LTR-SGMP-09-2 NP-Attachment

Westinghouse Electric Company

Westinghouse Presentation Materials for the January 9, 2009 Meeting with the U.S. Nuclear Regulatory Commission (NRC) Staff to Discuss Steam Generator H*/B* Issues

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H* Structural and Leakage Integrity Acceptance Criteria - Section 4

Industry/NRC Meeting — Update on H*

NEI 97-06 and Supporting Guidelines are Basis for Criteria

- Integrity Assessment Guidelines do not directly address degradation in tubesheet expansion region
  - "Failure to Meet H*" assumed equivalent to tube burst despite impossibility of burst
  - "Failure to Meet H*" defined as 0.25" slippage

    (Ref. NRC SER, EXELON, 2007), not complete pullout
- H* Meet SIPC: $3\Delta_{NOP}$ or $1.4\Delta_{SLB}$

Structural Criteria

- Whole bundle analysis at 0.95 probability at 50% confidence
  - Monte Carlo approach
- External to report, provide information on
  - "Whole Plant" evaluation at 95/95
    - Worst tube defined as that tube or locus of tubes that yield the largest nominal H* value
  - “Whole Plant” evaluation at 95/50

Leakage Criteria

- Darcy Model for flow through a porous medium
- Meet leakage criteria at 0.95 probability at 50% confidence
- Develop leakage factors for all DBAs and apply as in IARC
- Commitment: Identify any case where $Pc_{slb} < Pc_{nop}$ (Pc = Contact Pressure)

H* Plant Operating Conditions and Loading

Section 5

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Loading Conditions

- End Cap Loads
  - Normal Operating
  - Design Basis Accidents
    - SLB/FLB
    - Control Rod Ejection (bounded by SLB/FLB for structural)
    - Stuck Rotor (bounded by SLB/FLB for structural)
- Calculation of End Cap load is consistent with prior submittals, which are conservative compared to textbook equation (~32% high)

Calculation of End-Cap Loads

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Operating Condition	DP (psi) (P_{pri}-P_{sec})	Area (in^2) (Note 1)	End Cap Load (lbs.)	Factor of Safety	H* Design End Cap Load (lbs.)

Operating Conditions – Model F

Table 5-1 Operating Conditions – Model F H* Plants

Parameter and Units		Salem Unit 1 (1)	Millstone 3(2)	Seabrook 1 (3)	Vogtle Units 1 and 2 (4)	Wolf Creek (5)	Vandellos II (6)

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Similar table to be provided for Model D5, 44F and 51F in model-specific reports.

Model F – SLB Conditions

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Table 5-2 Steam Line Break Conditions						
Parameters and Units	Salem Unit 1	Millstone 3	Seabrook 1	Vogtle Units 1 and 2	Wolf Creek	Vandellos II*

Similar table to be provided for Model D5, 44F and 51F in model-specific reports.

FLB Conditions

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Table 5-3 Feedwater Line Break Conditions						
Parameters and Units	Salem Unit 1	Millstone 3	Seabrook 1	Vogtle Units 1 and 2	Wolf Creek	Vandellos II

Similar table to be provided for Model D5, 44F and 51F in model-specific reports.

Locked Rotor Conditions

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Table 5-4 Locked Rotor Event Conditions						
Parameters and Units	Salem Unit 1	Millstone 3	Seabrook 1	Vogtle Units 1 and 2	Wolf Creek	Vandellos II

Similar table to be provided for Model D5, 44F and 51F in model-specific reports.

Control Rod Ejection Conditions

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Table 5-5 Control Rod Ejection						
Parameters and Units	Salem Unit 1	Millstone 3	Seabrook 1	Vogtle Units 1 and 2	Wolf Creek	Vandellos II

Similar table to be provided for Model D5, 44F and 51F in model-specific reports.

Summary of End-Cap Loads

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Table 5-6 H* Design End Cap Loads for Normal Operating Plant Conditions, Locked Rotor and Control Rod Ejection for Model F Plants				
Plant	Low Tavg End Cap Load w Safety Factor (lbf)	High Tavg End Cap Load W Safety Factor (lbf)	Locked Rotor End Cap Load (lbf)	Control Rod Ejection End Cap Load (lbf)

H* Leakage Analysis – Section 9

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Ratio of Darcy Model For Flow Through A Porous Medium

$$\frac{Q_{DBA}}{Q_{NOP}} = \frac{\Delta P_{DBA}}{\Delta P_{NOP}} \frac{\mu_{NOP}}{\mu_{DBA}}$$

Premises for the Model:
1. The loss coefficient is the same for SLB and NOP (Ref. Individual tests correlation study)

