PRELIMINARY – DETAILED ANALYSES STILL IN PROGRESS

Duke Power.
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B&WOG/NRC Meeting
BAW-2374 Rev 2

Eric Henshaw

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Lynchburg VA

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Oconee Nuclear Station

- Current Status
  - Unit 1 replaced SGs in Fall 2003
  - Unit 2 replaced SGs in Spring 2004
  - Unit 3 replaced SGs in Fall 2004
  - Original OTSGs no longer in service
  - Replacement OTSGs have Inconel-690 tubes
  - Replacement OTSGs are analyzed for the LBLOCA transient described in Appendix A of BAW-2374 Revision 0

Oconee ROTSG Tube Stress

- Summary of Oconee ROTSG Stress Analysis
  - FANP generated thermal stress inputs for LBLOCA & SBLOCA transients
  - Duke Power generated thermal stress inputs for MSLB
  - BWC used inputs to define acceptable tube flaw sizes for all 3 events
  - Acceptable results obtained to enable tube surveillance to be performed.
    - LBLOCA = 38% TW for 360 uniform part through wall crack
    - SBLOCA = 56% TW for 360 uniform part through wall crack
    - MSLB = 56% TW for 360 uniform part through wall crack

Oconee ROTSG Tube Stress

- Summary of Oconee ROTSG Stress Analysis (cont'd)
  - LBLOCA transient analyzed is a large hot leg break
    - Maximum tube-to-shell ΔT = -374 degF
  - SBLOCA transient analyzed is a pressurizer surge line break
    - Maximum tube-to-shell ΔT = -248 degF

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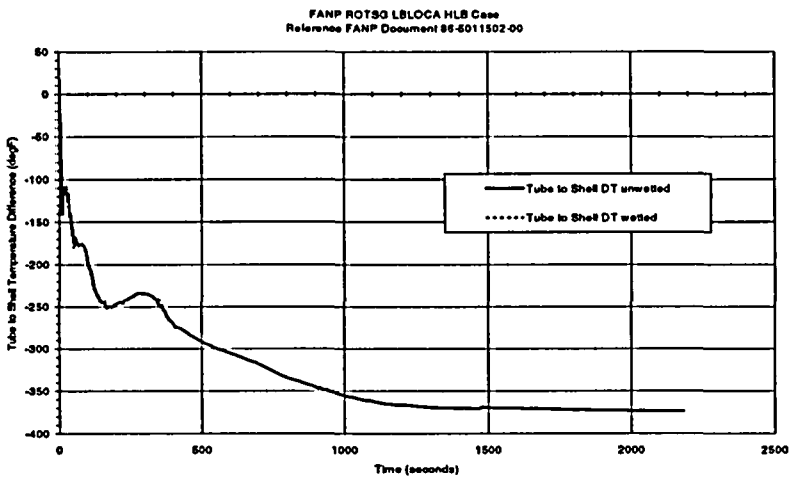
Oconee ROTSG LBLOCA



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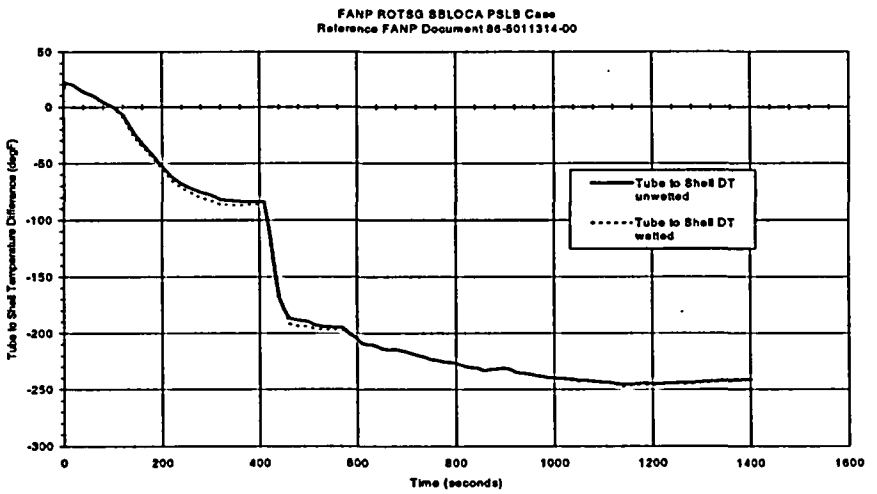
Oconee ROTSG SBLOCA



