

Steam Generator Batwing Inspections

Fall 2009 Refuel 16 Outage

Preliminary Results

An augmented inspection of Steam Generator #1 (SG-1) and Steam Generator #2 (SG-2) was performed during the November 2009 Refuel-16 (RF16) outage per work orders 153097-01 and 153098-01 respectively to determine if there were any changes in extent of condition or the critical variables that were the basis for the Refuel-14 repair plan and the Cycle 15 operational assessment.

The RF16 augmented inspections included:

- Visual exam of upper batwing weld and wrap around bar
 - verify no upper batwing weld/clip failures in stay cavity area
 - verify no gross deformation twisting of wrap around bar
- Through-tube bundle diagonal (45 Degree) visual inspection of upper stay cavity area
 - provide assurance that stabilized tubes are attenuating forces developed by broken batwings
- Bottom-up visual inspection of stay cavity area
 - monitor batwing degradation
 - verify no indications of gross tube deformation
- Foreign object search and retrieval (FOSAR)
 - verify no large batwing segments are present
 - remove accessible foreign objects

The augmented inspection performed met the established acceptance criteria. There were no changes to the extent of condition and the critical variables that were the basis for the RF 14 repair plan.

Steam Generator #1

Condition Reports

- CR-WF3-2009-06620 documents a discrepancy discovered between the actual batwing locations and the titled locations recorded on video.
 - This is a labeling issue only, which will be resolved with a translation table in the final report. This does not impact the technical evaluation of the weld inspections.

Upper Weld and Wrap Around Bar Inspection

- The wrap around bar and upper batwing to wrap-around bar welds were inspected from column 50 through 120, which bounds the stay cavity region area of interest, columns 64 through 113. The upper batwing to wrap-around bar welds were intact with no gross deformation or twisting of the wrap around bar or other significant degradation observed. The upper welds and wrap around bar condition had not noticeably changed from the previous inspections. All inspection acceptance criteria were met with no concerns identified.

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45° Through-Tube Bundle Inspection

- The batwing to tube interface around the stay cavity region area of interest was visually inspected. The stabilized tubes were intact with no gross deformation or severe damage indicated. Although the batwing damage had progressed with new batwings observed broken at center notch and displaced sideways, this was expected and the batwing to tube interface condition had not noticeably changed from the previous inspections. The progression of the batwing condition is following the progression observed in SG-2, excepting that the extent of damage is much less, no intrados tube wear has been observed, and no loose batwing segments have formed. All tubes met the acceptance criteria of less than 33% through tube wear, with no concerns identified.

Bottom-Up Video Inspection

- The bottom-up visual inspection of stay cavity region area of interest was performed. No gross tube deformation was indicated and no unexpected batwing degradation was found. The progression of the batwing condition is following the progression observed in SG-2, excepting that the extent of damage is much less. 18 batwings were identified broken at center notch versus 8 in RF15. One batwing had bent over and was above the other displaced batwings, which is also similar to but bounded by the conditions observed in SG-2. No missing batwing pieces had formed. All batwings met the acceptance criteria of less than 36" segments formed, with no concerns identified.
- The composite bottom-up video inspection was parsed and compiled to form a composite view. The composite view from RF16 and RF15 are provided as figures 1a and 1b, respectively.

Foreign Object Search and Retrieval Inspection

- The annulus between the tube bundle and shroud, blowdown lane, and blowdown dome area at the top of tubesheet were visually inspected for foreign objects. The foreign object search and retrieval inspection met the acceptance criteria with no batwing segments or accessible foreign objects found.

