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October 4, 1999

1CAN109905

Mr. Ellis W. Merschoff
Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

Subject: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
Special Report - Once Through Steam Generator Tubing Surveillance – Category C-3 Results

Dear Mr. Merschoff:

Steam generator tubing inspections of the Arkansas Nuclear One, Unit 1 (ANO-1), once through steam generators (OTSGs) were performed during the 1R15 scheduled refueling outage which began September 10, 1999. The inspections performed on both OTSGs involved a 100% full-length bobbin coil examination. Also performed in 1R15 was a 100% rotating pancake coil (RPC) probe inspection in the hot leg (HL) upper roll transition (URT) region. The RPC used consists of a Plus Point coil and a 0.115 inch pancake coil. The RPC was also utilized for confirmation of bobbin coil calls. The RPC was used to test the lower tubesheet rolls, lower tubesheet crevices, sleeves, dented locations, and rerolls that were installed in the previous refueling outage.

The "A" steam generator was classified as C-3 in two areas. The "B" steam generator was classified as C-3 in one area. Since the only sizing technique approved for OTSGs is for wear, all the indications, with the exception of Tube End Cracks (TECs) and Upper Tubesheet (UTS) Intergranular Attack (IGA) that meet specific acceptance criteria, were considered defective and included in the general classification. This resulted in greater that 1% of the tubes being classified as defective in the "A" OTSG. The second specific area in the "A" OTSG that was C-3 was the rerolls that were installed in 1R14. The "B" OTSG was C-3 due to rerolls as well.

These inspections resulted in plugging 213 tubes in the "A" OTSG and 63 tubes in the "B" OTSG. Sleeves were not utilized to repair defective tubes identified during this inspection.

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Additionally, 78 tubes in the "A" OTSG and 33 tubes in the "B" OTSG were repaired by rerolling in the upper tubesheet. Entergy Operations is reporting the inspection results in accordance with ANO-1 Technical Specifications (TSs) 4.18.6 and 6.12.5 for results which have been categorized C-3 (more than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective). Additionally, NEI 97-06 requires that a plugged tube report be submitted within 15 days of each inservice inspection of SG tubes. This submittal also includes the information requested for that report.

PLANT DESCRIPTION

ANO-1 utilizes Babcock and Wilcox (B&W) model 177 OTSGs which began operation in 1974. The two OTSGs each contain 15,531 sensitized alloy 600 tubes with a 0.625" outer diameter and a 0.037" wall thickness. The tubes were partially depth rolled in the 24 inch tubesheets. The 15 tube support plates (TSPs) are made of carbon steel with a three lobed broach design. Mechanical B&W sleeves (31" and 80") have been installed in the upper portion of the tube bundle.

INSPECTION RESULTS

A comprehensive eddy current examination was performed on the OTSGs during the 1R15 outage. The inspections were performed with equipment and techniques qualified in accordance with Appendix H of the Electric Power Research Institute (EPRI) PWR Steam Generator Examination Guidelines, Rev. 5, or demonstrated equivalent. The methods used are capable of detecting inactive, active, and potential modes of degradation. Table 1 provides a breakdown of the initial scope and expansions based on number of examinations.

TABLE 1
1R15 Inspection Summary

Test Type	# Planned	% Scope	Category	Expansion
A OTSG				
General Examination			C-3	
• Bobbin	14423	100		No
• RPC URT	12460	100		No
• B&W Sleeves	96	20		Yes
• B&W Sleeve Expansion	379	100		No
• UTS IGA	278*	100		No
• RPC LRT	393	20		No
• RPC LTS Crevice	742	20		No
• Super Heat Dented Locations	102	20		No
Rerolls	1963	100	C-3	No
B OTSG				
General Examination			C-2	
• Bobbin	14776	100		No
• RPC URT	13621	100		No
• B&W Sleeves	98	20		No
• UTS IGA	173*	100		No
• RPC LRT	231	20		No
• RPC LTS Crevice	420	20		No
• Super Heat Dented Locations	28	20		No
Rerolls	1155	100	C-3	No

* Number of previously detected IGA indications
LRT = lower roll transition LTS = lower tubesheet

Two alternate repair criteria (ARC) have been approved for use in the ANO-1 OTSGs through Technical Specifications amendments. The first ARC permits IGA in the upper tubesheet to remain in service for Cycle 16. The second ARC pertains to TECs in either the upper or lower tubesheets. These two degradation mechanisms will be addressed in detail in the 90 day operational assessment report.

