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South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project
Unit 2
Docket No. STN 50-499
Unit 2 Refueling Outage NEI-97-06 Tube Integrity Report

In accordance with the requirements of NEI (Nuclear Energy Institute) 97-06 Section 4.0, Reports to the Nuclear Regulatory Commission (NRC), a report containing the following information as specified by Appendix D is to be submitted to the Nuclear Regulatory Commission within 12 months of completion of an inservice inspection. This report satisfies that requirement for the Unit 2 refueling outage completed in November 1999.

If you have questions regarding the attachment, please contact Mr. R. L. Baker at (361) 972-8961 or me at (361) 972-7181.

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PLA

Attachment

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Attachment

NEI 97-06 Appendix D Content

1) Scope of Inspections performed

Summary of 2RE07 Inspection Scope

The following is a summary of the 2RE07 (1999) inspection program, applicable to all Steam Generators:

100% full length bobbin (except Rows 1 and 2 U-bend region)
34% hot leg Top of Tube Sheet (TTS) Plus Point critical area inspection
20% Row 1 and Row 2 small radius U-bend Plus Point
Special interest Rotating Pancake Coil (including Generic Letter 95-05 Rotating Pancake Coil requirements and freespan bobbin I-codes)

Additionally, a critical area inspection was performed to address potential circumferential Outer Diameter Stress Corrosion Cracking (ODSCC) at freespan ding pairs. This inspection included:

100% Plus Point inspection of all ding pairs in Steam Generator D. Steam Generator D had the largest number of ding pairs.

100% Plus Point inspection of ding pairs between 12C and 11C and a 20% Plus Point inspection of all hot leg and cold leg ding pairs in Steam Generators A, B, and C.

2) Steam Generator Active Tube Degradation Mechanisms found

The current EPRI Inservice Inspection guideline defines "Active Damage Mechanism" as a combination of 10 or more new indications of degradation (≥ 20% through-wall) and previous indications of degradation which display an average growth rate ≥ 25% of the repair limit per cycle in any one Steam Generator. Alternatively, the existence of 1 or more new or previously identified indications of degradation, including cracks, which display a growth greater than the repair limit in one cycle of operation shall require designation of the degradation mode as an active degradation mechanism.

The following degradation mechanisms are considered active in the South Texas Project Unit 2 Steam Generators for the 2RE08 inspection:

Axial ODSCC at hot leg Tube Support Plate (TSP) intersections
Axial ODSCC in the freespan region at dings

3) Non Destructive Examination (NDE) techniques utilized for each degradation mechanism.

Probe and Technique Sheet Application: Flaw Confirmation and Sizing				
Degradation Mechanism	Location	Probe Type	Field Procedure	EPRI Technique Sheet
Active Degradation Mechanisms				
Axial ODSCC	Tube Support Plate intersection	Bobbin, 0.610" diameter	NSD-FP-1997-8053	Appendix A of GL 95-05
Axial ODSCC	non-dented Tube Support Plate intersections	Plus Point 3-coil	NSD-FP-1997-8053	None approved; use #96402, #96404 as a guide.
Axial ODSCC	Freespan	Plus Point 3-coil	NSD-FP-1997-8053	None approved; use #96402, #96404 as a guide.
	Freespan dings ≤ 5 volts	Plus Point 3-coil	NSD-FP-1997-8053	None approved; use #96402, #96404 as a guide.
	Freespan dings ≤ 5 volts	Bobbin, 0.610" diameter	NSD-FP-1997-8053	Westinghouse Report SG-99-03-005
	Freespan dings > 5 volts	Plus Point 3-coil	NSD-FP-1997-8053	None approved; use #96402, #96404 as a guide.

4) Number of tubes plugged or repaired during the inspection outage for each active degradation mechanism. Repair methods utilized and the number of tubes repaired by each method.

All repairs were by Mechanical ribbed alloy 690 plugs. No sleeves have been installed.

TABLE 1 UNIT 2
Steam Generator 2RE07 Inspection Results

	Steam Generator 2A	Steam Generator 2B	Steam Generator 2C	Steam Generator D	Total
Total No. of Tubes	4,864	4,864	4,864	4,864	19,456
Number of Tubes Previously Plugged	165	193	187	189	734
Total No. of Tubes Inspected (100%)	4,699	4,671	4,677	4,675	18,722
No. of Defective TSP Indications	31	36	47	38	152
No. of Defective Tubes - Axial Ind. At "Dings"	2	1	2	4	9
No. of Defective Tubes - Volumetric Ind.	0	0	1	0	1
Total Number of Defective Tubes	33	37	50	42	162
Percent Defective	0.70%	0.79%	1.07%	0.90%	0.87%
Inspection Category	C-2	C-2	C-3	C-2	N/A
Preventative Plugging	11	2	12	0	25

5) Total number and percentage of tubes plugged and or repaired to date and the effective plugging percentage in each Steam Generator.

	Steam Generator 2A	Steam Generator 2B	Steam Generator 2C	Steam Generator 2D	Total
Total Plugged in 2RE07	44	39	62	42	187
Total Plugging to Date	209	232	249	231	921
Total % Plugged to Date*	4.3%	4.8%	5.1%	4.7%	4.73%
*South Texas design basis plugging limit is 10%.					

