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B&WOG/NRC Meeting on BAW-2374 Rev 2

Eric Henshaw

April 27-29, 2004
Lynchburg VA

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BAW-2374 Rev.2

- Review of last B&WOG & NRC Letters
- Establish the philosophy
- Review of proposed TOC
- Review the details…

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B&WOG March 13, 2003 Letter

- Primary purpose was to withdraw BAW-2374 Revision 1
- Discussed content for BAW-2374 Rev 2
- Attachment provided perceived mutually acceptable assumptions based upon February 6, 2003 B&WOG/NRC meeting

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B&WOG March 13, 2003 Letter

- Attachment topics
  - Regulatory basis
  - Break size
  - Failure of SG tubes
  - SG mechanical loads
  - Secondary isolation
  - Net positive suction head in the sump
  - Steam line integrity
  - Offsite dose

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NRC May 15, 2003 Letter

- NRC Staff clarification and responses to March 13, 2003 letter content.
- Topics discussed
  - March 13, 2003 letter statement
  - Attachment statement
  - Regulatory basis
  - Break size
  - SG mechanical loads
  - Secondary isolation
  - Net positive suction (NPSH) in the sump

NRC May 15, 2003 Letter

- Topics discussed (continued)
  - Steam line integrity
  - Offsite dose

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"Philosophy" of BAW-2374 Rev.2

- The following discussion is based upon the B&WOG March 13, 2003 letter to the NRC and the NRC May 15, 2003 letter to the B&WOG. The majority of the headings are the same, with some additional discussion.
  - Discussion items are to help identify where conservative and best-estimate approaches are proposed

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"Philosophy" (continued)

- Thermal-hydraulic response
  - The thermal-hydraulic analyses presented in BAW-2374 Appendix A are conservative calculations. This approach results in the limiting tube loads.
  - This approach is not conservative for either the NPSH or Dose analyses. It is also inconsistent with the Appendix K approach which is intended to maximize PCT calculations

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"Philosophy" (continued)

- SG mechanical loads
  - The steam generator tube loads resulting from the conservative thermal-hydraulic response are determined using upper bound tube material properties.
  - The B&WOG position presented in the March 13 letter discusses the intended final position of BAW-2374. The desired conclusion is that the design basis for the SG mechanical loads will continue to be based on the limiting break in attached piping (to the hot leg).

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"Philosophy" (continued)

- Failure of SG tubes
  - The current knowledge of the distribution of SG tube flaws will be used to determine the number of SG tubes expected to fail
  - If no tube failures are predicted a small number of failed tubes will be assumed in the analysis used to demonstrate adequate termination of the assumed event

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"Philosophy" (continued)

- Secondary Isolation
  - The evaluation of secondary isolation will be based on the success of any automatic actions (with no failures assumed and realistic delay times) and on successful operator actions, which will be based on applicable emergency operating procedures, but with realistic delay times and operator action times.
  - The single failure of an MSIV will be evaluated by combining a low probability of needing MSIV closure and available steam line isolation capability downstream of the MSIV

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"Philosophy" (continued)

- Net Positive Suction Head
  - The calculation of NPSH will be based on a best estimate approach using realistic assumptions, including the amount of ECCS fluid lost due to failed SG tubes, containment pressure, operator actions, and ECCS pump performance.
  - The NPSH calculation will require a best estimate approach to be consistent with the tube loads calculation. A bounding approach to NPSH is incompatible with a bounding approach to tube loads.

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"Philosophy" (continued)

- Secondary Line Integrity
  - A best estimate evaluation of steam line integrity will be performed to ensure that the weight of any potential water entering the steam lines is within the static load limit
  - Water hammer concerns in the steam lines and feedwater lines will be addressed using realistic assumptions

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"Philosophy" (continued)

- Offsite Dose
  - Any release of radioactivity and the resultant dose, under the provisions of 10CFR100 (or the alternate source term provided in 10CFR50.67), will be estimated using realistic assumptions for fuel damage, ECCS performance.
  - A realistic approach to the various dose calculations will be taken as the associated thermal-hydraulic transient does not produce a significant source term. The fluid conditions required to obtain a limiting tube load calculation are incompatible with a bounding approach to calculating dose.

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BAW-2374 Rev.2 TOC

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BAW-2374 Rev.2 TOC (cont)

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Thermal-Hydraulic Calculation

- RELAP5 Analysis
  - Boundary Conditions
  - Break Size
  - Transient Progression
  - Interaction with EOPs
  - Results
    - SG water level
    - Break size
    - BWST temperature
    - ECCS flow rates

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SG Mechanical Loads

- BAW-2374 tube loads extrapolated from Pzr surge line analysis (The surge line analysis boundary conditions are conservative).
- Used upper 95 material properties. This results in the highest tube yield values and highest tube loads applied
- Best-Estimate versus Conservative ??
- Inconel-600 vs Inconel-690 ??