Duke Oconee Tube Stress

- Duke Analysis of LBLOCA Tube Stress
  - The analysis performed parallels that performed by FANP for BAW-2374
  - Cases performed for Replacement OTSGs
  - Base cases performed to evaluate limiting tube-to-shell temperature difference (aka tube stress)
  - Sensitivity cases performed to assess
    - Variation of tube stress with break area
    - Variation of tube stress with break location
    - Variation of tube stress with BWST temperature
    - Variation of tube stress with decay heat assumption

Duke Oconee Tube Stress

- Duke Analysis of LBLOCA Tube Stress (cont'd)
  - Analysis designed to support NPSH evaluation, candidate single failures to maximize postulated tube leakage
    - RBS pump
    - RBCU
    - LPI suction valve from RBES
  - Initial QA review is not complete
  - Final cases remain to be performed

Duke Oconee Tube Stress

- Break Spectrum Case Description
  - Maximum LPI performance – passive cross-connect
  - Maximum HPI performance
  - Minimum EFW flow
  - Minimum RBS flow
  - AFIS actuation modeled to limit EFW flow
  - Rapid MFW coastdown
  - BWST temperature = 45 °F
  - EFW temperature = 130 °F
  - BOC decay heat (4 EFPD for 480 EFPD core)
  - Operator action to secure HPI at 15 ft BWST level

Duke Oconee Tube Stress

- Duke LBLOCA Tube Stress Analysis Status
  - Break Spectrum – uses consistent set of assumptions to evaluate variation of tube-to-shell ΔT with break area. Break located at the top of the hot leg
  - Maximum Tube-to-shell ΔT preliminary break spectrum results
    - 14.1 ft^2 = -238 °F
    - 5.0 ft^2 = -230 °F
    - 2.0 ft^2 = -250 °F
    - 1.5 ft^2 = -245 °F
    - 1.0 ft^2 = -260 °F (limiting case)
    - 0.5 ft^2 = -257 °F
    - 0.3 ft^2 = -245 °F

Duke Oconee Tube Stress

- Duke LBLOCA Tube Stress Analysis Status
  - Sensitivity case maximum tube-to-shell ΔT preliminary results, all assume break area = 1.0 ft²
    - Break spectrum case = -260 °F
    - Break location = -246 °F (SG inlet nozzle)
    - EOC decay heat = -244 °F (480 EFPD)
    - BWST temperature = -251 °F (70°F)
  - NPSH case to maximize RB sump temperature (70°F BWST, EOC decay heat)
    - maximum tube-to-shell ΔT = -248 °F (preliminary)

Duke Oconee Tube Stress

- Limiting Break Spectrum Case (1.0 ft² case)

Sequence of Events

0.0 sec	Break initiation
0.0 sec	Turbine Trip
0.0 sec	Main Feedwater trip
28 sec	ECCS actuation (HPI/LPI pumps start)
69 sec	EFW flow to SGs begins
100 sec	RBS flow starts
187 sec	AFIS actuation on SG A terminates EFW to Loop A
~ 200 sec	Loop A main feedwater line starts to flash
528 sec	AFIS actuation on SG B terminates EFW to Loop B

Duke Oconee Tube Stress

- 1.0 ft^2 case Sequence of Events (cont'd)

~ 530 sec	Loop B main feedwater line starts to flash
~ 1460 sec	Loop A SG pressure drops below Patm
2495 sec	HPI pumps secured on 15 ft BWST level
~ 3280 sec	Maximum tube-to-shell ΔT occurs
3301 sec	End of simulation
	BWST level = 6 feet, beginning of sump recirculation

Duke Oconee Tube Stress

- Oconee RELAP5 Model Description
  - Based upon RELAP5 model described in DPC-NE-3003-PA, Oconee Containment Response Methodology
  - Uses RELAP5/MOD2-B&W Version 13 (per licensed method)
  - Renodalized SG upper & lower downcomers
    - Defined fluid nodes based upon shell thickness
    - Increased number of nodes
  - Added detailed steam line nodalization
  - Added detailed main feedwater line nodalization