EVALUATION OF INSPECTION RESULTS

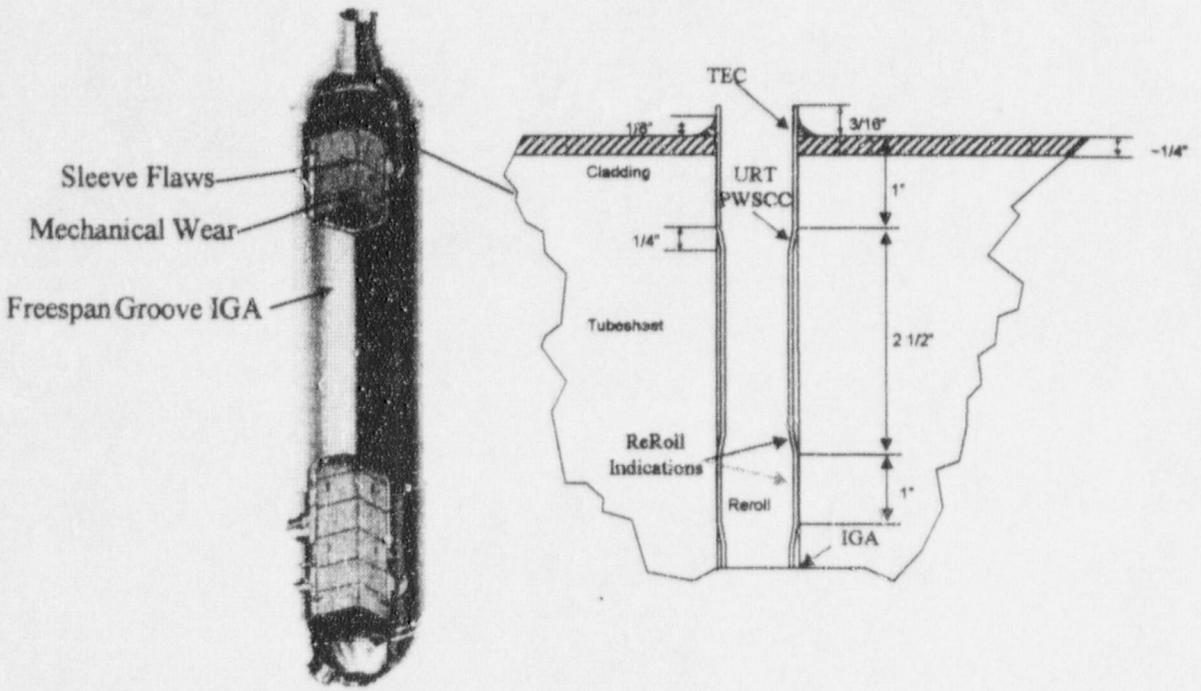
Table 2 list the type and number of indication found during 1R15:

TABLE 2
1R15 Flaw Summary

	A OTSG	B OTSG
	# Defective Tubes	# Defective Tubes
Upper Tubesheet IGA	3	1
Upper Roll Tube End	39	2
Upper Roll Transition	139	47
Freespan	27	23
Lower Roll Transition	0	0
Lower Tubesheet Crevice	0	0
Dents/Dings	0	0
Sleeve Transitions	6 Sleeves 1 Parent Tube	0
Rerolls	101	21

As noted in Table 2, the number of defective tubes due to indications in the upper roll transitions in the "A" OTSG and the rerolls in both OTSGs were greater than 1% of the corresponding number of tubes in that category. The tubesheet IGA and the TECs are considered under the ARCs and only counted as defective toward the general C-3 categorization if the tubes exceeded the ARC criteria. The individual damage mechanisms are discussed separately below. Figure 1 illustrates the different modes of degradation detected during the 1R15 inspection.

FIGURE 1
OTSG Degradation Detected During 1R15 Inspection



Upper Roll Transition

Over the past three upper roll area inspections (1R13, 1R14, and 1R15) there have been indications detected in the roll transition. These indications are detected with the 0.115" pancake coil and/or the Plus Point coil. Primary water stress corrosion cracking (PWSCC) has been confirmed in this general area (URT) through tube pulls at ANO-1, Oconee and Davis Besse.

As with the other modes of degradation contained within the upper tubesheet the flaws provide no burst concerns. Table 3 provides a history of the URT PWSCC with the predicted 1R15 numbers based on the cycle 15 operational assessment and the number of flaws detected during 1R15. The number of URT PWSCC indications are well within the range predicted by the cycle 15 operational assessment.

