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Subject: Oconee Nuclear Station, Unit 2
Docket No. 50-270
End-of-Cycle 19 Refueling Outage, November 2002
Steam Generator Inservice Inspection
Steam Generator Three Month Report

This letter transmits the results of the Steam Generator Tube Inservice Inspection performed during the Unit 2 End-of-Cycle 19 refueling outage.

Enclosure A provides a supplemental Inspection Assessment we believe will be helpful in reviewing the overall results of our steam generator inspections. The Inspection Assessment includes a summary of estimated primary-to-secondary leakage following a postulated Loss of Coolant Accident based on the as-found condition of the Steam Generators. This leakage summary is required by Condition 6 of the Unit 2 Facility Operating License, as amended by NRC letter to Duke Energy Corporation, dated December 15, 2000.

As required by Technical Specification 5.6.8.b, the results of the Steam Generator Tube Inservice Inspection performed during the refueling outage are submitted as Enclosure B.

If there are any questions you may contact R. C. Douglas at (864) 885-3073.

Very truly yours,

R. A. Jones
Site Vice President

Attachments

A047
A017

xc w/attachments: Mr. Luis A. Reyes
 Regional Administrator, Region II

xc w/o attachments: Mr. M. C. Shannon
 NRC Senior Resident Inspector

 Mr. L. N. Olshan
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Enclosure A

Oconee Unit 2 End-of-Cycle 19 Steam Generator Inservice Inspection Inspection Assessment

The following summarizes the Once-Through Steam Generator (OTSG) Eddy Current Testing (ECT) inspection scope during the Oconee Unit 2 End-of Cycle 19 (EOC-19) Refueling Outage:

Bobbin Coil (0.510 dia. MF)	100% A-OTSG 100% B-OTSG
Lane and Wedge: (0.460 dia. Plus-point)	Two Rows Around Sleeved Tubes A and B OTSG
MRPC Upper Tubesheet Roll (0.460 dia. Plus-point)	100% A-OTSG 100% B-OTSG
MRPC Re-rolls Upper Tubesheet (0.460 dia. Plus-point)	100% A-OTSG 100% B-OTSG
MRPC Lower Tubesheet Roll (0.460 dia. Plus-point)	100% Original Re-expansion
Bobbin Sleeve Exam (0.410 dia.)	100% Sleeves A-OTSG 100% Sleeves B-OTSG
Sleeve Upper and Lower Rolls (0.400 dia Plus-point)	100% Sleeve Rolls A-OTSG 100% Sleeve Rolls B-OTSG
Kidney Region (Sludge Pile) (0.460 dia. Plus-point)	100% A-OTSG 100% B-OTSG The inspection covers a minimum 12 inches into the tubesheet

RPC Special Interest (0.460 dia. Plus-point)

- 1) 100% Bobbin indications regardless of location
- 2) 100% Dents

The primary to secondary leak rate was less than <0.5 gpd at shutdown.

Disposition of the above inspection data and potential plugged tube severance issues required a total of 990 tubes (430 in the A-OTSG and 560 in the B-OTSG) to be removed from service. Active damage mechanisms identified during this inspection include Intergranular Stress Corrosion Cracking (IGSCC), Intergranular Attack (IGA), impingement, wear, and upper tubesheet roll Primary Water SCC (PWSCC). Tubes were removed from service by installing alloy-690 rolled plugs. A summary of the tubes plugged follows.

	<u>2A OTSG</u>	<u>2B OTSG</u>
Capture Locations	16	16
Tube Defects	414	544
IGA	7	10
Wear	1	0
Freespan SCC/IGA	380	491
Roll Transition PWSCC	12	9
Impingement	0	1
Dent SCC	0	8
Misc.	8	3
Dent/Vol. Combination	6	22
Total Plugged - EOC-19	430	560

In-situ testing was performed to confirm structural and leakage integrity at the end of the operating cycle. Tubes were selected for testing consistent with EPRI guidelines. The indications were sized and compared to the condition monitoring structural limit that considers the uncertainties associated with material properties, non-destructive examination (NDE), and the burst correlation. All tubes that exceeded the EPRI guidelines were in-situ pressure tested. The screening included voltage, depth, length, circumferential extent measurements as well as review of the indication eddy current signal, past tube pull results, and past experience with in-situ testing at the Oconee units. As a result of this screening, 22 tubes were in-situ pressure tested.