Duke Oconee Tube Stress

- Differences between FANP & Duke Calculations
  - Primary difference is secondary side liquid level assumed
    - Duke water level higher than FANP
  - Duke analysis assumes
    - Bounding high downcomer orifice plate flow area
    - Conservative main feedwater coastdown
    - Error adjusted control setpoints
    - Minimum EFW performance
    - AFIS actuation
    - Account for main feedwater piping volume from SG to control valve (minimum pipe length utilized)
  - Oconee specific boundary conditions for ECCS

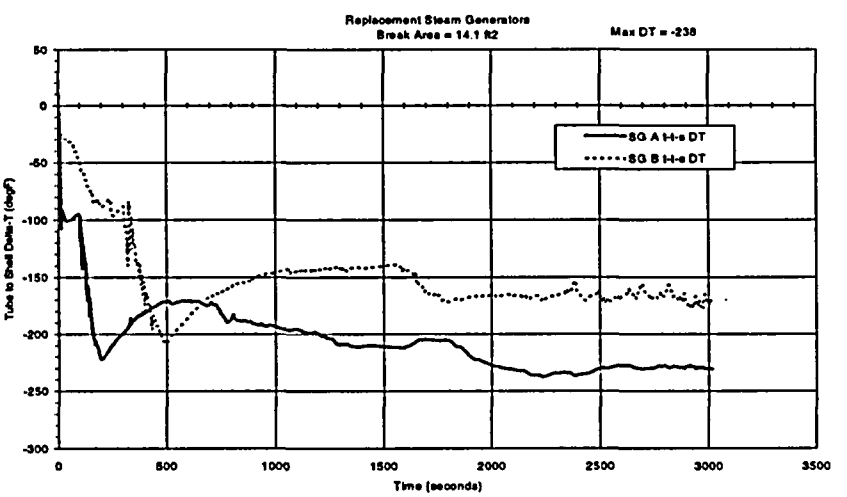
Duke Oconee Tube Stress

- Conclusions of Analysis
  - Tube stress is not sufficient to cause tube failure in the replacement OTSGs
  - Results expected to produce loads well within the current tube surveillance criteria
  - Therefore, no need to perform:
    - Postulated BAW-2374 tube failure cases
    - Associated NPSH evaluations
    - Additional dose analyses

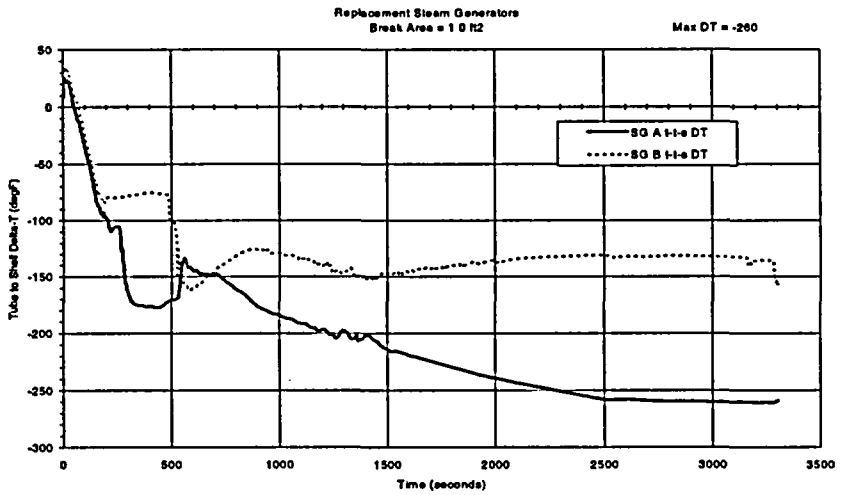
Duke Oconee Tube Stress

- Duke LBLOCA Tube Stress Analysis – Future
  - Limiting case for defining tube stress to be performed
    - Limiting break area from break spectrum
    - Need to consider single failure to eliminate EFW to faulted SG
  - Tube stress inputs from final case to be transmitted to BWC for incorporation into revised tube surveillance criteria
  - When the analyses have been completed, Duke will prepare a submittal based upon BAW-2374 Revision 1 to address this issue for Oconee.