TABLE 3
Upper Roll Transition Cracking

	1R13 Actual	1R14 Actual	1R15 Projected	1R15 Actual
A OTSG	57	180	137	139
B OTSG	52	172	131	47

Freespan

This form of degradation is classified as axial aligned IGA believed to be associated with grooves created by the broached lands when the tubes were inserted during assembly. The degradation is located in the freespan between the support structures, mainly in the upper bundle region where elevated temperatures exist. A few indications were detected at TSP locations and in the LTS. This degradation was identified in the ANO-1 OTSG tubing for the first time in 1R13.

Due to the small number of indications detected in the lower tubesheet and the tube support plate locations they are considered along with the freespan flaws, consistent with the previous operational assessment. The number of defective tubes detected during the 1R15 inspection was well within the range of values contained in the cycle 15 operational assessment. Table 4 provides a history along with a 1R15 projected and actual freespan flaws detected.

TABLE 4
Freespan Degradation

	1R13 Actual	1R14 Actual	1R15 Projected	1R15 Actual
"A" OTSG	12	55	75	56
"B" OTSG	13	20	27	30

Rerolls

During the previous outage there were 1,963 tubes in the "A" OTSG and 1,155 in the "B" OTSG to which a one inch repair roll (reroll) was performed. The reroll creates a new RCS pressure boundary beyond the degraded section of tubing. The process was developed and qualified by Framatome Technologies Inc. and the B&WOG and was approved for use by the NRC on April 10, 1998, by TS Amendment 190 (1CNA049802). This was the first repair roll effort performed on the ANO-1 OTSGs. As part of the requirements for implementation, a 100% eddy current exam was performed during 1R15 on the rolls installed during 1R14. This exam consisted of using a RPC/Plus Point technique for detection of degradation. During this exam several indications were detected in roll area. These indications were broken down into two categories (volumetric and axial/mixed mode). The volumetric indications are likely small IGA patches. However, they could be an installation induced anomalous signal that was produced during the reroll process. Regardless of the cause, indications detected in the roll resulted in plugging the affected tube. The axial/mixed mode indications are likely PWSCC at the roll transition and in some cases extending into the 1" effective roll.

Tube End Cracking

During the 1R14 refueling outage a 100% Plus Point upper roll area inspection was performed and as a result indications were detected in the heat affected zone (HAZ) region of the tube end. A root cause analysis determined the flaws to be most likely PWSCC. The indications had been identified at ANO prior to 1R14 and at other OTSGs, but were believed to be above the tubesheet and therefore outside the pressure boundary. During a 1R14 bubble test two of the tube indications were found to leak, and the subsequent investigation led to the conclusion that repairs were necessary. Subsequent to 1R14, the B&WOG developed a TEC ARC for this specific degradation mechanism and location. The ARC was approved by the NRC for use at ANO-1 by TS Amendment 201 on September 14, 1999 (1CNA099903), allowing the indications to remain in service based on meeting specific criteria including radial position and associated flaw leakage.

During the 1R15 inspection there were a total of 803 tubes containing TECs in the "A" OTSG and 213 tubes in the "B" OTSG. Of these flaws, 39 tubes did not meet the ARC criteria (e.g., circumferential orientation) and were repaired or plugged. A listing of the tubes containing axial TECs along with a detailed leakage assessment will be provided to the staff as part of the 90 day report per TS 4.18.6.

Upper Tubesheet IGA

Intergranular Attack (IGA) in the upper tubesheet has been present since the early 1980s timeframe with very little change or growth. Since the cause of the IGA (high sulfate) has been eliminated, the IGA initiation rate is essentially zero. An ARC that allows the IGA detected during the 1R15 inspection to remain in service for the duration of Cycle 16 was approved for use by ANO-1 TS Amendment 202, issued October 4, 1999 (1CNA109901). The ARC is based on comparing three current eddy current parameters with previous readings (Plus Point amplitude, axial length and circumferential extent). As part of the acceptance criteria, an overall population growth comparison was performed on the IGA flaws detected during 1R14. There were 278 IGA flaws in the "A" OTSG and 173 IGA patches in "B" OTSG that made up the population for the growth comparison. The comparison concluded that no overall population growth was evident. Growth data was provided to the NRC in correspondence dated September 24, 1999 (1CAN099906).

Additional measures per the management program require each IGA indication to be assessed against a set of repair limits. A total of four indications exceeded the repair limit and were plugged. A detailed assessment of the IGA will be submitted to the NRC as part of the 90 day report per TS 4.18.6.

Sleeves

During the 1R15 sleeve Plus Point inspection, seven indications were detected during the exam of the "A" OTSG. Of the seven indications, one was a parent tube indication in a lower rolled joint. The other six were sleeve ID indications in the upper roll expansion of the upper joint. The exam consisted of 100% of the "A" OTSG and 20% of the "B" OTSG.

