Entergy Meeting with NRC
Topic: Waterford 3 Batwings

March 22, 2007

Purpose

- Communicate our technical understanding of the Batwing condition
- Review analysis that support safe operation of the plant
- Review the mitigation actions that been taken
- Discuss preliminary plans for mid-cycle inspection

Agenda

1.	Introduction	Bob Murillo	8:00-8:05	(5)
2.	Current Status	Joe Kowalewski	8:05-8:15	(10)
3.	RF13 and RF14 RCA	Rex Putnam	8:15-8:40	(25)
4.	Eddy Current Results	Bill Cullen	8:40-9:05	(25)
5.	W3 and Ginna	Bill Cullen	9:05-9:30	(25)
	BREAK		*9:30-9:45*	*(15)*
6.	Batwing Analysis*	Jeff Hall	9:45-10:10	(25)
7.	Wrap-Around Bar Welds*	Jeff Hall	10:10-10:35	(25)
8.	Loose Part Considerations*	Jeff Hall	10:35-11:00	(25)
	BREAK		*11:00-11:05*	*(5)*
9.	Mid-Cycle Inspections	Rex Putnam	11:05-11:30	(25)
10.	Summary	Joe Kowalewski	11:30-11:35	(5)

* Presentation contains Proprietary information

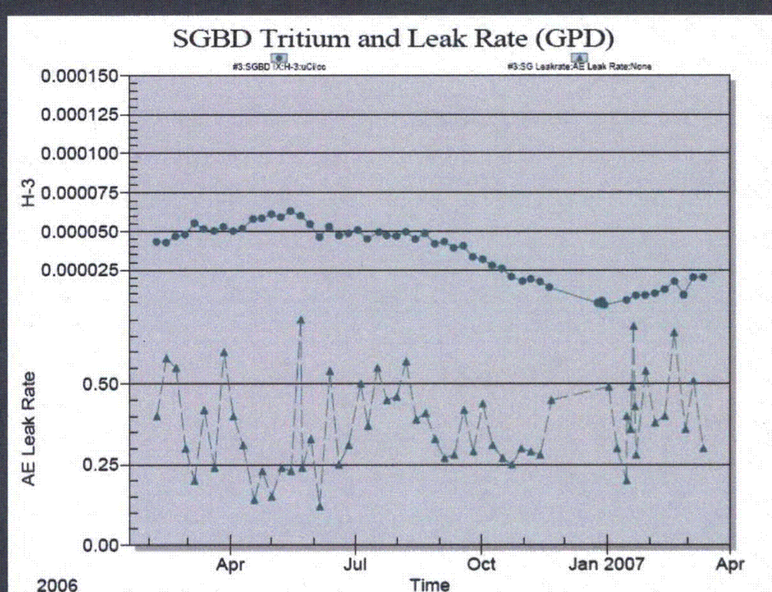
Current Status

Joe Kowalewski

GM Plant Operations, Waterford 3

Current Status

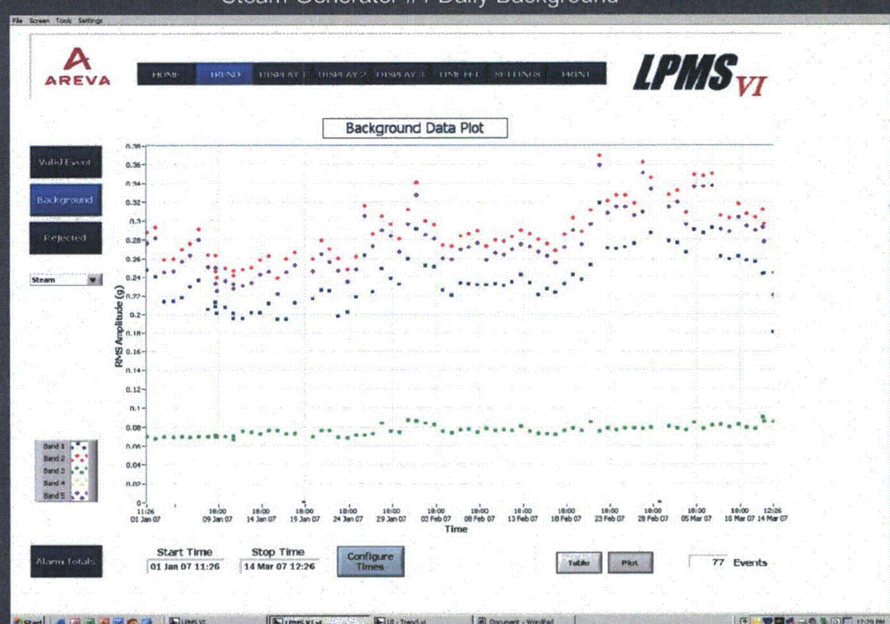
- Plant Performance since Startup
  - Tritium Grab Samples
  - Radio-isotopic analyses
- SG Loose Parts Monitor
  - Third sensor installed as a temporary change
  - No impacts or adverse trend identified
  - Startup transients

