspectors noted that the licensee had continued the commendable practice they had used in prior outages of using two separate companies to perform independent primary and secondary analysis of eddy current data. ABB Combustion Engineering and ZETEC, respectively, performed the primary and secondary eddy current data analysis in this refueling outage. The inspectors reviewed the certification records for approximately 102 analysts and other examination personnel involved in Refueling Outage 2R11 steam generator tubing examinations. The inspectors verified that the certifications for personnel, equipment, and calibration standards were approved by the licensee's nondestructive examination section, engineering, and authorized nuclear inspector.

4.3 Eddy Current Program Oversight

The licensee performed surveillances of steam generator tubing eddy current examination and repair activities as part of their oversight program. The inspectors reviewed licensee reports issued for the last five surveillances performed in these areas. The reports reviewed are identified in Attachment 2 of this report. These surveillances addressed compliance with eddy current data management and control guidelines; implementation of the data analysis guidelines, including selection of probes, frequencies, spans and rotations, calibration; steam generator tube repairs; and compliance with procedures requirements. The inspectors concluded that the documented surveillance activities were of appropriate scope and depth.

4.4 Review of Tube Examinations

The inspectors observed acquisition of eddy current examination data for 56 tubes in Steam Generator A and 45 tubes in Steam Generator B. The top of tube sheet hot-leg motorized-rotating pancake coil examinations were performed using the manipulator mounted with four guide tubes. When the tube zone configuration allowed it, the examination personnel examined four tubes at the same time. Two operators using separate work stations performed the examinations by each independently controlling two motorized-rotating pancake coil probes and probe pushers. A calibration standard was attached to each probe guide tube. The eddy current data collected for a group/zone of tubes included data recorded for the calibration standard at the beginning and ending of the zone of tubes examined. The inspectors noted that the licensee and contractor nondestructive examination personnel were knowledgeable and resolved any data acquisition problems in a competent and professional manner.

A previous NRC inspection (50-313/94-17; 50-368/94-17) noted that the licensee examination program contained limited requirements regarding verification that the desired tubes were being examined. The inspectors noted during this inspection that the licensee had modified Section 14.2 of Procedure ANO-410-006 to require position verification prior to eddy current work in the generator; at the beginning of each zone and the bottom of each eddy current examination sheet, not to exceed 70 tubes per guide tube between position verification; if problems occur with the positioner; and upon concluding eddy current work in the generator. The inspectors verified that the licensee was performing position verification in accordance with these requirements during the observed eddy current data acquisition activities.

4.5 Review of Tube Examination Data

The inspectors noted that the licensee's vendors independently evaluated the individual tube eddy current data by a primary and a secondary analyst at separate remote work locations. The results from the primary and secondary analyses were compared using the Eddynet computer program. If the results of the primary and the secondary analyst agreed, the tubes with possible indications were marked for evaluation by the senior analyst. Where the results did not agree, the lead-primary and -secondary analysts, who were certified Level IIIA examiners in eddy current testing, reviewed the data. If they could not agree on a resolution, the data was provided to the senior analyst for evaluation. The senior analyst, a certified Level IIIA eddy current examiner, was then responsible for evaluating each tube containing a possible indication and quantifying any indications. The inspectors noted no performance problems during a limited review of eddy current data and the resolution process. At the inspectors' request, the senior analyst performed a review of examples of the more significant defect indications that had already been identified, including comparison of the respective data from the pancake coil and Plus Point coils for individual defect indications. The inspectors observed that the Plus Point coil usually provided a much clearer definition of the existence of a circumferential defect than was indicated by the data from the probe pancake coil. The inspectors concluded that the Plus Point coil appeared to reduce the effects of copper in the sludge on data and improved the ease of analysis.

4.6 Review of Sleeving

The inspectors performed a detailed review of the welding and post-weld heat treatment requirements that were applicable to the ABB Combustion Engineering sleeving process. The inspectors noted during this review that licensee personnel had not verified that the post-weld heat treatment temperature (required by Welding Procedure Specification GTAA-43.43-974) would be attained by the parameters specified in ABB Combustion Procedure STD-500-020, "Technical Operating Procedure for Post-Weld Heat Treatment and Heater Dryout of Above-the-Tubesheet (ATS) Welds Using Resistance Heating for Steam Generator Tubes With .048" Wall Thickness," Revision 0. In response to the inspectors' request for qualification data for the post-weld heat treatment device, the licensee obtained ABB Combustion Engineering Report TR-ESE-881,

"Test Report for the Qualification of the Post Weld Heat Treatment Tool for 3/4" Tubing With .042", .043", and .048" Wall Thickness," Revision 01. This document indicated that the parameters specified for the post-weld heat treatment device would produce the temperature range required by the welding procedure specification. The inspectors had no other questions as a result of this review.