Oconee ROTSG Result (14.1 ft2)



Oconee ROTSG Result (1.0 ft2)



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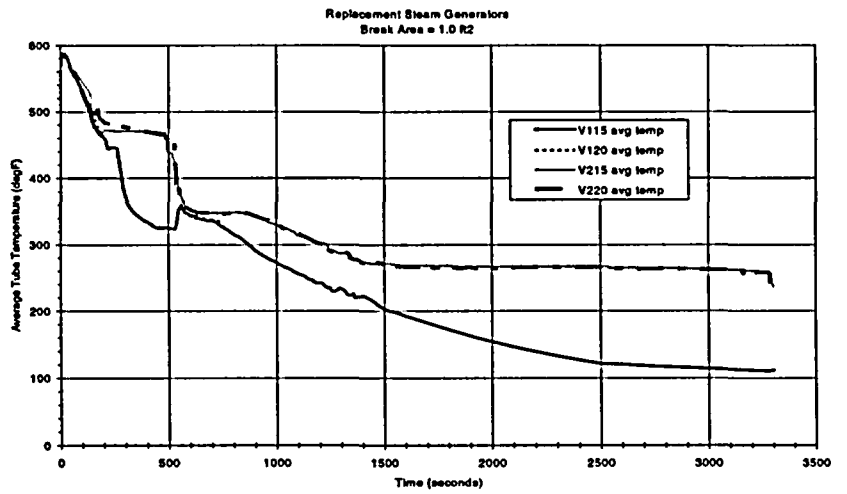

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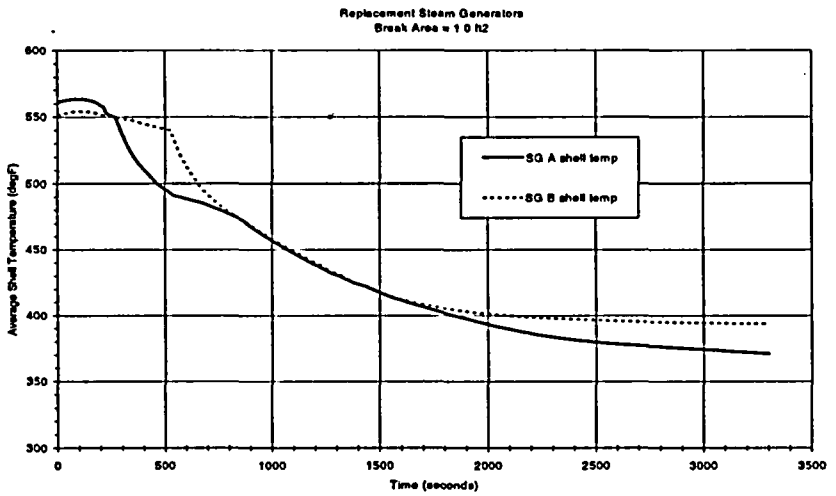

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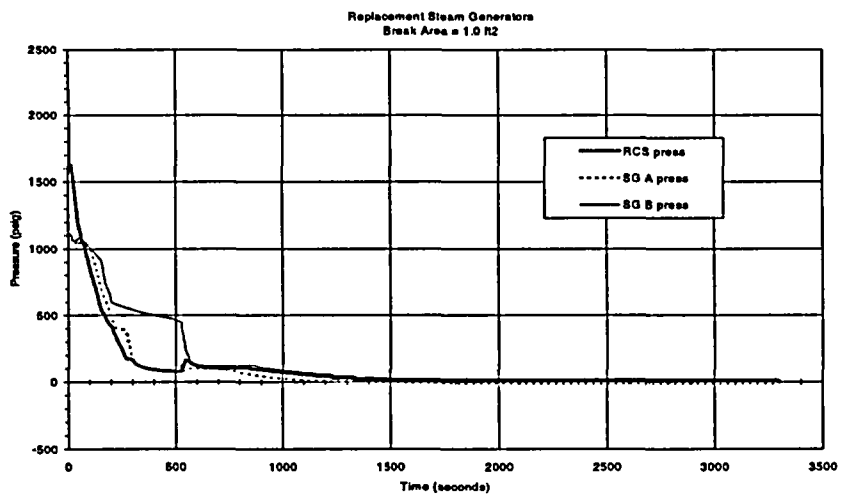