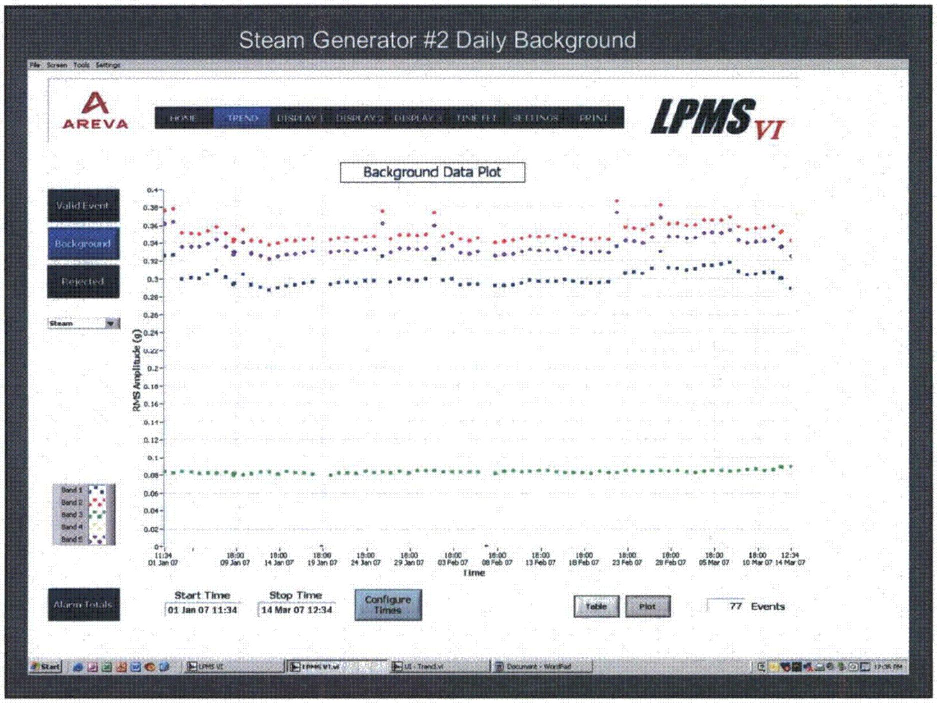


SG Loose Parts Monitor

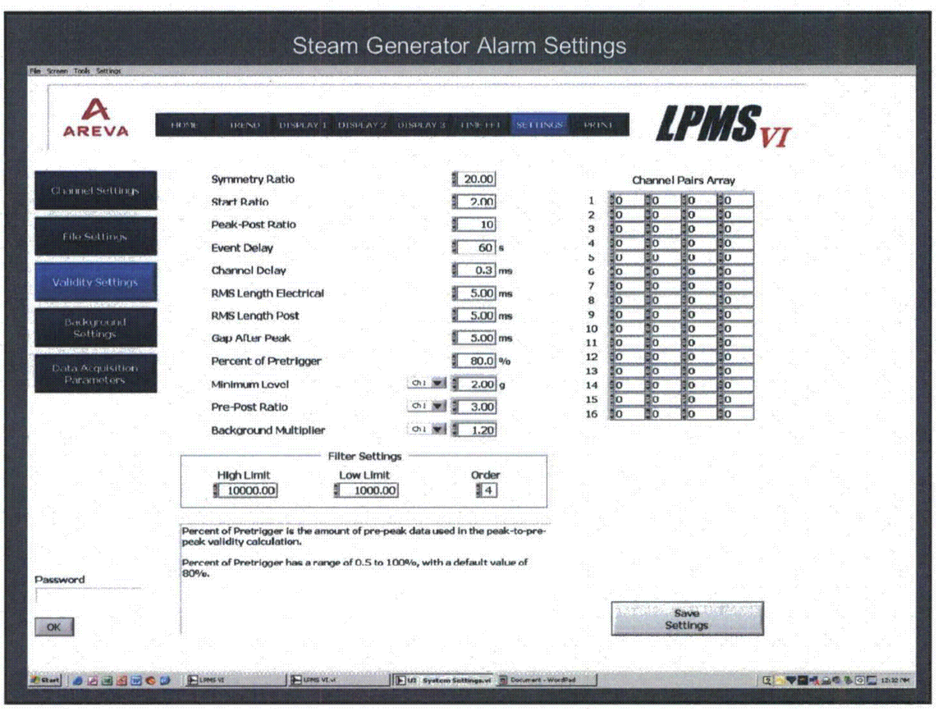
- Continuous monitoring of SG secondary for loose parts
  - Memory feature captures and saves impacts
  - Baseline is trended
- State-of-Art Monitor
  - Areva LPMS VI components
  - Sensors meets Reg. Guide 1.133
  - Sensitivity validated by calibrated hammer
  - 0.5 lbm impact should alarm
  - Slow rise in overall energy would also alarm

Steam Generator #1 Daily Background





Steam Generator #2 Daily Background
AREVA
HOME
TREND
DISPLAY 1
DISPLAY 2
DISPLAY 3
TIME FFT
SETTINGS
PRINT
LPMS VI
Background Data Plot
Valid Event
Background
Rejected
Steam
RMS Amplitude (g)
Time
Band 1
Band 2
Band 3
Band 4
Band 5
Alarm Totals
Start Time
01 Jan 07 11:34
Stop Time
14 Mar 07 12:34
Configure Times
Table
Plot
77 Events



Steam Generator Alarm Settings
AREVA
HOME
TREND
DISPLAY 1
DISPLAY 2
DISPLAY 3
TIME FFT
SETTINGS
PRINT
LPMS VI
Channel Settings
File Settings
Validity Settings
Background Settings
Data Acquisition Parameters
Symmetry Ratio 20.00
Start Ratio 2.00
Peak-Post Ratio 10
Event Delay 60 s
Channel Delay 0.3 ms
RMS Length Electrical 5.00 ms
RMS Length Post 5.00 ms
Gap After Peak 5.00 ms
Percent of Pretrigger 80.0 %
Minimum Level Ch1 2.00 g
Pre-Post Ratio Ch1 3.00
Background Multiplier Ch1 1.20
Filter Settings
High Limit 10000.00
Low Limit 1000.00
Order 4
Channel Pairs Array
Percent of Pretrigger is the amount of pre-peak data used in the peak-to-pre-peak validity calculation.
Percent of Pretrigger has a range of 0.5 to 100%, with a default value of 80%.
Password
OK
Save Settings

Batwing Commitment Status

- 12 of 15 Commitment have been closed.
- Open commitments include:
  - Provide SG Loose Part output in the Main Control Room - 8/1/07
  - Conduct a mid-Cycle 15 outage - 11/30/07
  - Perform augmented inspections - RF-15

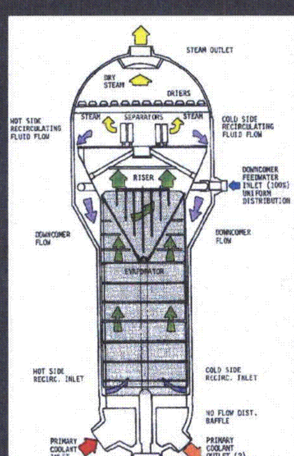
Summary

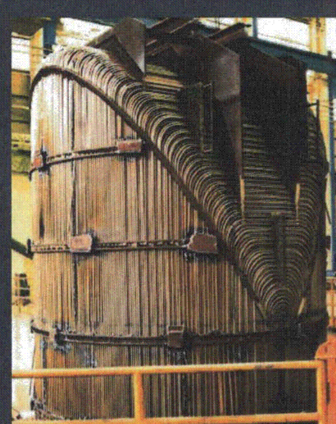
- Primary to secondary leakage has been steady
  - 0.4 gpd and consistent with previous cycle
- SG Loose parts monitor has not identified any metallic impacts
  - SG#2 has higher energy baseline, which is consistent with expectations given batwing damage
  - A small rise in baseline noise is indicated in both SGs, most likely due to feedwater
  - Higher scatter in SG#1 baseline is most likely due to sensor location closer to feedwater nozzle

