

**TVA Sequoyah Nuclear Plant Unit 2 Cycle 11
Steam Generator Tube Inspection
Update as of 04/28/2002**

1. **Primary to secondary leakage prior to shutdown:** < 0.1 gpd (below detection)
2. **Results of secondary side hydro:** No post shut down secondary side hydro due to non-detectable primary to secondary side leakage.
3. **A general description of areas examined, expansion criteria, types of probes:**

Based on all active and potential damage mechanisms, the following steam generator (SG) inspection is being performed.

100% Full-length bobbin examination in all 4 SGs

100% Hot leg top of tubesheet examination in all 4 SGs with +Point

100% Row 1, 2, 3, and 20% of Row 4 U-Bend examination in all 4 SGs with mid range mag bias +Point U-Bend probe

100% ≥ 2 volt dented intersections with +Point probe (452 exams)

<2 volt dents are inspected via the bobbin examination. Analysts are trained to detect PWSCC using the qualified detection technique

20% freespan dings ≥ 2 volts from HTS to H02 in all 4 SGs with +Point (43 exams)

A qualified bobbin exam is utilized to detect freespan axial ODSCC in <5 volt dings

Expansion Criteria

TTS Expansion Criteria

Top of tubesheet examination will be expanded to the cold leg if hot leg inspection is categorized as C-3 or if an indication in the hot leg fails performance criteria.

20% random sample of the cold leg TTS will be performed in the affected SG if this expansion is necessary.

Dented TSP Intersection Expansion Criteria

Expansion to the cold leg would occur if PWSCC axial or circumferential indications are identified in the highest hot support plate. Then a 20% random sample of the >2 volt dents at C07 will be performed in the affected SG.

If circumferential cracking is identified in a 2-3 volt dented intersection, the +Point dent inspection would be expanded to 1-2 volt dents

Freespan Ding Expansion Criteria

If one crack-like indication is identified in the freespan ding inspection, 100% of the dings up to H02 will be inspected and a 20% buffer zone up to the next highest TSP in the affected SG will be performed.

U-Bend Expansion Criteria

If one crack-like indication is identified in R4, 100% of Row 4 and 20% of Row 5 will be inspected.

Expansions

Due to the detection of one ODSCC axial indication in a freespan ding, the hot leg freespan ding examination was expanded to all hot leg dings ≥ 5 volts. A qualified bobbin technique was utilized to detect axial ODSCC in freespan dings < 5 volts. Computerized Data Screening is utilized as secondary analysis and the program detected the ODSCC axial indication by bobbin. This expansion is more conservative than the planned expansion.

4. Analyzed EC results: (approximately 100% complete)

	Total Projected In Preoutage <u>Assessment</u>	Total Pluggable <u>U2C11 To Date</u>	Total Cumulative <u>Plugged</u>
TTS Axial PWSCC	20	16	96
TTS Circ PWSCC	10	6	21
TTS Axial ODSCC	18	7	22
TTS Circ ODSCC	10	3	11
TSP Axial PWSCC	10	2	4
TSP Axial ODSCC	17	3	14
(Indications saved by ARC)	1,095	1,057	
Anti-Vibration Bar Wear	2	1	26
Cold Leg Wastage	2	11	47
U-Bend Axial PWSCC	5	1	85
U-Bend Circ PWSCC	5	2	8
Freespan ODSCC	3	1	1
Other	0	6	27

Thirty-two tubes were plugged in order to utilize the Westinghouse Flexi Rail System in future inspections. This system eliminates manual robot moves once the robots are installed.

Total to be plugged thus far - 91

Total cumulative thus far - 394 (including preventive plugging from past outages)
2.9%

The SQN Unit 2 Cycle 11 Steam Generator inspection results are categorized below:

<u>Initial Exam Sample</u>	<u>SG1</u>	<u>SG2</u>	<u>SG3</u>	<u>SG4</u>
Full Length Bobbin Coil	C-2	C-2	C-2	C-3
Low Row U-bend (+Pt)	C-3	C-1	C-1	C-1
Top of Tubesheet (+Pt)	C-2	C-2	C-2	C-2
Dented Tube Support Sample	C-2	C-3	C-1	C-1
Freespan Ding Sample	C-1	C-1	C-3	C-1

The bobbin program is C-3 due to the large number of ODSCC axial indications at tube support plates that remain in service via the GL 95-05 alternate repair criteria. The low row U-Bend program in SG1, the dented support plate program in SG2, and the freespan ding program in SG3 are C-3 due to the small sample size. One or two indications equal >1% defective.