During a 1R13 (Oct. 1996) sleeve transition Plus Point exam, 10 indications were detected in the parent tube of various roll locations. Additionally, one indication was identified at the upper joint of a sleeve. This was the first time inservice sleeves were repaired at ANO-1 due to eddy current indications. It is believed that the parent tube indications, both the ten detected during 1R13 and an additional one detected during the 1R14 inspection (100% Plus Point) were all anomalous indications and had been present since installation. It should be noted that the parent tube indications are not necessarily signals from degradation. Nonetheless, the indications will continue to be conservatively plugged. The one indication detected in the lower joint of the parent tube during the 1R15 inspection is included in this category. However, the six indications in the sleeve ID were crack-like.

In-situ Pressure Testing

In-situ pressure testing was performed on a total of 5 flaws. The reason for testing is to provide data for the upcoming operating assessment and to ensure the condition monitoring criteria is met. The tubes are listed in Table 5. The tubes tested included two tubes containing axial cracks in the rerolls, two circumferential cracks in rerolls, and one tube containing multiple freespan flaws. The tubes located within the tubesheet were tested up to the main steam line break (MSLB) pressure to measure any leakage. No structural testing is required since burst is precluded in the tubesheet. None of the tubes leaked at the temperature corrected MSLB pressure of 2850 psi. The freespan cracks were tested in stages at normal operating, MSLB, and three times normal operating pressure differential (ΔP). No leakage was observed at normal operating ΔP or MSLB, and the tube held $3\Delta P$ with no leakage or burst. Based on the result of these tests and previous in-situ tests performed at ANO-1, all tubes met the condition monitoring criteria for accident induced leakage and structural integrity.

TABLE 5
ANO-1 IN-SITU TEST RESULTS FOR 1R15

OTSG	Row	Tube	Flaw Type	Normal Operating Pressure	Main Steam Line Break	3ΔP	Leakage
B	111	6	MAI – Reroll	1450	2850	N/A	0
B	145	34	MAI – Reroll	1450	2850	N/A	0
B	52	3	SCI – Reroll	1450	2850	N/A	0
B	38	12	SCI – Reroll	1450	2850	N/A	0
A	110	2	MAI –Freespan	1450	2850	4350	0

MAI = multiple axial indication SCI = single circumferential indication

ROOT CAUSE AND CORRECTIVE ACTIONS

Tubing degradation has been reported in earlier C-3 reports. The roll transition cracks are attributed to PWSCC. The freespan cracks are identified as outside diameter IGA/SCC, generally located in the area of grooves/scratches in the tubing.

The axial degradation in the reroll upper transition (heel transition) was unexpected after one cycle. Based on the location and prior industry experience the cause is likely classical PWSCC. A root cause is being performed under the corrective action program to further investigate the condition.

CONCLUSIONS

In summary, a comprehensive eddy current examination was performed in accordance with NEI 97-06. Both OTSGs were tested 100% full length with the bobbin coil and 100% at the hot leg roll transition region with Plus Point. Based on the in-situ pressure test results for the selected flaws, which are considered bounding, the condition monitoring criteria are satisfied. The population growth rate assessment of the upper tubesheet volumetric IGA indications demonstrated that these indications are not growing.

ANO-1 utilizes N-16 monitors for primary-to-secondary leakage detection, as well as condenser off-gas and main steam line radiation monitors. The technical specification limit on primary-to-secondary leakage is 0.104 gallon per minute (150 gallons per day). Abnormal operating procedures are in place in the event that leakage is detected. Entergy Operations is sensitive to the potential rapid progression of tube leakage and will take the necessary measures upon detection, should a primary-to-secondary leak occur. Operators routinely train on primary-to-secondary leaks and tube ruptures utilizing the simulator. Chemistry routinely collects samples on a weekly basis and calculates leakage based on tritium and Argon 41.

There was no evidence of primary-to-secondary leakage during the last operating interval (values were below the minimum detectable level of 5 gallons per day).

Based upon the comprehensive actions performed during 1R15 in conjunction with the ability to rapidly detect and respond to any primary-to-secondary leakage, as described above, ANO-1 is safe to resume plant operation. An operational assessment will be completed within 90 days following startup. Based upon the results of 1R15, it is anticipated that this assessment will demonstrate it is safe to operate ANO-1 for the entire duration of the next fuel cycle. The next planned outage is in the spring of 2001.

Should you have any questions regarding this submittal, please contact me.

Very truly yours,

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