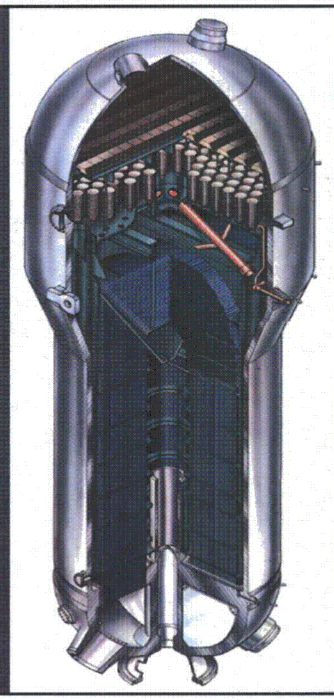
RF13 and RF14 BW Condition and Root Cause

Rex Putnam
Manager, Engineering Programs

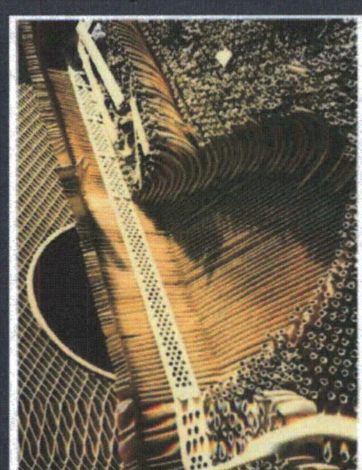
Steam Generator Overview



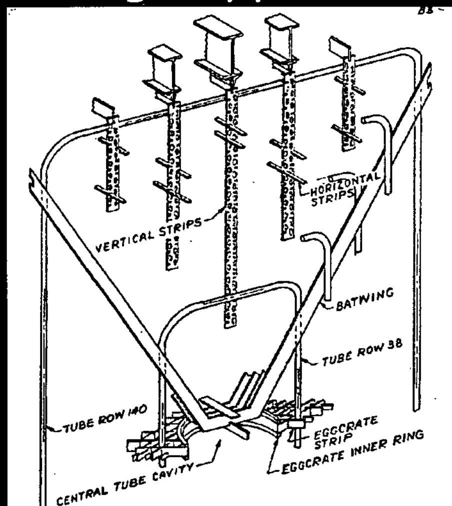




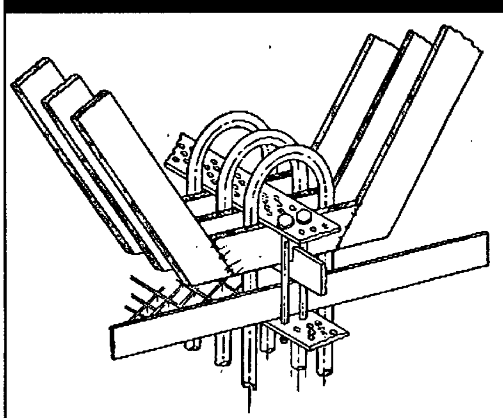
Stay Cavity Cross Section

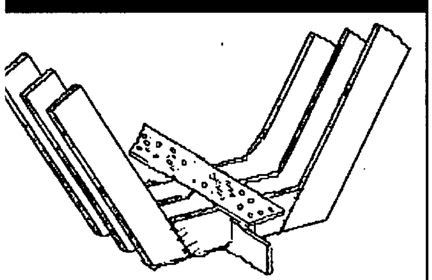


Batwing Support Structure



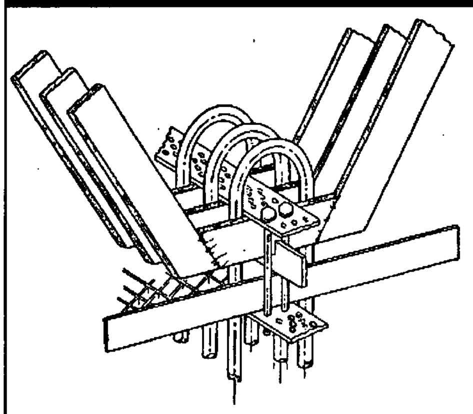
Batwing Support Structure



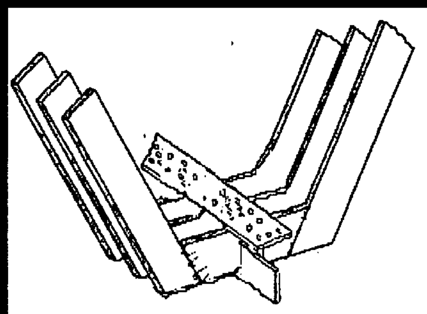


Batwing Support Structure

Outside Stay Cavity Area



Inside Stay Cavity Area



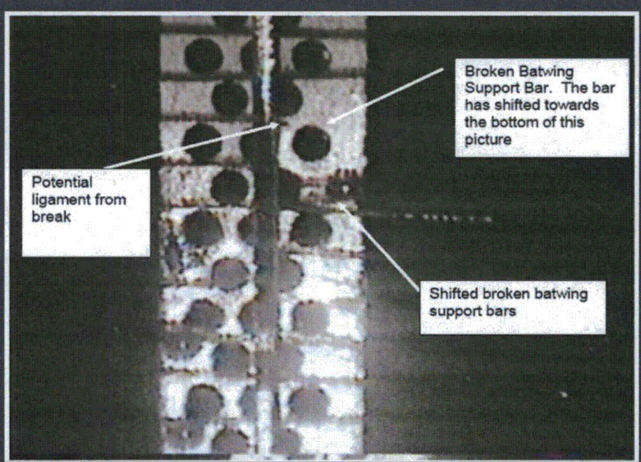
RF13 (4/05) Batwing Findings

- SG #2 batwing #9 shifted down
- Detected by eddy current signals
- Confirmed by visual inspection