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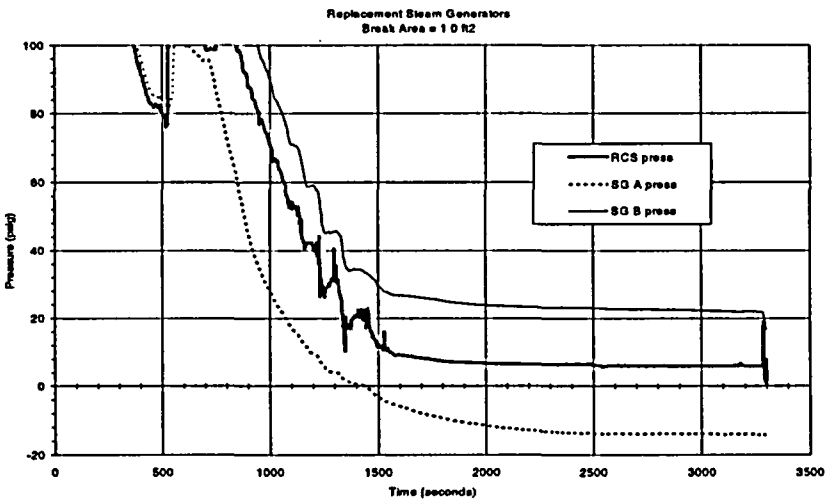

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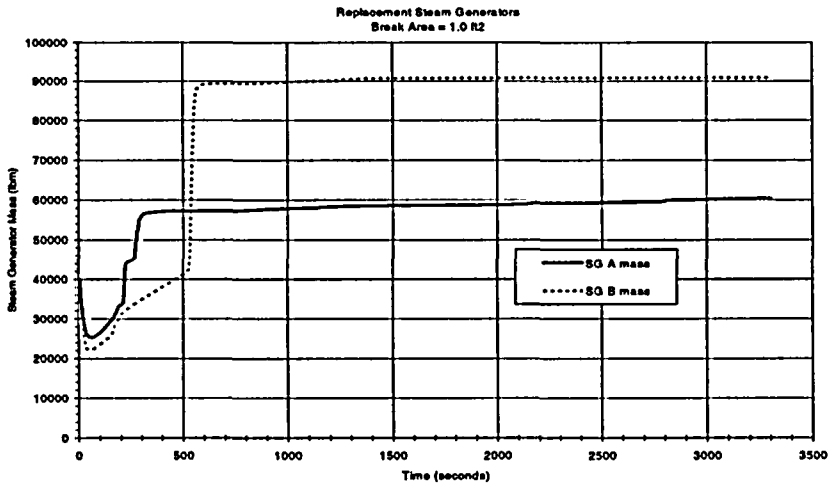

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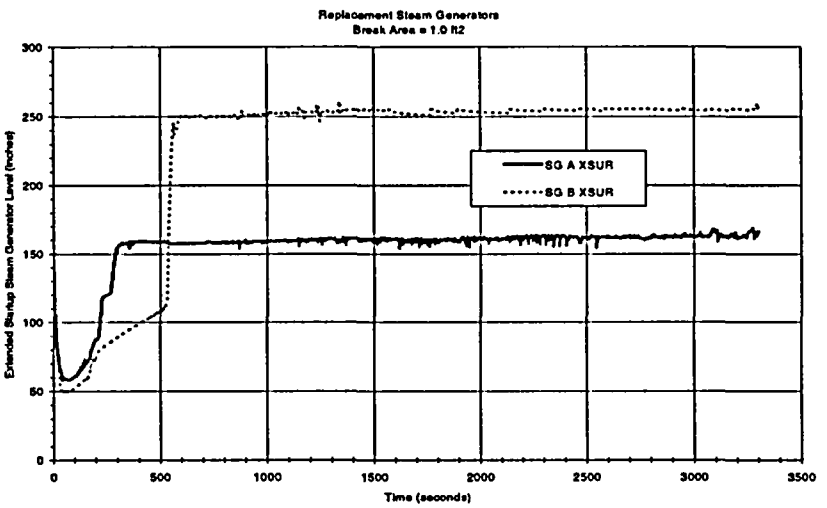