<u>Expansion Sample</u>	<u>SG1</u>	<u>SG2</u>	<u>SG3</u>	<u>SG4</u>
Full Length Bobbin Coil	N/A	N/A	N/A	N/A
Low Row U-bend (+Pt)	N/A	N/A	N/A	N/A
Top of Tubesheet (+Pt)	N/A	N/A	N/A	N/A
Dented Tube Support plate	N/A	N/A	N/A	N/A
Freespan Ding Sample	100%	100%	100%	100%
	≥5 volt Hot Leg Dings			

Significant Indications

Limiting Flaw for Structural and Leakage Analysis

Tubesheet PWSCC Axial – All the indications are below the top of the tubesheet. The majority are > 0.5” below the top. Of the 3 indications closest to the top (< 0.5”), the largest length is 0.16” and the largest voltage is 0.38 volts.

Tubesheet PWSCC Circ – All indication are below the top of the tubesheet. Only one indication is less than 2 inches below (HTS – 0.36). This indication is 97° and 0.98 volts.

Tubesheet ODSCC Axial – All indications are close to the top of the tubesheet (HTS –0.18 to HTS + 0.1). The largest length is 0.25” and the largest voltage is 0.23 volts.

Tubesheet ODSCC Circ – All indications are close to the top of the tubesheet (HTS-0.14 to HTS + 0.0). The largest indication is 65° and the largest voltage is 0.98 volts.

ODSCC associated with a 2.65 volt Freespan Ding – Only one indication was identified this inspection and the size is 0.15” and 0.3 volts

PWSCC associated with Dented Support Plates – This damage mechanism has a qualified sizing technique with quantified uncertainties. The limiting burst pressure is greater than 3ΔD. The indications were located in a 3.7 volt and in a 6 volt dent.

U-Bend Axial PWSCC – One indication was identified at H07+3.95, 0.24” and 1.32 volts.

U-Bend Circ PWSCC – Two indications were identified. Both were in situ pressure tested for leakage concerns. The indications were tested to steam line break pressure without leakage.

<u>Row</u>	<u>Col</u>	<u>Location</u>	<u>Length</u>	<u>Volts</u>
1	21	H07+3.95	45°	1.67
1	28	H07+10.58	45°	2.58

5. Describe repair/plugging plans:

All crack-like indications are being plugged on detection except for indications that can be left in service through alternate repair criteria for Axial ODSCC at TSPs.

AVB Wear	Plug indic's that are $\geq 40\%$
Cold Leg Wastage	Plug indic's that are $\geq 40\%$
ODSCC Axial at Non-Dented TSP	Plug indications per GL-95-05
PWSCC Axial at Dented TSP	Plug indic's that are $\geq 40\%$
All other crack like indications	Plug on detection.

No sleeving is planned .

6. Previous history; "look backs" planned:

Cracked support plate indications are compared to past outage data to ensure that the indications are not indicative of active damage.

Distorted signals from bobbin are compared to past outage data to ensure there is no change and to determine if plus point examination is required.

7. New inspection findings:

This is the first inspection to identify ODSCC axial indications associated with freespan dings. One indication was identified. The inspection was expanded to 100% of the hot leg freespan dings ≥ 5 volts. No other indications were identified. CDS was programmed to detect ODSCC axial indications in freespan dings < 5 volts. This indication was in situ pressure tested and reached the target pressure of $3\Delta P$ with no leakage. This degradation mechanism was documented in the site's corrective action program.

8. Reliance on X-Probe

X-Probe is not used for any inspections.

9. In situ pressure test plans and results, if available and tube selection criteria:

In situ pressure testing was planned as a contingency for flaws detected that challenge structural or leakage limits based on SQN-specific screening criteria developed by conducting a performance demonstration on potential degradation mechanisms. The EPRI Steam Generator In Situ Pressure Test Guidelines Rev. 1 will be utilized as well as the Interim Guidelines issued by the SGMP October 2000.

The new degradation was pressure tested and discussed in question #7.

Two U-Bend circumferential indications were detected that had voltages that exceeded screening criteria. They were both in situ pressure tested and are discussed above.