RF13 Corrective Action Plan

- Displaced batwing was a new degradation mechanism
- Caused by fatigue failure at the batwing notch due to flow induced vibration
- Mitigated by a plugging and stabilization strategy
- Final corrective action was to accept the condition "As-Is"
  - Additional inspections were performed in RF14 to confirm analytical assumptions
  - Wear model was determined to be conservative

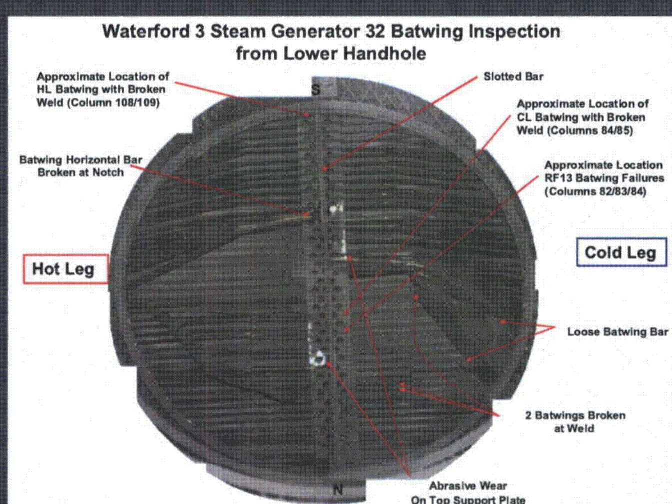
RF13 (4/05) SG#2 Visual Exam



RF14 (11/06) Batwing Findings

- SG#1 inspections found no batwing damage
- SG#2 inspections found additional batwing damage – all associated with the stay cavity
  - 18 additional batwings broke at the notch
  - 2 batwings also broke at the diagonal bar weld
  - 2 batwing to wrap-around bar welds broke
    - One of these had also broken at the batwing to slotted bar notch connection, the other had an intact notch
    - The batwing with both the broken (upper) weld and (lower) notch had dropped several inches into the tube bundle

RF14 SG#2 Visual Exam



RF14 Causal Determination for SG#2

- Different SG degradation mechanisms from RF13
  - Two loose segments, two broken wrap-around bar welds, and a batwing displaced into the tube bundle
- Batwings in the stay cavity area failed due to cyclic fatigue
  - Low margin in the design for the actual forces being applied
  - Susceptibility of batwings to FIV identified in 1984
    - W3 plugged and stabilized 142 tubes in each SG during Cycle 1
  - RF13 caused progressive damage on adjacent batwings
- Batwing wrap around bar welds failed due to being of poor quality and not meeting original design requirements
  - One of the welds that failed had an intact batwing notch at the slotted bar connection in the stay cavity area

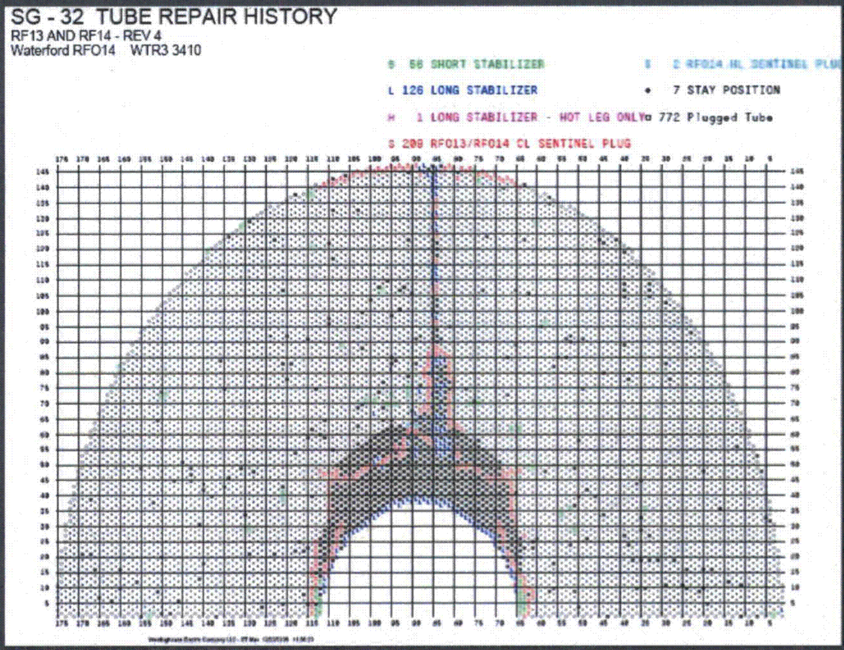
Mock-up Batwing Response

Final Corrective Action

- Batwing wrap around bar welds
  - Accessible welds in SG#2 were re-welded
  - The dropped batwing was mitigated by stabilizers and Sentinel plugs
  - One batwing in SG#1 had single sided welds and was mitigated by stabilizers and Sentinel plugs.
  - Additional Sentinel plugs installed at top of tube bundle and the eighth eggcrate for defense-in-depth
- Batwing degradation is stay cavity
  - Plugged to no-load contact force point (16.4 year wear point for limiting twisted batwing)
  - Mitigated by stabilizers and Sentinel plugs
  - Additional Sentinel plugs installed around the stay cavity as defense-in-depth measure

RF14 CA Plan (Continued)

- Defense in depth
  - Third loose parts transducer installed on SGs
  - Administrative limit of 15 gpd primary to secondary leakage
  - Mid-cycle outage to perform addition inspections to confirm assumptions
- Final corrective action - accept "as-is"
  - Administratively open pending permanent installation of the third transducer



Summary

- SG#2 batwing upper welds failed due to being poor quality, short, and single sided
- SG#2 Batwings in the stay cavity area were damaged due to FIV
- All damage was repaired or mitigated (plugs, stabilizers, and Sentinel plugs) in support of accepting "as-is"
- Robust defense in depth was established to protect active tubes by a combination of:
  - Sentinel plug strategy that bounds batwing degradation mechanism
  - Installation of a new SG Loose Parts Monitor
  - Additional administrative limits including 15 gpd secondary leakage
  - Mid-cycle inspections to confirm analysis assumptions