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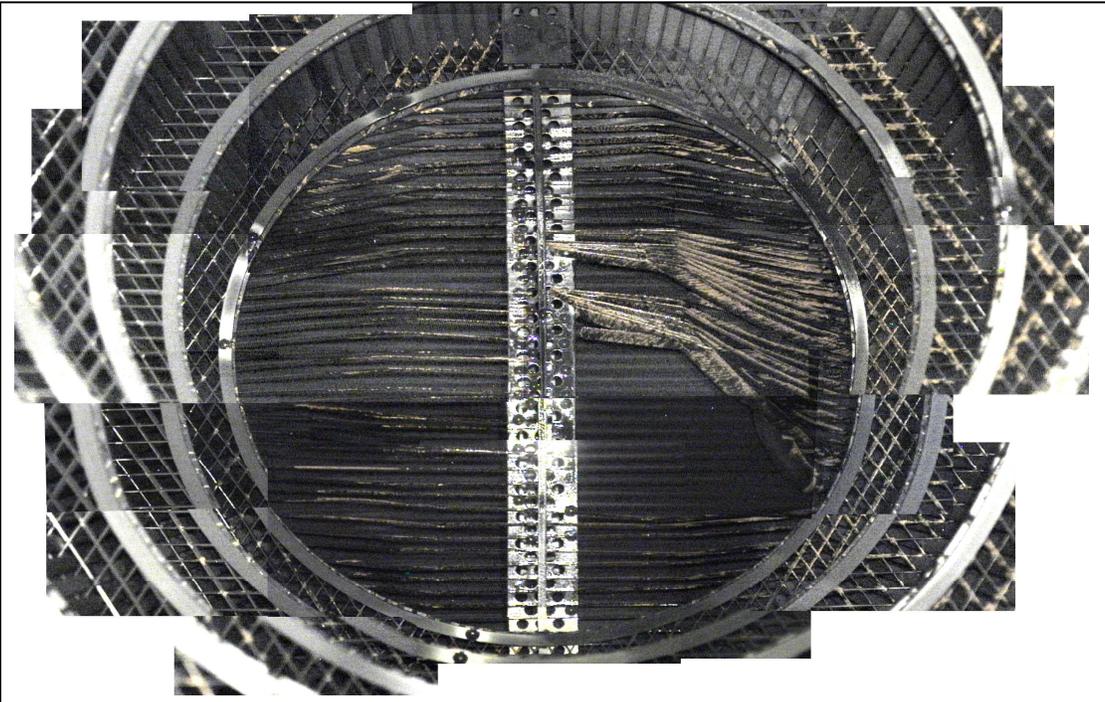
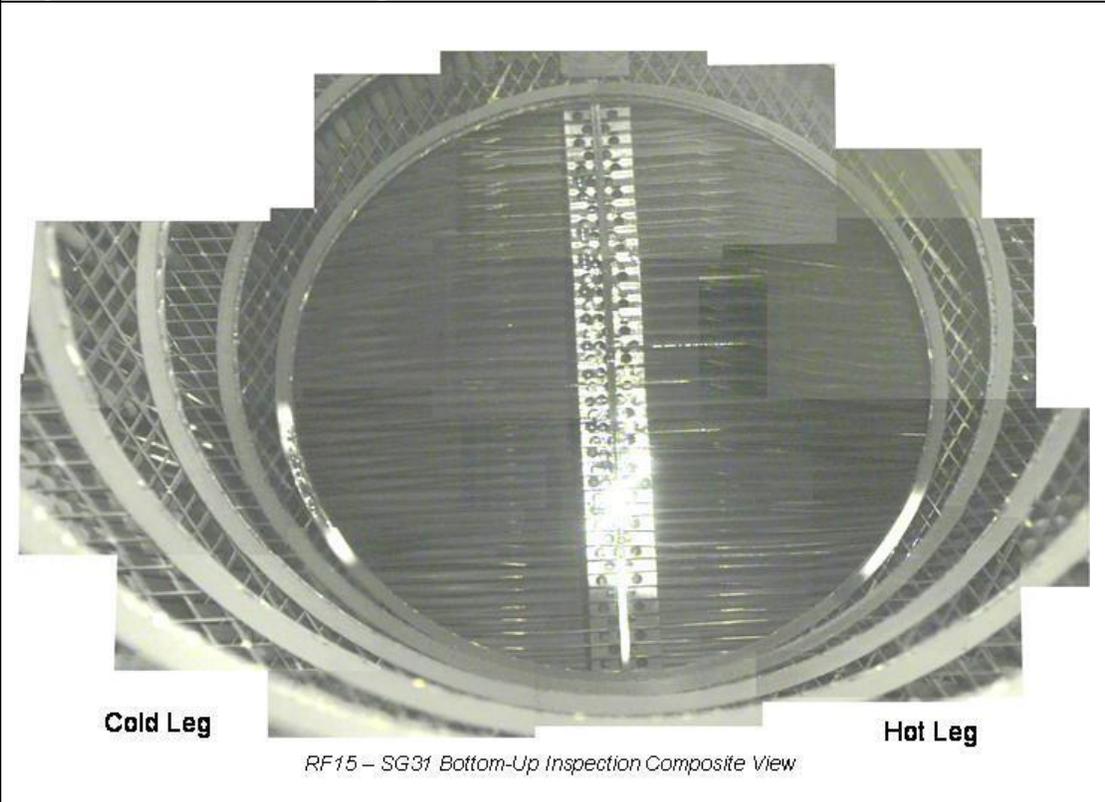