All tubes with degradation were shown to meet 3 times Normal Operating Pressure (NOP) ΔP by analysis or in situ pressure testing with the exception of tube R37-T27. This tube was identified for in-situ pressure testing and began leaking at approximately 3900 psi, which was below the target pressure of 4300 psi. The maximum pressure attained in the test was 3987 psi. Based on the in-situ test, the tube would have remained functional during the previously completed operating cycle (EOC-19). No leakage would have occurred as a result of a postulated limiting MSLB accident. Therefore the OTSG was operable during the past cycle.

The indication in tube R37-T27 can be traced back several cycles. The indication was complicated to interpret in the past due to an manufacturing burnish mark superimposed on the dent signal. All other tubes with precursor signals (volumetric with a dent) were preventively removed from service by plugging. The average depth of the indication in tube 37-27 is estimated to be 74% to 77% through-wall (TW). Based on this information and operating Effective Full Power Years (EFPY), the growth rate is 14.26% TW per EFPY. The growth is just below the bounding growth rate for axial freespan indications. Based on this growth rate and the plugging of precursor signals, full cycle operation is justified. Hence, structural and leakage integrity was demonstrated.

In summary, the observed degradation was analyzed consistent with NEI 97-06 and EPRI guidelines to justify full cycle operation. All inputs were considered at 95th percentile bounding values. The projected deterministic worst-case end of cycle structural and leakage integrity margins satisfy the criteria in NEI 97-06 and full cycle operation is warranted.

IGSCC

The limiting degradation of concern is axial IGSCC in the freespan. Based on previous tube pull examination, these indications are associated with grooves on the OD surface of the tubes. Tubes with these indications are removed from service on detection.

All of these tubes provided adequate margin against rupture. This determination is based on previous tube pull data, structural calculations, and in-situ pressure tests.

Extensive growth rate studies have been performed for past inspections at Oconee with similar results. The analysis of the Oconee Unit 2 EOC 19 data is bounded by the Oconee Unit 1 EOC 18 analysis. The Oconee Unit 1 EOC 18 analysis indicates a best estimate upper 95th percentile growth rate of 15.6% Through Wall (TW) per EFPY. Assuming a flaw is 40% TW at the Beginning of Cycle (BOC), a growth rate of 15.6% TW per EFPY for the next cycle, and at the 95th percentile flaw length of 1.0 inches, full cycle operation is justified. The predicted burst pressure of the assumed flaw at the end of the next cycle is above three times normal operating differential pressure considering uncertainties in the material properties and the burst pressure relationship.

Wear

Tubes with wear are removed from service based on sizing with a rotating coil. The plugging limit is $\geq 40\%$ TW. Using the analysis described above and including sizing uncertainties, the predicted burst pressure of the assumed flaw at the end of the next cycle is above three times normal operating differential pressure (assuming 61% TW, 1.5 inches long, and less than 135° circumferential extent).

IGA

These indications are volumetric in nature with limited circumferential extent. A Plus-point probe was used in the sludge pile region of the lower tubesheet to provide enhanced detection instead of a bobbin probe. The circumferential extent of IGA is typically below 70 degrees. Tubes with IGA are removed from service based on detection by Plus-point.

Based on the structural limit and the limited circumferential extent of IGA, all of these tubes provided adequate margin against rupture. The conclusion is supported by tube pull data, analysis, and in-situ pressure testing with no observed leakage. The growth rate of volumetric IGA is extremely low. Assuming an initial flaw size of 25% TW, full cycle operation is justified based on the wear analysis that bounds IGA indications.

Impingement

Impingement indications are volumetric in nature with limited axial and circumferential extent similar to IGA. Based on the broached opening width, the maximum possible circumferential extent is estimated to be 98 degrees. The structural limits are equivalent to IGA or wear.

Tubes with indication of impingement were found to have an adequate margin against rupture. This determination is based on previous tube pull data, analysis, in-situ test data, and eddy current sizing abilities. Typically, the maximum observed depth is 60% TW. The average growth rate of existing impingement is approximately 10% TW per cycle. Previous pulled tube specimens at 60% TW burst at greater than 9000 psi, which is typical for impingement defects. Analysis of impingement is bounded by IGA and wear. Therefore, full cycle operation is justified.