Eddy Current Results Summary: RF13 versus RF14

SG Overall Condition

Bill Cullen
Westinghouse

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Objective

- Compare observed eddy current wear depth results from RF13 (2005) and RF14 (2006) and wear growth rates to determine impact of operation with failed batwings
- Examine the nature of R67 C99 tube wear
- Establish a basis that ECT is not necessary for mid-cycle timeframe
- Provide general overview of SG condition for mechanisms other than batwings

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Historical Wear Growth Rates

Average Growth Rates								
Outage	SG	Overall Growth	Eggcrates	BW1	BW2-8	BW9	BW9 (non SC)	BW9 (SC)
RF12	31	0.60%	1.40%	2.20%	0.30%	2.40%	2.80%	2.30%
	32	1.70%	0.00%	0.60%	1.90%	2.80%	2.20%	3.10%
RF13	31	1.10%	3.10%	0.00%	0.80%	3.30%	0.00%	3.80%
	32	1.60%	1.40%	1.20%	1.70%	1.40%	3.20%	0.70%
RF14	31	0.00%	1.70%	0.00%	0.00%	0.00%	1.00%	0.00%
	32	0.00%	0.00%	0.00%	0.00%	2.50%	2.40%	2.60%

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Historical Wear Growth Rates

Maximum Growth Rates								
Outage	SG	Overall Growth	Eggcrates	BW1	BW2-8	BW9	BW9 (non SC)	BW9 (SC)
RF12	31	13%	7%	12%	13%	13%	11%	13%
	32	10%	9%	9%	10%	10%	6%	10%
RF13	31	20%	11%	8%	16%	20%	8%	20%
	32	22%	13%	22%	17%	20%	17%	20%
RF14	31	13%	10%	8%	13%	13%	2%	13%
	32	23%	3%	4%	8%	23%	23%	16%

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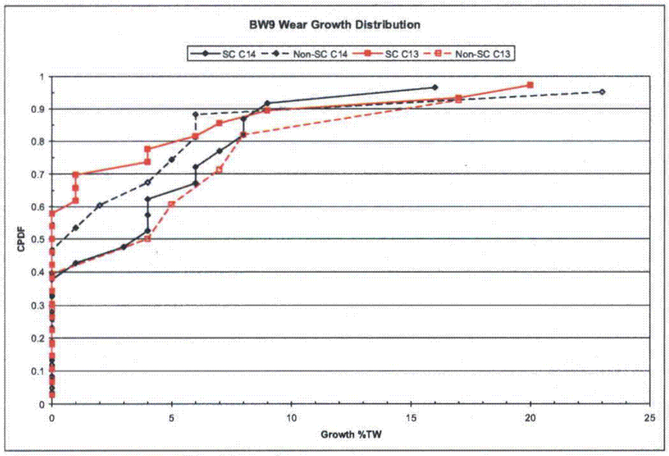
Comparison of BW9 Growth Distributions: RF13 vs RF14



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SG32 Growth Rate Summary

- Slight increase in growth rates observed for Cycle 13 compared to Cycle 12; slight decrease in growth rates observed for Cycle 14 compared to Cycle 13
- Cycle 14 operation at EPU appears to have had no influence upon growth rates
- Largest growth for Cycle 14 (23%) observed on R3 C1 at BW9; Cycle 13 growth was 17%. Location was stabilized and plugged RF14 (55%TW)
- RPC testing of R3 C1 shows batwing not dropped, wear at edge (horizontal bar) and tapered

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Dropped Batwing Wear

- At RF14, five tubes adjacent to original failed batwings were deplugged; no new or additional wear with batwing in dropped elevation
- All stay cavity tubes out to Row 70 were RPC tested at BW9 location to determine if non-detected wear (bobbin) was present by RPC inspection
- No conclusive evidence of wear in dropped elevation was found
- Largest stay cavity wear growth for Cycle 14 was 16% (R67C99) and occurred prior to batwing drop

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SG32 R67 C99 at BW9

- The attenuation model does not include localized alignment/fitup conditions
- Tube vibration alone can be a source of wear
- No other tubes in the vicinity of R67 C99 have wear scars; RF13 experience showed "strings" of wear scars over multiple rows in columns 82, 83, and 84
- Conclusion: Wear on R67 C99 is due to localized alignment/fitup and is not related to failed batwing

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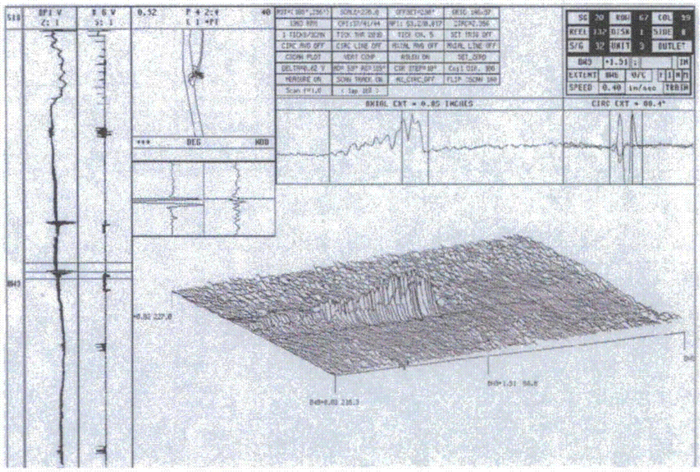
R67 C99 Wear Profile



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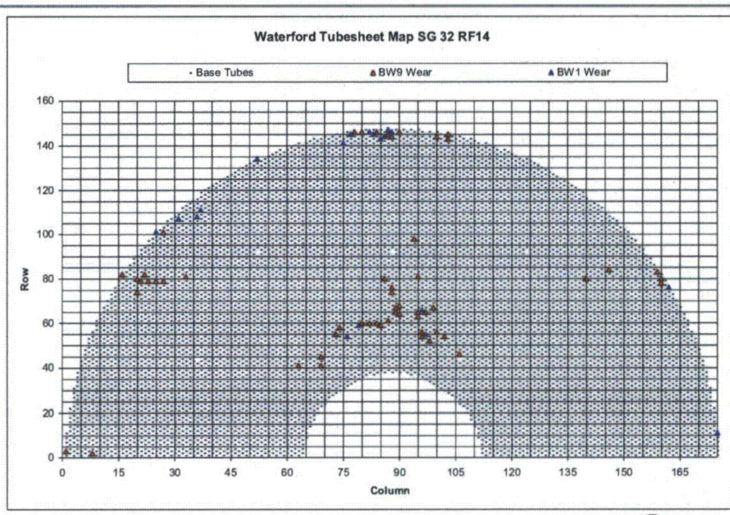
SG32 Wear Map: BW1 and BW9