Figure 1a: RF16 SG-1 Composite

Figure 1b: RF15 SG-1 Composite



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Steam Generator #2

All inspections results are bounded by the acceptance criteria

Condition Reports

- CR-WF3-2009-06206 documents a loose part (M2x3mm) noted as missing from Telex communication video equipment that was used inside the generator during inspections. Small screw missing was a size M2 x 3mm.
- CR-WF3-2009-06486 documents intrados tube wear appearing to be through wall and through portions of the stabilizer.
- CR-WF3-2009-06620 documents a discrepancy discovered between the actual batwing locations and the titled locations recorded on video.
 - This is a labeling issue only, which will be resolved with a translation table in the final report. This does not impact the technical evaluation of the weld inspections.

Upper Weld and Wrap Around Bar Inspection

- The wrap around bar and upper batwing to wrap-around bar welds were inspected from column 50 through 120, which bounds the stay cavity region area of interest, columns 64 through 113. The upper batwing to wrap-around bar welds were intact with no gross deformation or twisting of the wrap around bar or other significant degradation observed. The upper welds and wrap around bar condition had not noticeably changed from the previous inspections. All inspection acceptance criteria were met with no concerns identified.

45° Through-Tube Bundle Inspection

Results

- The batwing to tube interface around the stay cavity region area of interest was visually inspected. The stabilized tubes were intact with no gross deformation or severe damage indicated. Although the batwing damage had progressed, this was expected and the batwing to tube interface condition had not noticeably changed from the previous inspections. The intrados tube wear that had been previously observed was examined in detail. The wear models predicted the stabilized tubes adjacent to the stay cavity region could have through-tube wear, and established gross tube damage criteria that would characterize unexpected or unacceptable wear. The gross tube damage was defined as irregular tube spacing, tube dislocation, through-wall wear greater than 180 degrees of the tube circumference or, if stabilized, the stabilizer is visibly scalloped, gouged or torn such that the structural integrity of the stabilizer fence around the stay cavity boundary may not be able to restrain the forces generated. During the mid-cycle outage and RF15 outage, one cold leg tube had what appeared to be a teardrop-shaped wear scar (approximately 1 1/2 inches long by 3/8 inch wide) on the intrados tube wall at or near the C103 tube. This wear scar had progressed, and is now about 25% through tube wear, with two strands of the stabilizer having visible wear. Figures 2a and 2b are of this wear. All tubes met the

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acceptance criteria of less than 33% through tube wear, and observed stabilizer wear was analyzed and confirmed to be acceptable with at least 30% of the stabilizer remaining at the end of the cycle 17.