5 FOLLOWUP OF OPEN ITEM

5.1 (Open) Inspection Followup Item 313;368/9417-01: Licensee Actions to Address Program Requirements for Loose Parts

Background

The inspectors had noted an overall program weakness pertaining to the absence of requirements relative to the actions to be taken on identification of loose parts in steam generators. The inspectors were particularly concerned about the absence of any criteria for identification, reporting, retrieval attempts and feedback, and ongoing monitoring for wear in abutting tubes. The licensee had acknowledged the observation and initiated a review of this subject prior to the conclusion of the inspection.

Inspector Followup

In response to this concern, the licensee issued Procedure HES-41, "Steam Generator Secondary Side Potential Loose Parts Tracking," Revision 0, dated September 14, 1995. This procedure provided instructions for tracking of steam generator potential loose parts and secondary side anomalies. Attachment 1 of Procedure HES-41 contained identification of potential loose parts and secondary side anomalies located in Unit 1 through inspection from Refueling Outage 1R10 (Spring 1992) and thereafter. Attachment 1 also identified that one location for potential loose parts and secondary side anomalies was identified in Unit 1 Steam Generator A during Refueling Outage 1R12 (February of 1995). Attachment 2 of Procedure HES-41 covered inspections from Refueling Outage 2R10 (Spring 1994) and thereafter, and did not identify any potential loose parts or secondary side anomalies found in Unit 2 steam generators during these inspections.

The inspectors were concerned that the licensee did not have any specific administrative requirement to assure that some level of data screening would be performed by the eddy current data analysts to identify the presence of loose parts. The licensee indicated that future action would be taken to provide more complete program requirements.

ATTACHMENT 1

1 PERSONS CONTACTED

1.1 Licensee Personnel

*B. Allen, Manager, Maintenance
*A. Buford, Senior Lead, Design Engineering
*D. Cantrell, Licensing Specialist
*B. Converse, Supervisor, Engineering Programs
*B. Eaton, Plant Manager, Unit 2
*R. Edington, Plant Manager, Unit 1
*R. Fougerousse, Engineering Programs
*D. Graham, Supervisor, Engineering Programs
*M. Harris, Manager, Unit 2 Maintenance
*D. Harrison, Senior Lead Engineer, Engineering Programs
*R. Lane, Director, Design Engineering
*D. Lomax, Manager, Engineering Programs
*J. McWilliams, Manager, Modifications
*D. Meatheany, Technical Specialist, Engineering Programs
*D. Mims, Director, Licensing
*R. Partridge, Acting Superintendent, Chemistry
*J. Ray, Supervisor, Nondestructive Examination
*D. Scheide, Specialist, Licensing
*B. Short, Supervisor, Unit 1 Operations Standards
*M. Smith, Supervisor, Licensing
*R. Smith, Supervisor, Engineering Programs
*D. Wagner, Supervisor, Quality Assurance
*L. Waldinger, General Manager, Plant Operation

1.2 Contractor Personnel

R. Maurer, Manager, Nondestructive Examination Technology
ABB Combustion Engineering

1.3 NRC Personnel

S. Campbell, Resident Inspector
*C. Johnson, Reactor Inspector
*J. Melfi, Resident Inspector

In addition to the personnel listed above, the inspectors contacted other personnel during this inspection period.

*Denotes those persons that attended the exit meeting on October 6, 1995.

2 EXIT MEETING

An exit meeting was conducted on October 6, 1995. During this meeting, the inspectors reviewed the scope and findings of the inspection. Although the inspectors reviewed nuclear steam system supplier documents, which had been marked to indicate they contained proprietary information, no proprietary information was included in the inspection report.