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Wear Observations

- BW9 wear is primarily located near center area of stay cavity, at peripheral regions and near edge of partial eggcrates and not generally throughout SG
- R67 C99 wear and growth is isolated and not related to batwing in its dropped condition
- Only RF14 wear depth >40%TW was outside of stay cavity (R3 C1)

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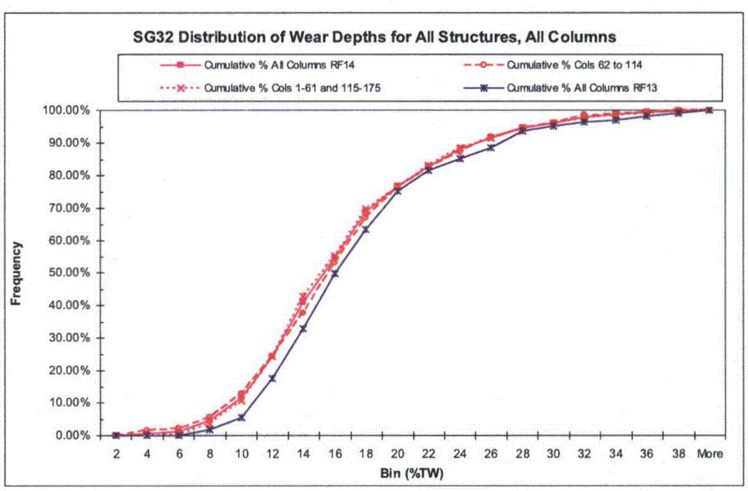
SG32 Distribution of Wear Depths



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Conclusions Regarding Observed Wear

- Distribution of wear depths from stay cavity (Row 62 to 114) are identical to non-stay cavity locations and overall SG distribution
- Scuff marks on perforated plate suggest Cycle 14 batwing failures occurred during operation
- Deplugged tubes show no new wear (1+ cycles)
- Strong basis to anticipate RF15 wear will be consistent with past observations, supporting conclusion that mid-cycle ECT is not necessary
- RF15 maximum simulated wear depth 48%TW

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Overall SG Condition

- 18.12 EFPY at RF14; Plugging due to ECT indications; SG31 5.54%, SG32 3.10%, very low SGTP for 18.12 EFPY
- Majority of ECT based plugging due to eggcrate axial ODSCC; no required ISPT, deepest eggcrate ODSCC depth of about 60%TW; 180 to 220 confirmed eggcrate ODSC predicted for RF15
- Distribution of eggcrate ODSCC lengths and +Pt amplitudes consistent for last 3 inspections
- Cycle 15 OA predicts margins for all mechanisms

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Summary of Overall SG Condition

- Historical wear growth rates have not been adversely impacted by EPU or the observed batwing damage
- R67 C99 tube wear was caused by localized batwing alignment/fitup and not the dropped batwing
- Batwing related tube wear is consistent between stay cavity area and non-stay cavity areas, indicating no systemic wear related differentiation
- Based on empirical wear growth rates and wear simulation model, mid-cycle eddy current inspection is not necessary
- SCC mechanisms are predictable
- Cycle 15 OA predicts margins for all mechanisms

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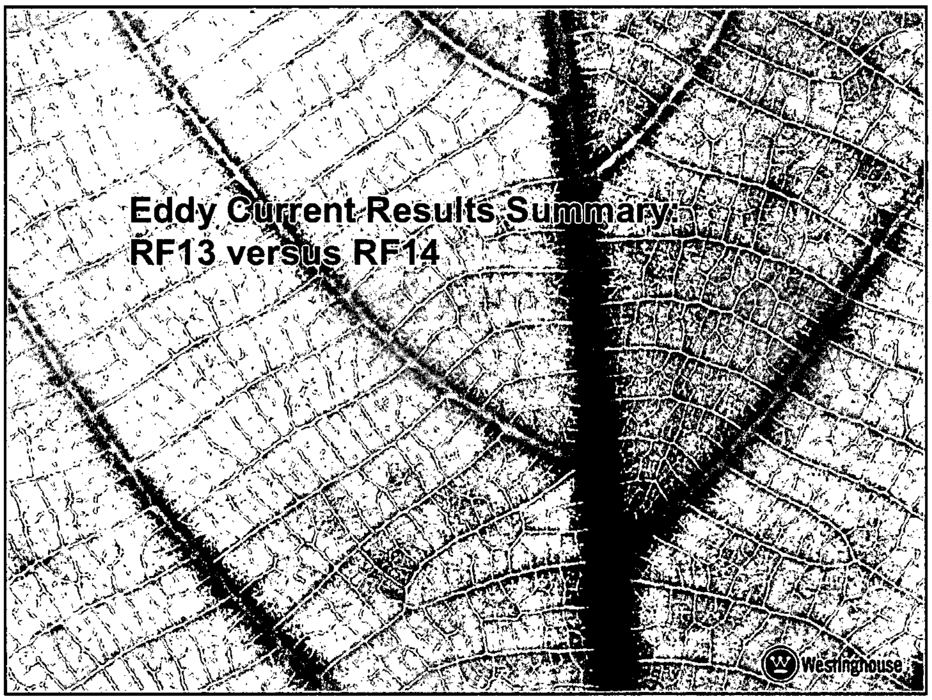

Comparison of Waterford Upper Bundle Region and Ginna Event with Regard to Plugged Tube Damage Potential

Bill Cullen
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Objective

- Recap of Ginna significant contributing events and show differences for Waterford condition
- Compare flow conditions for the two plants to show that normal flow velocity conditions for peripheral TTS and central cavity are not similar
- Review historic burst and collapse testing
- Establish that a cascading tube damage event is not a credible event for a C-E SG in upper bundle region