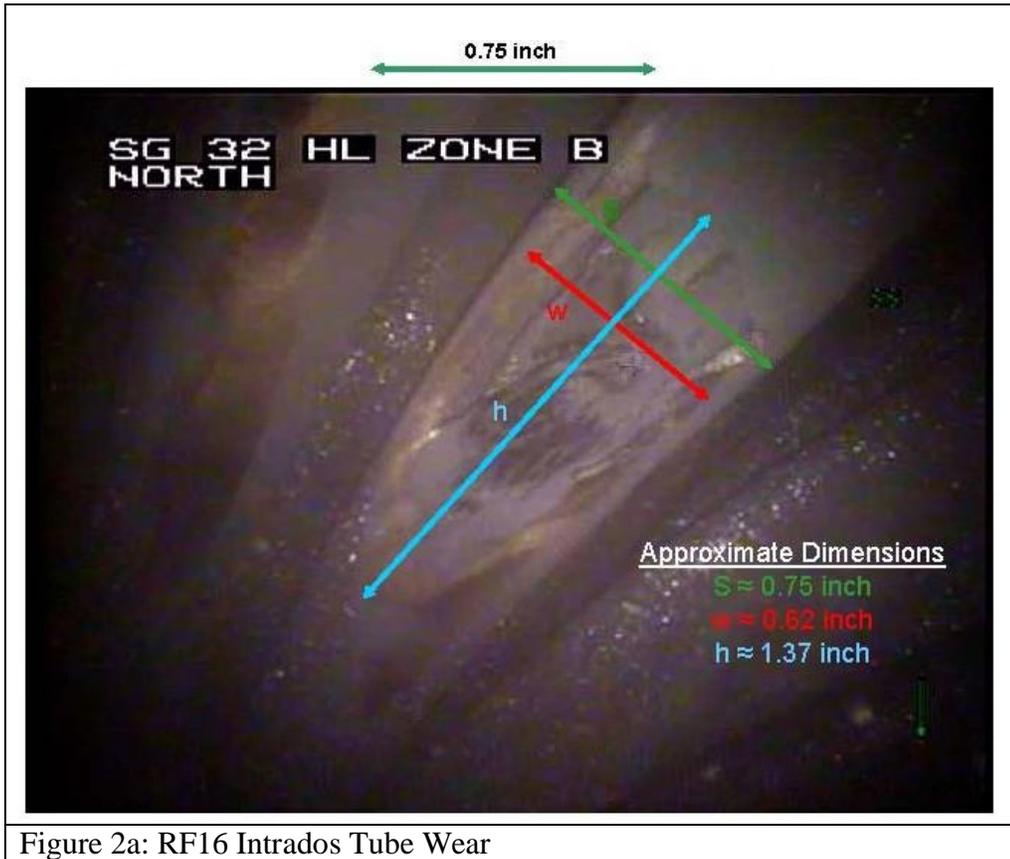


Figure 2a: RF16 Intrados Tube Wear

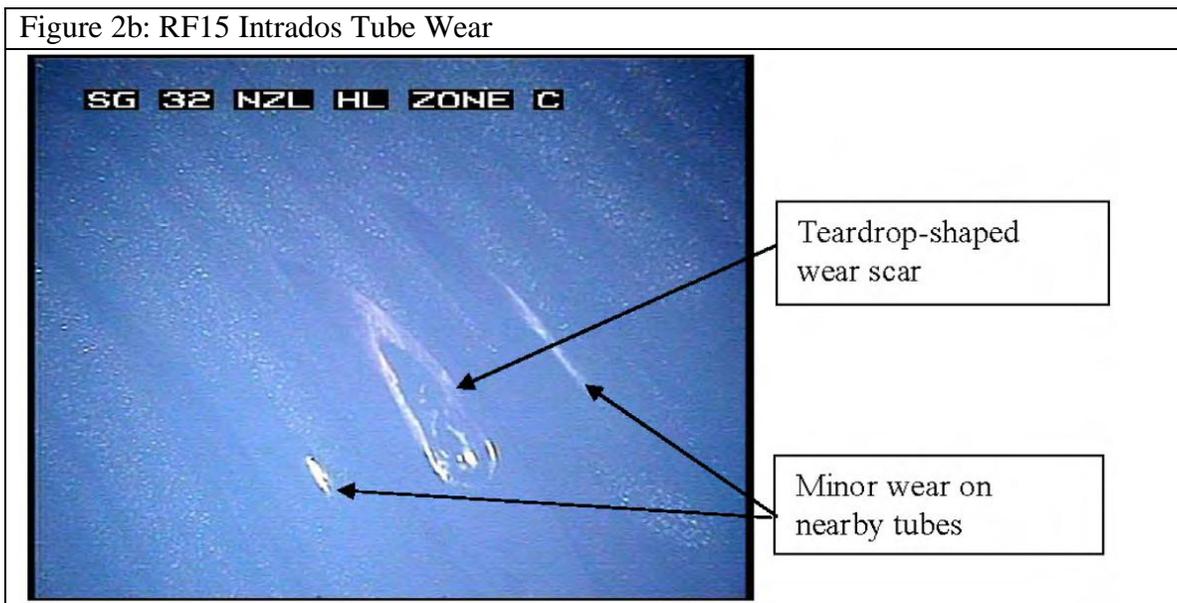


Figure 2b: RF15 Intrados Tube Wear

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Bottom-Up Video Inspection

- The bottom-up visual inspection of stay cavity region area of interest was performed. No gross tube deformation was indicated and no unexpected batwing degradation was found. 25 batwings were identified broken at center notch, 18 of which had separated half horizontal bar segments of about 6.5 inches in length versus 4 in RF15. Otherwise, the general batwing condition remained similar to the conditions previously observed in SG-2. 5 loose batwing segments were located. Previous analyses accept worst case wear from the loose batwing segments and all loose batwing segments met the acceptance criteria of less than 36". No other concerns were identified.
- The composite bottom-up video inspection was parsed and compiled to form a composite view. The composite view from RF16 and RF15 are provided as figures 3a and 3b, respectively.