ATTACHMENT 2

LIST OF DOCUMENTS REVIEWED

NRC Inspection Reports

50-313;368/92-26, dated March 16, 1993
50-313;368/93-22, dated May 25, 1993
50-313;368/94-17, dated July 13, 1994

Licensee Surveillance Reports

94-003E-2	ABB-CE Performance Demonstration Test(s), dated April 4, 1994
94-004E-2	ABB-CE Data Management Performance Demonstration Test(s), dated April 4, 1994
94-19	Unit 2 Steam Generators 2R10 Eddy Current Inspection, dated June 10, 1994
QCR-95-A23563-P	Steam Generator Tube Plugging Surveillance, included in Inter-Office Correspondence NQ-95-00054 dated March 6, 1995
QCR-95-A23564-P	Steam Generator Tube Plugging Surveillance, included in Inter-Office Correspondence NQ-95-00054 dated March 6, 1995

Procedures for:

Data Analysis

HES-28	ANO-2 Steam Generator Bobbin ECT Data Analysis Guidelines, Revision 4, dated October 2, 1995
HES-29	ANO-2 Steam Generator ECT Performance Demonstration Guidelines, Revision 2, dated December 21, 1994
HES-35	ANO-2 Steam Generator RECP Data Analysis Guidelines, Revision 2, dated October 3, 1995
HES-41	Steam Generator Secondary Side Potential Loose Parts Tracking, Revision 0, dated September 14, 1995

Examination

ANO-410-006	Procedure for Multi-Frequency Eddy Current Examination of Non-FerroMagnetic Steam Generator Tubing Using MIZ-18A/MIZ-30 Equipment, Revision 5, dated August 30, 1995
ANO-410-007	Procedure for Control of Eddy Current Data for Use with Multiforth or Eddynet Acquisition Systems, Revision 4, dated July 18, 1995

ANO-410-008	Procedure for Multifrequency Eddy Current Examination of Steam Generator Tube Sleeves, Revision 2, dated August 30, 1995
STD-400-017	Procedure for Marking the Steam Generator Tubesheet, Revision 1, dated January 24, 1989
STD-NSS-072	Manual Installation and Removal of ABB/Combustion Engineering Genesis Manipulators, Revision 5, dated July 5, 1995
STD-NSS-074	Remote Installation and Removal of ABB/Combustion Engineering Genesis Manipulators, Revision 7, dated July 5, 1995
STD-NSS-078	Setup, Checkout, and Operation of ABB/Combustion Engineering Genesis Manipulators, Revision 7, dated July 5, 1995

Sleeves

STD-400-151	Linearity Verification of the Ultrasonic Instrumentation Used for the Examination of the Sleeved Tube Welds, Revision 0, dated November 1, 1994
STD-400-157	Visual Examination of Steam Generator Tube Sleeve and Sleeve Plug Welds, Revision 0, dated May 24, 1995
STD-400-158	Technical Operating Procedure for the Transition Zone Sleeve Rolling Tool and Controls for Steam Generator Tubes with 3/4" O.D. and 0.43 " or .048" Wall Thickness Using the Computer Controlled Sleeving System, Revision 00, dated September 1, 1995
STD-500-020	Technical Operating Procedure for Post-Weld Heat Treatment and Heater Dryout of above-the-Tubesheet (ATS) Welds Using Resistance Heating for Steam Generator Tubes with .048" Wall Thickness, Revision 0, dated July 31, 1992
2005331-001	Installation Specification/Traveler for Installing Tube Sleeves in the Steam Generator Tubesheet Expansion Transition Zone Using the Genesis 2000 Control System, Revision 0, dated September 19, 1995
00000-ESE-802	Mechanical Test Procedure for Transition Zone Sleeve Rolling Tool Development, Revision 1, dated July 29, 1992
GTAA-43.43-974	Weld Procedure Specification, Revision 00, dated July 31,1992

00000-NSS-062	Procedure for Ultrasonic Examination of Steam Generator Tube to Sleeve Upper Welds, Revision 10, dated February 22, 1995

Plugs/Stabilizers

STD-410-081	Remote Mechanical Tube Plug Installation Utilizing Computerized Control System, Revision 0, dated August 9, 1995
STD-410-057	Remote Mechanical Tube Plug Removal, Revision 4, dated September 12, 1995
STD-410-058	Manual Mechanical Tube Plug Removal, Revision 2, dated April 1, 1993
2005331-002	Mechanical Tube Plugging Steam Generator with 0.750" O.D. 0.048" Wall Tubes, Revision 2, dated September 11, 1995
2005331-004	Removal of Flexible Tube Stakes in CE Steam Generators, Revision 0, dated July 21, 1995

Testing

STD-100-204	Procedure for the Checkout and Operation of the Steam Generator Tube In-Situ Hydro Test, Revision 0, dated July 21, 1995
2005331-003	In-Situ Hydro Test, Revision 0, dated July 21, 1995