Ginna Recap

- The 1982 Ginna tube rupture event scenario is not directly relatable to Waterford
  - Repeated large mass foreign object impacts over extended axial lengths causing localized, high residual stresses and imbalanced tube loadings leading to fatigue at TTS with subsequent cascading damage
  - Initial object impact could cause significant damage thus acting as an initiator for the fatigue event
  - Peripheral TTS region is subject to thermal growth effects and tubesheet rotations introducing bending stresses not present at upper bundle region

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Ginna Recap

- Objects were remnants of J-nozzle replacement in 1975 (up to 1/2" thick x 6 x 4 inches)
- Tube plugging in vicinity of rupture as early as 1976; ruptured tube had ECT indications in 4/1981 inspection, rupture occurred 2/1982, thus not a rapidly propagating event

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Comparison of Conditions

- Waterford wear scar length is limited to a maximum of 4 inches, does not involve repeated impacts by large objects, and does not involve change in material properties which in turn result in imbalanced loadings
- Flow conditions and densities are not consistent
  - ρV^2 comparison shows greatly reduced tube excitation potential for Waterford
- Tube stiffness and unsupported lengths are not consistent

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Comparison of ρV^2

	Temp	Normal Velocity	Fluid Condition	ρV^2 Ratio
Top of Tubesheet	440F	10-12 ft/sec	Liquid	N/A
R38 C88 BW9	540F	2.66 ft/sec	Two phase	28.3
R38 C88 BW5	540F	10.72 ft/sec	Two phase	2.4
R34 C98 BW9	540F	0.94 ft/sec	Two phase	285
R34 C98 BW5	540F	11.47 ft/sec	Two phase	2.6
R24 C106 BW1	540F	1.96 ft/sec	Two phase	231
R24 C106 BW5	540F	12.29 ft/sec	Two phase	3.4

Crossflow velocities, and thus, normally oriented ρV^2 terms decay quickly once inside tube bundle

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Tube Support Differences

- Ginna: 50 inch cantilever length from 1st TSP to TTS, minimum tube to tube gap of 0.4 inch
- Waterford: Row 38: 24.8 inches from 07EC to batwing intersection, 0.25 inch tube to tube gap
- After 2 chemical cleanings, unlikely that tubes are fixed, postulated free end not likely to be excited like a cantilever beam
- Maximum free end displacement of 0.23 inch for lattice configuration

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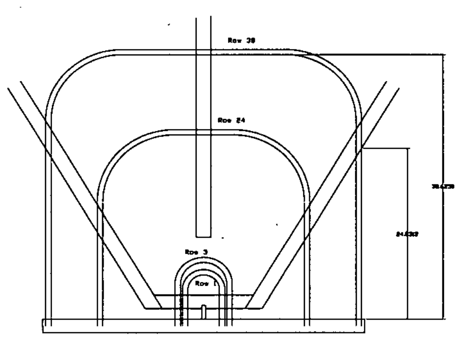
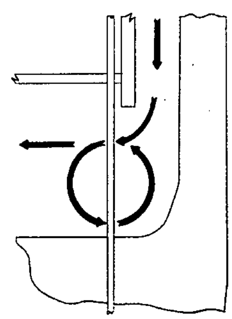
Tube Support Differences





Failed batwings expected to channel more flow vertically due to reduced restriction (open spaces)

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Historic Burst/Leakage Testing

- 75%TW, tapered wear scars, burst pressures of 5000 to 7200 psi at 650F (0.048 wall tubing)
  - "Burst" was a localized opening, no tearing of base metal
- 100%TW tapered wear scars used for leakage testing at 1350, 1750, and 1300 psid, sequentially
  - 1300 psid leak rates (following 1750 psid) returned to near the 1350 psid rates
  - Little or no gross deformation during pressure differential increase

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Historic Collapse Testing

- 90%TW, tapered wear scars, 2500-2525 psi collapse pressures (0.042 wall tubing)
- Limiting Waterford sec-pri differential = 980 psi
- Collapse occurred over about a 10 second period
- Collapse was localized to wear scar only

Conclusion: Tapered wear scars do not represent a burst or collapse potential

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Collapse Testing (2007)

- Bounding wear scar shapes at limited secondary to primary pressure differential (980 psi)
- 4 inch long, uniformly deep wear scars
  - Localized collapse at 85%TW; wear scar "creased", tube mostly retained its shape
  - Limited change in cross section to flow
  - No anticipated change in axial load bearing capability due to large remaining wall thickness
- Control samples using 1.5 degree wear tapers still to be tested

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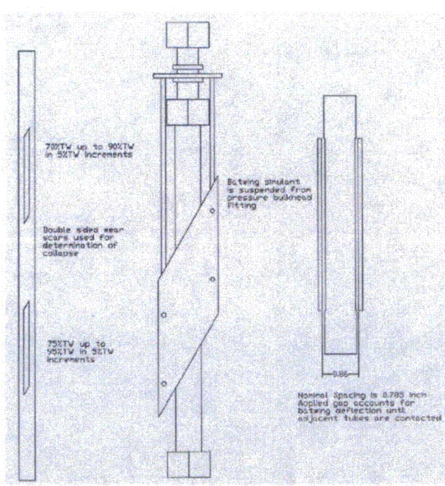
Test Configuration



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2007 Collapse Test

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Summary

- Event details surrounding Ginna event are not a direct comparison with a wear only scenario
- ρV^2 comparison is a minimum of about 30 times less for batwing/tube intersection compared to TTS; flow is mainly axially oriented in central cavity
- Large prying forces are not realistic for a worn/thinned batwing due to inherent weak point associated with wear on batwing; batwing would likely fail in fatigue at first tube in a large amplitude mode due to preexisting wear

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Summary (cont'd)

- At RF14 and RF13, in Columns 50 to 126 and Rows less than 90, no tubes reported with wear at 07C/H through 10C/H, thus no significant crossflow velocities in this area
- Half of BW1-BW9 wear is at BW5; vertically oriented flow
- Maximum free end displacement of 25 inch tube extension is 0.23 inch, or less than tube to tube gap of 0.25 inch
- Extreme wear scars do not cause complete tube collapse
- A "cascading tube damage event" within the original preventive plugging region is not a credible event for mainly axially oriented flow