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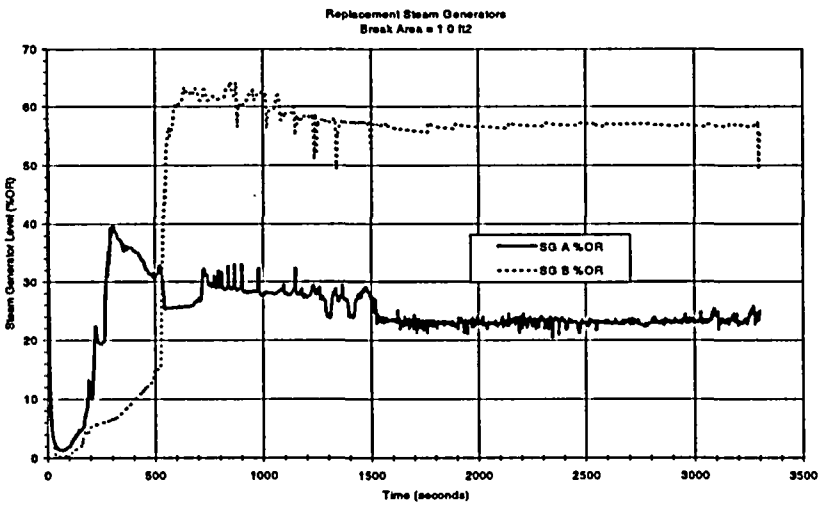

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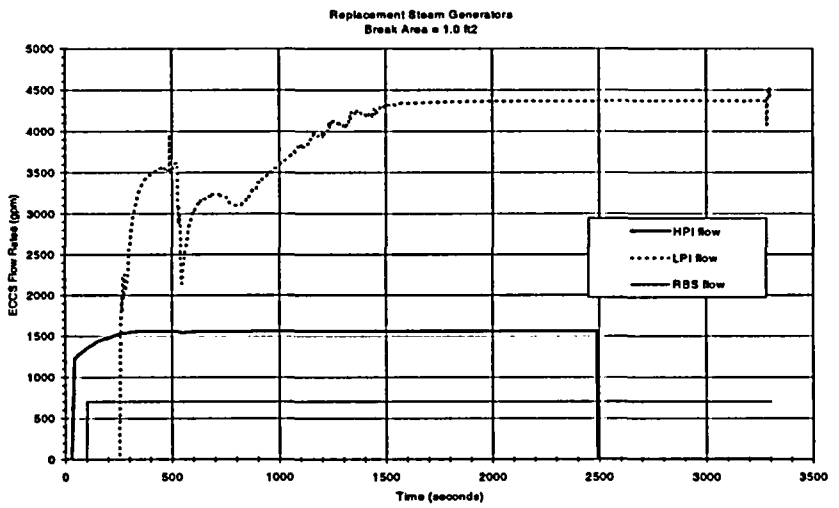

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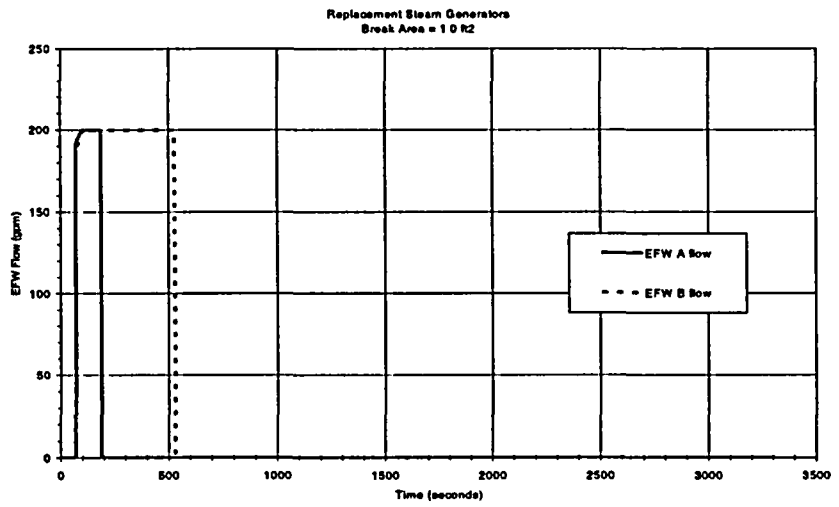