10. Describe tube pull plans and preliminary results, if available and tube selection criteria:

Tube pull was performed in support of the OD Axial ARC . Three intersections were pulled and will be metallurgically examined. The best candidate for pulling was a 3.35 volt indication at the first hot support plate in SG#4. A 0.44 volt indication at the third hot support plate of the same tube was pulled as the second intersection to comply with the commitment to pull two intersections. Pulling one tube saves dose, and there are no other indications were large enough to provide data to industry correlations..

11. Assessments of tube integrity for the previous cycle:

Condition monitoring is being performed in accordance with NEI 97-06 and the Steam Generator Integrity Guidelines. Indications are sized using documented sizing techniques. NDE uncertainties from the SQN SSPD are used. Burst pressure is calculated using the EPRI Flaw Handbook equations, which account for correlation and material property uncertainties. If the indication has a burst pressure lower than performance criteria, in situ pressure testing will be performed on each indication that fails performance criteria.

For leakage analysis, the voltage is used to determine the potential for leakage at accident conditions. If the voltage exceeds screening criteria, the indication is in situ tested.

12. Assessments of tube integrity for the next operating cycle:

Operational assessment is being performed in accordance with NEI 97-06 and the Steam Generator Integrity Guidelines. Projections of beginning of cycle worst case flaws are estimated and Sequoyah-specific growth data is used to determine an end of

cycle flaw size. Burst pressure and leakage are calculated in a similar manner as discussed above.

13. Schedule for SG related activities

Tube pull and repairs could begin as early as Sunday.

14. Steps taken in response to the Lessons Learned from the Indian Point Unit 2 Tube Failure

Prior to the inspection the ETSS qualification data sets applicable to stress corrosion cracking were evaluated for noise. In the absence of industry issued quantitative acceptance limits, TVA conducted a review of noise levels in the pulled tubes and lab samples used in the EPRI qualification and compared these values to noise levels in the SQN-2 SGs. Since automated techniques to make these measurements have not been developed at this time, a sample was selected rather than quantifying the entire tube population. Both peak to peak (VPP) and vertical maximum (VVM) voltages were measured. Average values as well as the individual worst case voltages were identified. Approximately 10% of the row 1 and 2 U-bends were reviewed in each SG and about 100 tubes total were reviewed at the hot leg tubesheet expansion transition and the hot leg sludge pile. As shown in the table below the noise levels in the SQN-2 SGs are either comparable with or bounded by the noise levels in the EPRI qualification data.

Area	Probe & ETSS	ETSS AVG VPP	SQN-2 AVG VPP	ETSS AVG VVM	SQN-2 AVG VVM	ETSS Worst VPP	SQN-2 Worst VPP	ETSS Worst VVM	SQN-2 Worst VVM
Ubend ID	+ Pt 965112	1.11	0.90	0.28	0.37	1.60	1.45	0.61	0.75
ExpTrn OD	+ Pt 204091	0.50	0.22	0.39	0.10	2.51	0.56	2.30	0.29
ExpTrn ID	+ Pt 967011	0.57	0.34	0.19	0.11	1.57	0.58	0.48	0.23
SLG OD	Bobbin 960081	0.87	0.64	0.45	0.13	1.66	1.78	1.18	0.32

In generator noise levels will be monitored and the voltage measurements recorded during the inspection by dedicated data quality analysts.

All of the low row U-bends will be reviewed. Noise levels which exceed 110% of the EPRI qualification will be subject to re-analysis by the resolution team. The results of this review will result in either acceptance of the original test data (following a review and comparison with last inspection data), retest with the same type of probe, or a new test using a high frequency plus point coil.

A random sample of data from the hot leg tubesheet expansion area and sludge region will be reviewed. Noise levels which exceed 110% of the EPRI qualification

will be subject to re-analysis by the resolution team. The resolution team will determine whether additional diagnostic testing or re-examination is required.

The tube support plates will be reviewed to ensure that the data does not contain extraneous noise, however there will be no quantitative limits requiring a resolution review. The ODSCC and PWSCC alternate repair criteria at tube supports assume a very conservative 0.6 probability of detection under USNRC Generic Letter 95-05 and WCAP 15128, respectively. The bobbin detection technique was qualified on lab samples which specifically modeled the responses from Sequoyah-2. The primary limitation on detection with this technique is denting. This ETSS is qualified at dented supports up to 1.99 volts and TVA is plus point testing all hot leg dented supports that are 2.0 volts and greater.