6) Description of the tube integrity assessment

Axial ODSCC at Tube Support Plate Intersections

Using the standard modeling methodology, the limiting Steam Generator predicted for End of Cycle (EOC)-8 is Steam Generator C, with a burst probability for 1 or more tubes of 6.4×10^{-3}, and predicted Steam Line Break leakage of 0.48 gpm. Using a voltage dependent growth rate modeling methodology and voltage dependent Probability of Prior Cycle Detection (POPCD), the burst probability and Steam Line Break leakage prediction for Steam Generator C is 9.8×10^{-3}, and 0.68 gpm. The maximum predicted amplitudes for EOC-8 are 6.2 volts using the standard methodology and 6.3 volts using the voltage dependent methodology. The Steam Line Break burst probabilities and leak rates satisfy the operational assessment requirements.

Circumferential ODSCC at the TTS

No circumferential ODSCC was reported at 2RE07. Considering a Plus Point detection threshold of about 20% Percent Degraded Area (PDA), and upper bound growth of 30% PDA, the maximum postulated circumferential flaw PDA value at 2RE08 is judged to be bounded by about 50%, which is well below the structural limit of 77% PDA.

Axial ODSCC and Primary Water Stress Corrosion Cracking (PWSCC) at the TTS

No axial ODSCC or PWSCC was reported at 2RE07. Considering a Plus Point detection threshold of about 0.1 inches, equal to the coil diameter, and upper bound growth of about 0.25 inches, the maximum postulated axial flaw length at 2RE08 is judged to be bounded by about 0.35 inches, which is well below the structural limit for a 100% through-wall axial flaw of 0.48 inches.

Ding ODSCC

The apparent maximum depth growth of the axial ODSCC in tube R20 C95 Steam Generator C is judged to be approximately 20% through-wall for the Cycle 7 operating period. As the Cycle 8 operating period is a maximum of 461 Effective Full Power Days and the Cycle 7 length was 343 Effective Full Power Days, the adjusted maximum depth growth allowance for ding ODSCC is estimated to be 27% through-wall (461/343 x 20% through-wall). Using a conservative detection threshold of 60% through-wall, the estimated maximum depth of axial ODSCC at dings is judged to be bounded by about 87% through-wall at EOC-8. As such, Steam Line Break leakage from ding ODSCC is not anticipated at EOC-8.

The laboratory flaws developed in the bobbin ding program were shown to be limited in length by the stress field produced by the ding. A study of ding shapes was performed prior to the 2RE07 outage. This study evaluated the ding axial lengths, for predominantly axially oriented dings. The average ding axial length for all dings evaluated was found to be 0.296 inches. The average axial length of dings identified with axial ODSCC at 2RE06 was found to be 0.306 inches. The 115 pancake coil response was used for the ding measurements since the Plus Point coil would be expected to reduce the geometry influences. Considering look ahead and look behind influences, the actual ding axial lengths are expected to be about 0.1" less than the NDE reported lengths. Conservatively, the NDE reported ding lengths are used for estimation of flaw lengths at 2RE08. Of the dings produced in the lab which developed ODSCC, the maximum reported flaw length was 0.375 inches.

The ding stress field influence can be estimated to extend past the geometry change by a factor of ($2^{1/2}$ x t) where t is the nominal wall thickness, resulting in an end effect of 0.061 inches in each direction, resulting in an upper bound ding axial ODSCC length of 0.42" at EOC-8. With an upper bound maximum depth of 87% through-wall and length of 0.42 inches, ding axial ODSCC is not expected to represent a challenge to structural integrity at EOC-8. Assuming the flaw depth is constant at 87% through-wall, the calculated burst pressure using Lower Tolerance Limit material property values is 4290 psi, which is greater than the $3\Delta P_{NormOP}$ value of 3750 psi.

Antivibration Bar (AVB) Wear

The maximum AVB wear depth reported at 2RE07 was 32% through-wall. The maximum observed AVB wear growth was reported at 11% through-wall. Adjusting the growth for cycle length results in a bounding AVB wear growth rate of 15% through-wall. Therefore, the maximum postulated AVB wear depth expected at EOC-8 is 47% through-wall. Considering a bounding AVB wear depth measurement uncertainty of 19% through-wall, the limiting depth reported by NDE is expected to be bounded by 66% through-wall. The 2RE07 degradation assessment established the AVB structural limit to be 77% through-wall for an assumed AVB wear scar length of 0.4 inches.

Assessment Conclusions

The analysis of the limiting 2RE07 indications has concluded that all flaws had burst capability exceeding the three times the normal operating pressure requirement, thus the structural performance criteria of NEI 97-06 were satisfied. Based on observed flaw parameters at 2RE07, Steam Line Break leakage is not considered relevant for degradation mechanisms other than axial ODSCC at Tube Support Plate intersections, which is addressed by GL 95-05.

The only operating parameter which will change for Cycle 8 is the operating period, estimated at 461 Effective Full Power Days. The analysis of ding axial ODSCC has shown that Steam Line Break leakage is not expected for the postulated limiting flaw at EOC-8, and burst capability is expected to be well in excess of the $3\Delta P_{NormOP}$ value of 3750 psi, thereby satisfying the performance criteria of NEI 97-06.

7) Description of corrective actions, if any, implemented.

Not applicable.

8) Evaluation of circumstances if condition monitoring results exceeded the previous cycle operational assessment.

The total number of tube support plate axial indications projected for 2RE07 was approximately equal to the actual reported value. However, the maximum voltage growths showed a substantial increase in the tails of the distributions. Cycle 8 projections have incorporated the increased growth experienced and supplemental analysis using voltage dependent growth has been performed.