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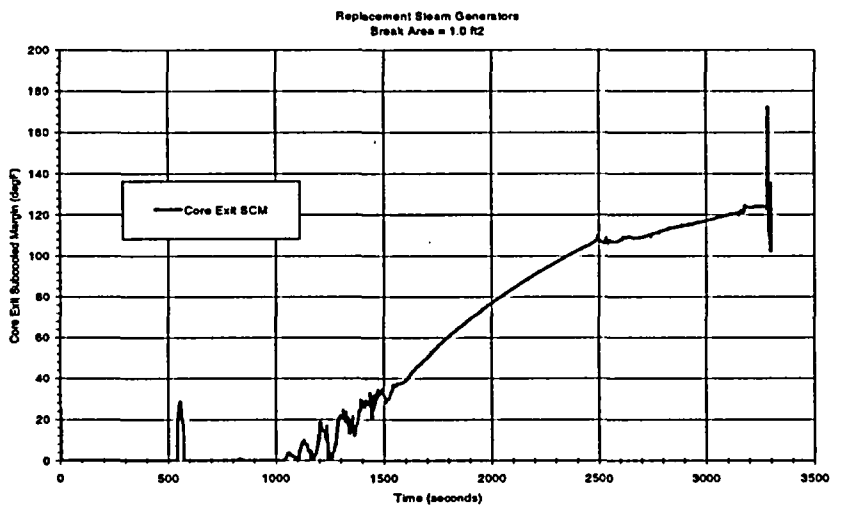

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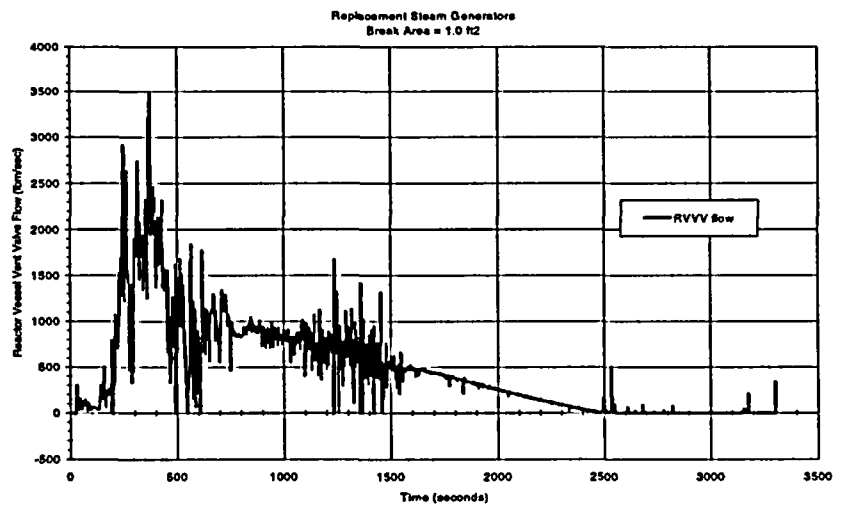

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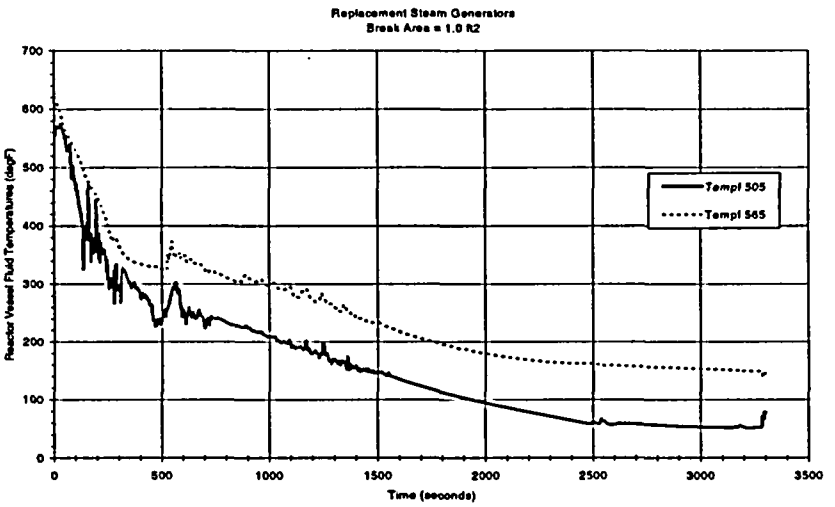

GBS notes

- Describe limiting case (scenario/sequence of events)
- Show limiting case plots
- Explain why better
- Conclude where we are with these results
- Where will these results take us in the SG tube surveillance
- We will have BWC us the final QA'd case going forward
- No need to consider SGTR and consequences