

Obstructed Sleeves at SONGS Unit 2

March, 2004




Sleeve Design

- Spans expansion transition zone at the top of tubesheet
- Dimensions
 - Length 17.5"
 - Diameter 0.625"
 - Wall thickness 0.0315"
- Material is thermally treated Alloy 690
- Upper end is welded to tube
- Lower end is rolled into tube inside tubesheet
 - Metal bands improve sealing and pullout strength



Sleeve Installation Process

- Tube End Marking
- Tube End Rolling
- Tube ID Cleaning and Verification
- Particle Removal
- Sleeve Insertion/Expansion
- Tube to Sleeve Weld
- Sleeve Weld UT and VT
- Postweld Heat Treat
- Sleeve Torque Roll
- ECT



Industry History of Obstructed Sleeves

- In 1999 KOR1 1 found 14 of 558 obstructed after 1 cycle
- Trojan found 2 explosively welded sleeves obstructed
- In 2001 Beaver Valley found 4 of 350 laser welded sleeves obstructed after 1 cycle
- Farley found 1 of ~1000 laser welded sleeve obstructed
- Since the early 80s, ~10 of 12,000 TIG welded sleeves have been found obstructed (Ginna, Zion, Prairie Island)
- SONGS, 398 sleeves, 10 with obstructions
- None of these resulted in primary to secondary leakage



Possible Leak Paths

- Parent Tube Defect
 - Expansion transition zone
 - Lower rolled joint zone
- Sleeve to Tube Weld
 - Lack of fusion
- Sleeve to Tube Rolled Joint
- Sleeve Material



Obstructed Sleeve Issues

- Bulged sleeves limit ECT probe access
- Bulged sleeves may impede primary flow
 - Small number of obstructed sleeves minimizes effect (10 out of 398 existing sleeves or about 2.5%)
- Structural and leakage integrity
 - No primary to secondary leakage last cycle.
 - Qualification of sleeve included collapse testing (Topical Report CEN-630-P, Rev 02)
 - Both welded and rolled joint remained leak tight



Actions Taken

- Data from previous sleeving campaigns reviewed
 - No pattern to affected sleeves
 - UT data shows complete weld fusion
 - Torque trace data shows nominal values
- Procedure review conducted
 - No process changes between SONGS campaigns
 - No obvious reasons for the 10 sleeve bulges

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Conclusions

- Water leaked between tube and sleeve at cold conditions
- Heat up results in increased pressure condition
- Once tube bulged, pressure is relieved and no additional stress is placed on sleeve
- No adverse effects on operation or safety,
- No definitive cause identified

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Actions (cont.)

- OA written to address ability to perform specific functions
- Preparations to reduce the maximum linear heat rate from 12.6KW/R and increased analyzed plug limit

	E088 Plugs	E088 Sleeves	Total
Prior to Outage	773	232	1025
After outage	838	348	1254
	E089 Plugs	E089 Sleeves	
Prior to Outage	817	~145	963
After outage	860	~180	1149

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Actions (cont.)

- Review of Torque Roll Calibration
 - S/G E088 & S/G E089
 - All Rolls Performed Under One Calibration Group in Each S/G
 - Due to Limited Numbers of Sleeves, Performed Rolls in Each S/G as One Batch
 - Calibration Records Acceptable
 - No indications of abnormalities

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Actions (cont.)

- Cleaning Review of Random Tubes U2C13
 - Re-inspected 5 Tubes in S/G 88

Tube ROC	Count in Branch Limb
25/41	7th of 11
80/56	8th of 10
43/36	14th of 22
17/113	1st of 18
37/116	10th of 18

- Rotated for 350 Degree Examination
 - Uniform Cleanliness Exhibited

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Actions

- Proceed with Sleeving in Unit 2
 - Verified that no tube defects exist in the roll joint zone
 - As discussed we perform visual inspection of tube in roll joint zone to characterize surface condition, and modified the procedure to capture the cleaning process.
 - Operators and inspectors were briefed on situation and re-reviewed the critical process steps, e.g. cleaning and roll parameters

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