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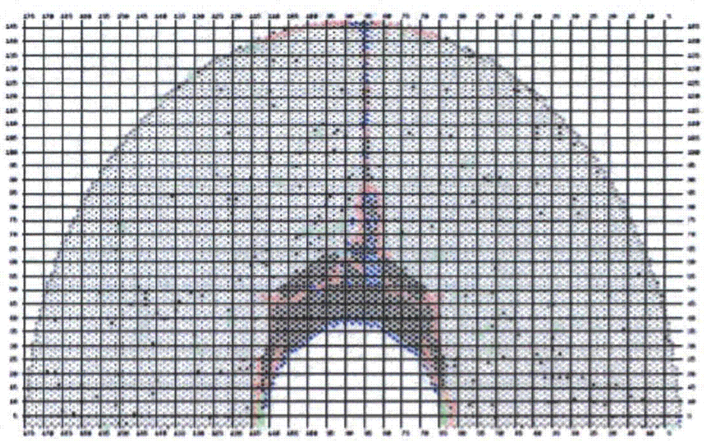
Preventive Plugging Map



08 Partial EC provides additional support starting at Row 49

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Comparison of Waterford Upper Bundle Region and Ginna Event with Regard to Plugged Tube Damage Potential

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Mid-Cycle Inspection Scope

Rex Putnam
Manager, Engineering Programs W3

Entergy

Mid-Cycle Inspection Presentation Objectives

- Review purpose of mid-cycle outage inspections
- Review scoping decision for removing degraded batwings
- Review key assumptions of critical analyses
- Identify needed mid-cycle inspections needed to verify assumptions are conservative

Inspection Purpose

- Purpose Of Mid-Cycle Inspection
  - Obtain data to consider removing degraded batwings in a future outage
  - Monitor progress of batwing degradation mechanisms
  - Assure conservatism of critical analyses and key assumptions
  - Verify acceptability of current configuration

Batwing Removal

Tooling Concepts Considered

Technology Type	Reliability	Maintainability	Control of Byproduct	Geometry
Wire EDM	[illegible]	[illegible]	[illegible]	[illegible]
Abrasive Wire Cutting	[illegible]	[illegible]	[illegible]	[illegible]
Abrasive Water Jet	[illegible]	[illegible]	[illegible]	[illegible]
Band Saw	[illegible]	[illegible]	[illegible]	[illegible]

- Multiple concepts considered
- "Pros/Cons" matrix used to evaluate tooling options
- Abrasive Wire Cutting (Diamond Wire) was optimal

Batwing Removal

- Tooling required a new access hole along the tube lane
- Stay Rod is located in the tube lane
  - Tooling to cut and remove stay rod
  - Must capture by-products of cutting
- Significant technical issues and first of a kind evolution
  - Risk of additional SG damage
- Decision to not implement during mid-cycle outage
  - Existing analysis and plugging/stabilization is acceptable
  - Degraded batwing removal may be considered at a future outage

Key Analysis Assumptions

- Actual eddy current results were used to establish wear growth rates, dropped batwing wear, and wear distribution.
- Cyclesim was used to establish largest expected RF15 wear depths. Cycle 15 Operational Assessment predicts margins for all mechanisms
  - Assumption - no additional batwings have slipped into the tube bundle
  - Inspection - visual exam to verify no upper weld failures for batwings in stay cavity area

Key Analysis Assumptions

- Ginna tube rupture event analysis involved the repeated impacts of a large mass foreign object over several years. Batwing degradation mechanisms do not result in large mass foreign objects
  - Assumption - no large mass foreign objects
  - Inspection – foreign object search and retrieval

Key Analysis Assumptions

- Attenuation Force analysis determined the depth batwing forces can attenuate into the tube bundle
  - Assumption – twisted batwing forces can result in minor tube spreading that would not be expected to allow penetration of a loose batwing segment
  - Inspection – foreign object search and retrieval and visual inspection of stay cavity area for indications of gross tube deformation

Key Analysis Assumptions

- Batwing wrap around bar weld analysis determined the repaired weld is not limiting
  - Assumption – clips remain affixed, weld repair was of appropriate quality and that sufficiently random moments would be applied by degraded batwings such that the wrap around bar would not twist
  - Inspection – visual exam to verify no upper weld failures for batwings in stay cavity area and no gross deformation twisting of wrap around bar
- Non-Stay Cavity area batwings have much lower loads (notch failure is not expected) and would remain captured in an acceptable configuration should failure occur. Thus, no inspections are required.

Key Analysis Assumptions

- Broken batwing analyses evaluated acceptability of tube impacts and wear, including normal and accident condition
  - Assumption – maximum weight/size of broken batwing
  - Inspection – visual exam to verify no large batwing segments are formed in stay cavity area and to remove any segments that can be accessed

Expected Batwing Condition

- SG#1
  - Upper batwing welds should be intact.
  - Stay cavity damage is not expected, but may be observed.
  - Should a batwing break at the notch connection, a progressive mechanism would be expected and damage similar to that observed in SG#2 could result.
- SG#2
  - Upper batwing welds/clips and wrap around bar should be intact.
  - Stay cavity batwing damage is expected to propagate since the degradation mechanisms have not been arrested.
  - No indications of gross tube deformation or large batwing segments are expected.
  - Additional Batwing related loose segments may be found

Secondary Inspection Scope

- Secondary visual exam of upper batwings
  - verify no upper batwing weld/clip failures in stay cavity area
  - verify no gross deformation twisting of wrap around bar
- Foreign object search and retrieval
  - to verify no large mass foreign objects are present
  - to remove accessible foreign objects
- Secondary visual inspection of lower stay cavity area
  - to monitor batwing degradation
  - to verify no indications of gross tube deformation
  - to verify that no large batwing segments have formed in stay cavity area and remove segments that may be accessible

Primary Inspection Scope

- Attenuated wear model was verified to be conservative in RF14
- Non-stay cavity batwings are not expected to fail
  - Robust support structure
  - Low flow forces applied
  - Failed non-stay cavity batwings would remain captured
- Cyclesim and Cycle 15 OA shows margin for all tube degradation mechanisms
- Mid-cycle primary side inspection is not indicated. Depending on what we find in secondary, a primary side inspection may be required. We will be ready for a primary side inspection, if needed.

Summary

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Summary

- Robust engineering analyses and expertise have developed clear understanding of Batwing condition
- Compelling defense in depth accounts for uncertainties and continued safe operation is assured
- Planned mid-cycle inspections provide additional conservatism