SG Tube Flaw Distribution

- Review of observed circumferential cracks and volumetric flaws from plant inspections
- Data obtained from all 7 units for last 2 inspections.
- Data subdivided into the following categories
  - FS = unexpanded tubing in the free span
  - TS = unexpanded tubing within the tubesheets
  - UTE/LTE = expanded tubing within the tubesheets
- Data obtained is not sorted according to flaw size
- Data obtained is not sorted for radial location

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SG Tube Flaw Distribution

- Summary of SG tube flaw data
  - Majority of circumferential cracks occur in the roll transition which is identified as UTE/LTE in the data
  - Limited number of circumferential cracks in free span
  - Significant number of volumetric flaw indications in free span
- Considerations
  - Tube load is a function of radial location in the steam generator
  - Previous calculations have shown that the total leakage through the observed UTE/LTE indications is quite small (<10 gpm)

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SG Tube Flaw Distribution

	Circumferential			Volumetric		
	Free Span	Tube Sheet	Tube Expand	Free Span	Tube Sheet	Tube Expand
BWOG						
Max	3	3	168	63	13	44
Avg	0.36	0.21	36.7	12.6	2.42	10
St Dev	0.73	0.63	44.7	16.5	3.03	14.6
95/95	1.82	1.47	126.2	45.7	8.49	39.2

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SG Tube Flaw Distribution

	Circumferential			Volumetric		
	FS	TS	TE	FS	TS	TE
Non-ONS Units						
Max	1	3	75	63	7	39
Avg	0.19	0.25	29.3	7.63	2.42	11.6
St Dev	0.40	0.77	29.9	15.3	2.39	14.0
95/95	0.99	1.80	89.1	38.2	7.20	39.7

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Secondary Side Isolation

- Review of transient phenomena
- Probability of secondary side integrity with vacuum
- EOP actions
  - For Oconee, the EOP actions depend upon whether the EOPs treat the event as a Large Break or a Small Break LOCA. Defined based upon LPI flow.

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ECCS pump NPSH

- NPSH is a function of the following parameters:
  - Pump flow rate
  - Fluid temperature
  - Containment overpressure
- The limiting LOCA tube load transient results in significant reductions in fluid temperature
- Dependent upon duration of postulated fluid loss to the steam generator secondary

Secondary Line Integrity

- Evaluate static load of water (current hanger design)
- Evaluate waterhammer in steam line
  - Lacks velocity for column closure waterhammer
  - Lacks subcooling for condensation waterhammer
- Evaluate waterhammer in feedwater line
  - Liquid flashes during event, voiding the line
  - Line would subsequently refill
  - Refill limited by main feedwater nozzles

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Dose Evaluation

The following approach is used to evaluate the resultant dose from a postulated tube failure for the limiting transient

- Alternate source term (RG 1.183) for timing of release from fuel, percentage of core inventory in the gap, chemical form of iodine, etc.
  - For stations that have not made an AST submittal, will need to consult RG 1.195.
- LOCA source term with no fuel melt and gap release only from the failed fuel rods that are assumed to fail during the transient

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Dose Evaluation

- Mechanistic transport of source term to the secondary side
  - Initially relatively clean ECCS water will be in the SG.
  - Contaminated sump liquid arrives after transfer to the sump
- Define a leakage duration
- Consider the pathways available for leakage to reach the environment.
- Consider pH of steam generator fluid
- Consider fluid temperature of leaking fluid
- Possible credit for plate-out of iodine in steam line

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Dose Evaluation

- Offsite (EAB and LPZ) and Control Room doses are determined to be within Reg limits of 25 rem TEDE and 5 rem TEDE respectively
- The following items would not be addressed due to the probability of the event
  - Direct shine from feedwater/steam lines

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Compensatory Actions

- The following modifications are possible to alleviate tube stress concerns
  - Ensure EOP contains complete list of valves for SG isolation
  - Throttle LPI to maintain core exit subcooling
  - Throttle LPI to maintain a mid-span RVLIS indication
  - Initiate DHR and allow RCS to drain to mid-hot leg
  - Open dump to sump lines
  - Raise SG levels early on LBLOCA
  - Ensure steam line drains to waste holdup system
  - Intentionally break vacuum in secondary