Impingement is removed from service based on bobbin sizing ($\geq 40\%$ TW). Additionally, impingement defects $\leq 40\%$ TW are preventatively removed from service based on previous data and location of the defect.

Sleeve Indications

No tubes were removed from service due to an axial indication in a sleeve roll. Tubes with degradation in the sleeves would have been removed from service.

Dents

A total of 8 tubes with indications in dents were removed from service due to axial or volumetric indications. The indications were axial or volumetric in nature and bounded by the IGSCC analysis. This conclusion is supported by analysis and in-situ pressure testing with no observed leakage. As discussed above, dent/manufacture burnish mark combinations were preventatively plugged. All of these tubes provided adequate margin against rupture as discussed above. Therefore, full cycle operation is justified.

Tubes with indications in dents are removed from service based on detection with a Plus-point probe.

Miscellaneous

These tubes were preventatively removed from service for miscellaneous reasons, typically tube obstructions, permeability, or volumetric indications near the lane and wedge region, or other ambiguous eddy current indications that may mask degradation.

Upper Roll PWSCC

Tubes with indications of PWSCC in the upper tubesheet roll area are repaired by installing a new roll in the upper tubesheet or removed from service by plugging. Tubes are repaired based on Plus-point detection.

All of these indications are captured in the tubesheet. The indications will not burst due to tubesheet constraint and do not present a structural concern. Laboratory helium leak tests

did not identify leakage in tubes pulled in the past from Oconee Unit 1 and Oconee Unit 3. During a previous Oconee Unit 1 outage, in-situ pressure testing was performed on twelve tubes representing the deepest degradation. No tube leakage was identified.

LBLOCA Evaluation

The as-found condition of the steam generators was evaluated to determine the best estimate primary to secondary leakage following a LBLOCA as described in Appendix A to BAW-2374¹. For the purpose of this evaluation, volumetric indications were conservatively analyzed as circumferential indications with the maximum depth applied to the full circumferential extent of the indication. Circumferential indications were also considered in this analysis. The best estimate primary to secondary leakage is 3 gpm. This estimated leakage would maintain offsite dose well below the limits of 10 CFR 100.

Swollen Plugged Tube Inspection

As a result of issues raised by the occurrence of a plugged tube becoming severed at another nuclear plant, inspections were performed to detect the possibility of such an occurrence at Oconee. The inspection at Oconee did not indicate any wear on the tubes adjacent to plugged tubes or any tube severance at the upper tube sheet. A total of 38 plugged tubes were inspected. Of these five contained water. Tube B 32-8 water level was 87% and was swollen by approx. 0.030" to 0.040" along the entire length of tube. This tube was initially plugged in 1993. The primary inlet plug was found missing in 1994. The cause of the missing plug was an installation torque issue. The inlet plug was replaced without dewatering in 1994. Tube B 31-7, immediately downstream in the steam flowpath from Tube B 32-8, did not show indications of wear and eddy current verified that tube B 32-8 was not severed. Tube B 32-8 was replugged with a full-length stabilizer installed.

This condition is not expected to occur during the next operating cycle.

¹ Framatome Technologies Inc. Topical Report, BAW-2374, "Justification for Not Including Postulated Breaks in Large-Bore Reactor Coolant Piping in the Licensing Basis for Existing and Replacement Once-Through Steam Generators," July 2000.

Enclosure B

Unit 2 End-of-Cycle 19 Steam Generator Inservice Inspection Steam Generator Three-Month Report

<u>Attachment</u>	<u>Title</u>	<u>Number of Pages</u>
1	S/G A List of Imperfections Bobbin	68
2	S/G B List of Imperfections Bobbin	88
3	S/G A List of Imperfections MRPC/Plus Point	51
4	S/G B List of Imperfections MRPC/Plus Point	109
5	S/G A Tubes Plugged for Eddy Current	9
6	S/G A Tubes Plugged to Capture Non-stabilized Plugged Tube Locations	1
7	S/G B Tubes Plugged for Eddy Current	12
8	S/G B Tubes Plugged to Capture Non-stabilized Plugged Tube Locations	1
9	S/G B Tubes Rerolled	1