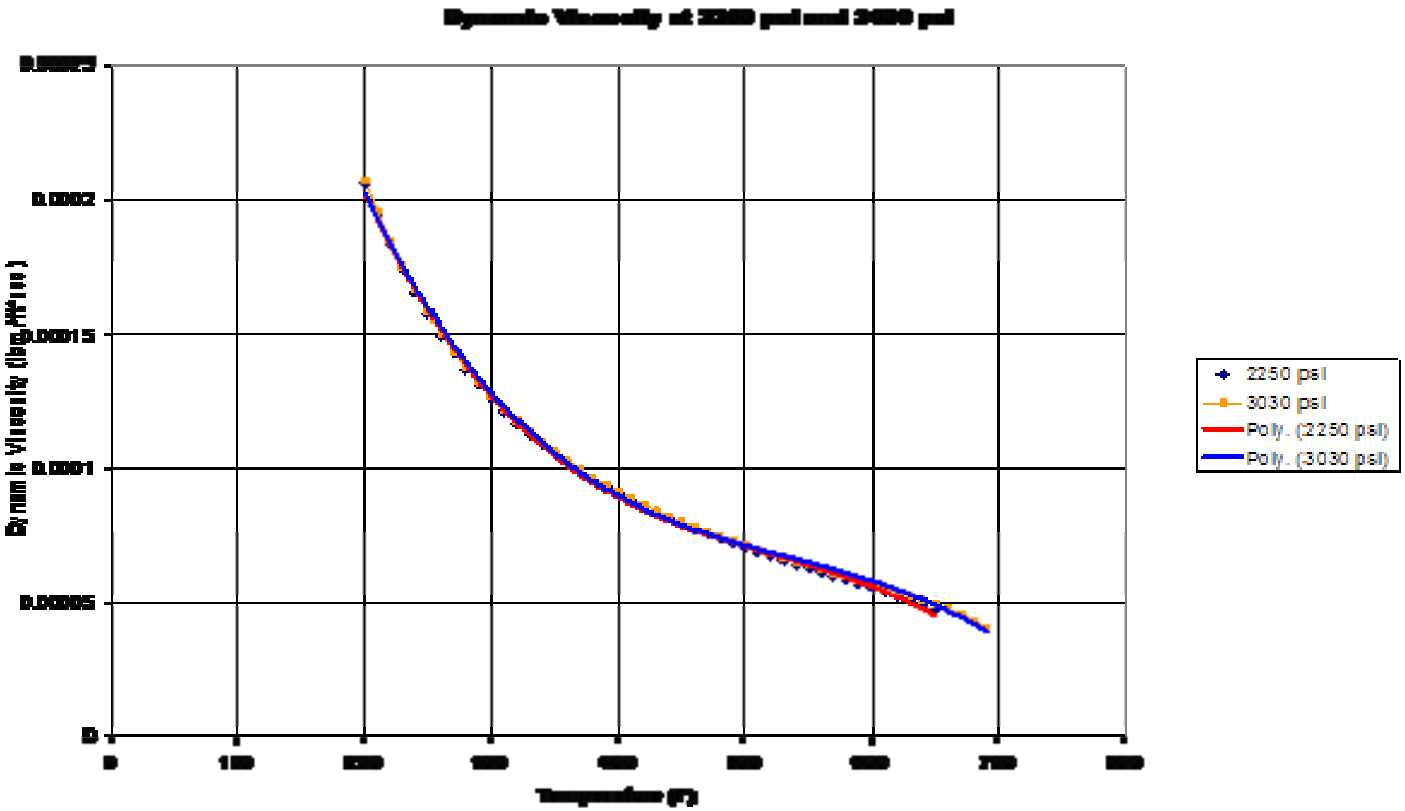
2. The tube and tubesheet are in contact over the full length of the tubesheet
(show in Structural Analysis)

Other premises:

1. Contact pressure at SLB > Contact pressure at NOP (show in Structural Analysis)

2. Tubesheet hole ovalization does not lead to flow channeling (show in Structural Analysis)

Dynamic Viscosity Data



Dynamic viscosity data from Isothermal Properties of Water, National Institute of Standards and Technology, Online Database, webbook.nist.gov.

Limiting Transient for Leakage

- Depends on the leakage assumed in UFSAR for DBAs on a plant-specific basis
- Radiological Dose Consequences define the limiting transient
  - UFSARs state that the radiological dose consequence of a postulated FLB is enveloped by SLB (a cooldown event)
- For the Model F H* plants, [ ]a,c,e
- For other model SG [ ]a,c,e
- Each utility will have to identify the accident analysis leakage assumption for each DBA and then determine if the calculated overall leakage factor results in a more restrictive normal operating leakage criterion than the current Tech Spec leakage criterion of 150 gpd

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Table 9-8 Leak Rate Factor Calculation Process												
	SLB/FLB Transient				Locked Rotor Transient				Control Rod Ejection Transient			
Plant	SLB Δp Ratio (1)	SLB ΔP with Uncertainty (2)	Viscosity Ratio (3)	Overall Leakage Factor (4)	LR/NOP Δp Ratio (1)	LR ΔP Ratio with Uncertainty (2)	Viscosity Ratio (3)	Overall Leakage Factor (4)	CRE/NOP Δp Ratio (1)	SLB ΔP Ratio with Uncertainty (2)	Viscosity Ratio (3)	Overall Leakage Factor (4)

Table 9.8 Notes

Notes: (Refer to equation (7))

(1) From plant normal operating conditions and Table 9-3 and knowledge of SG secondary side pressures.

(2) From comparing values from (1) with Figure 9-16

(3) From Figure 9-1 and Table 9-2

(4) Δp Ratio for respective transient multiplied by viscosity ratio

ΔP Adjustment

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Example - Salem

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Table 9-9 Design Basis Accident Plant-Specific Leakage Factor Table [3] [4]								
SG Model	Plant	SLB/FLB COOLDOWN	FLB HL HEAT UP	FLB CL HEAT UP	Locked Rotor – HL [5]	Locked Rotor – CL [5]	Control Rod Ejection HL [6]	

Transient Duration Leakage Correction

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CRE Time History

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LR Time History; Model F

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Assumptions- LR, CRE

- No significant change in coolant temperature during pressure spike
  - Large heat sink; thermal inertia; short time
  - No coolant viscosity reduction

Conservatisms

- Transient Δp adjusted for leak rate uncertainty
  - 95% probability leak rate factor
  - Approximately a factor of 2 on Δp

H* Leakage Analysis Conclusion

- Leakage factors for all Accident Conditions for all H* candidate plants is conservatively bounded by 2.