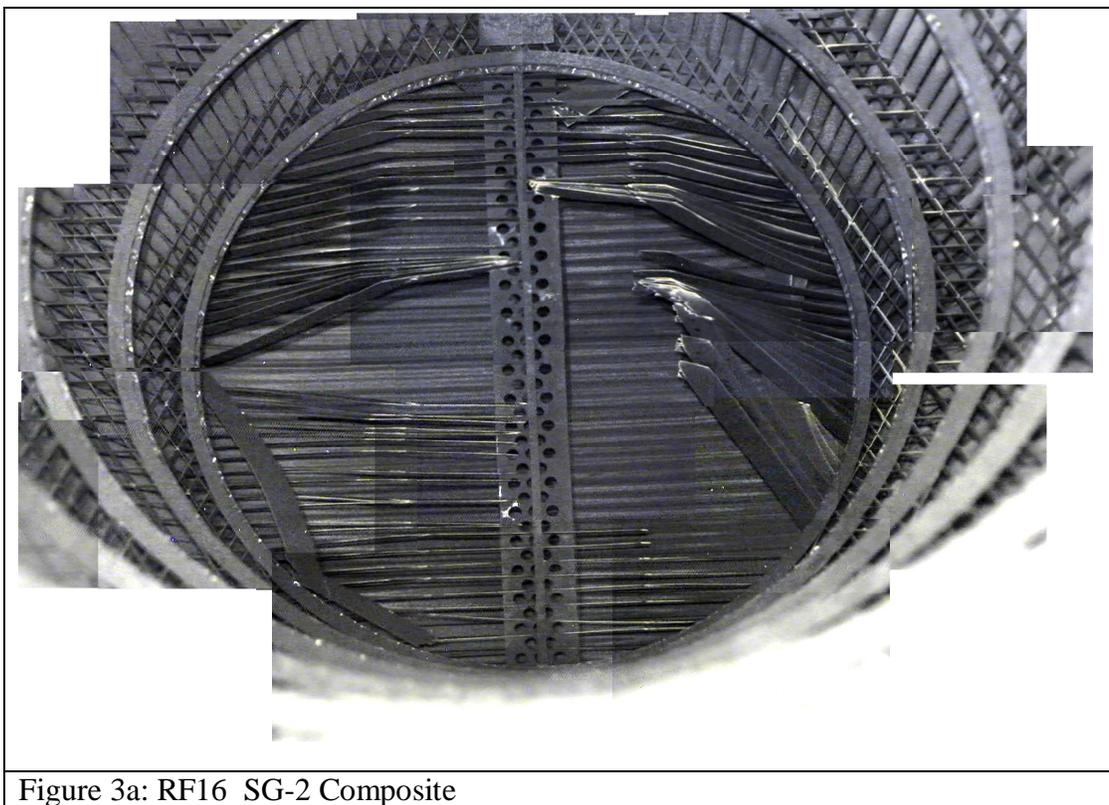


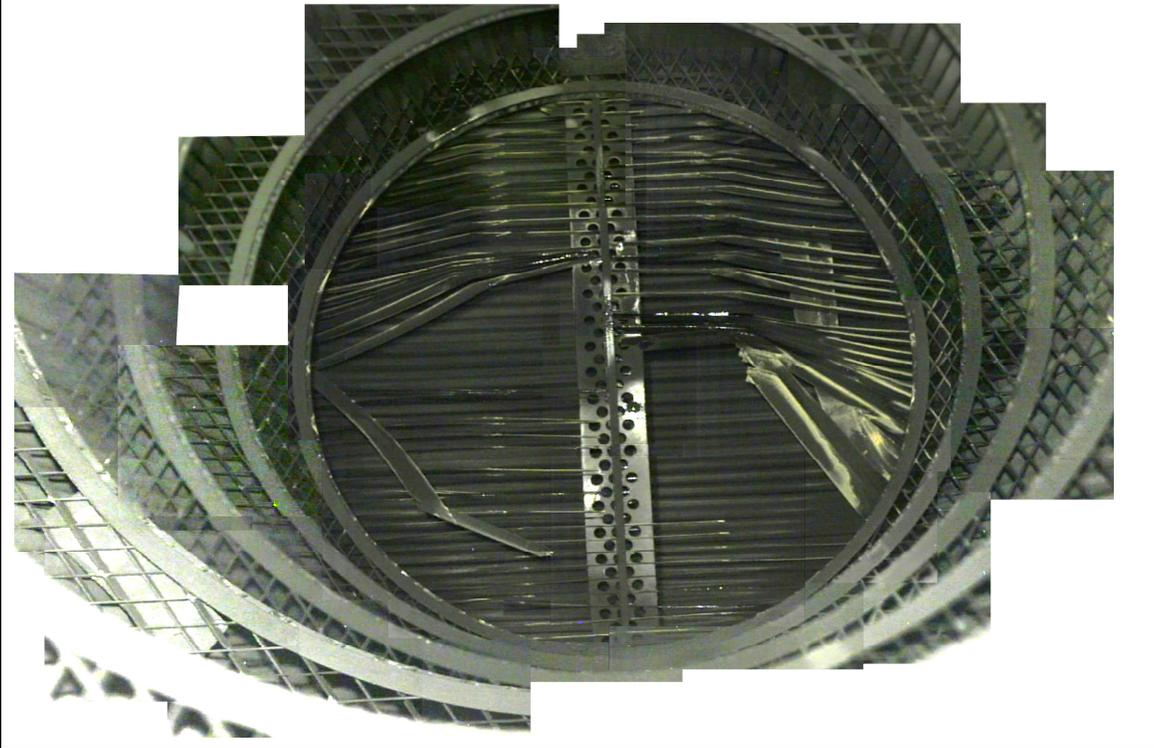
Figure 3a: RF16 SG-2 Composite

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Figure 3b: RF15 SG-2 Composite



Foreign Object Search and Retrieval Inspection

- The annulus between the tube bundle and shroud, blowdown lane, and blowdown dome area at the top of tubesheet were visually inspected for foreign objects. The foreign object search and retrieval inspection met the acceptance criteria with no batwing segments or accessible foreign objects found.