Proposed Alternative Transition Break Size and Associated Benefits

Meeting with NRC
November 18, 2004

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Meeting Objective

- Identify anticipated safety benefits of 50.46 rule change and effect of TBS selection on these benefits
- Process to reach agreement with NRC on frequency and size of Transition Break Size:
  - Address Uncertainties
  - Address degradation mechanisms

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Potential Pilot Applications

- WOG has a lead plant poised to prepare a submittal
  - Includes safety benefit and operational benefit
    - Most likely safety benefit is to reduce requirement for containment spray
      - Improves NPSH at sumps
      - Reduces "wash down" of containment debris
      - Reduces demand on RWST inventory
    - Operational benefit will be directed to increasing margin in peaking factors and diesel generator start time
- WOG will participate in develop implementation guidelines
  - PRA support
  - Analysis support

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Safety Benefits of Smaller Transition Break Size

Westinghouse Owners Group meeting with NRC
November 18, 2004

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Benefits of LBLOCA Redefinition

- Safety benefits
  - Retaining mitigation capability for breaks beyond the "transition break size" maintains defense in depth
  - Improved fuel utilization increases design margin and improves safety over entire fuel cycle
  - Improved equipment availability and reliability from increased design margin
  - More effective utilization of mitigation equipment such as safety injection and containment spray

Types of Potential Safety Benefits

- Improved System Response to Risk-Significant Events
- Better Utilization of Equipment
- Improved Fuel Mgt.
- Improved Margin
- Improved Equipment Reliability

Potential Safety Benefits of Smaller TBS

- Smaller TBS results in improved safety benefits:
  - Relaxed fuel design limits result in significant benefits to fuel utilization
    - Reduce number of fuel assemblies required
    - Fewer spent fuel assemblies to be handled, transported, and stored
    - Large benefit to public health and safety
  - The containment spray system and LPSI pumps may not have to start automatically for LOCA
    - Improve RWST margin
    - Avoid or delay need to switch over to recirculation
    - Lessen debris transport to the sump
    - Increase margin for NPSH during recirculation

Potential Safety Benefits of Smaller TBS (cont.)

- Accumulators may no longer be needed to mitigate design basis events
  - Actuation pressures may be optimized or staggered to extend accumulator usefulness (e.g., in the mitigation of severe accidents)

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Example Safety Benefits – Better Utilization of Equipment

- Safety Benefit (based on July 1, 2004 SRM)
  - Modifications to Containment Spray actuation setpoints and logic will increase the RWST inventory available for core cooling
    - Extend time to recirculation, and reduce potential for debris transport during the recirculation
    - Improve ECCS NPSH margin because SI pumps are not competing with CS pumps
- Dependence of benefit on break size

	DEGB	2 x 14"	6"
Actuation Time	< 10 s	~ 30 s	~ 3-15 min

=> Total spray volume reduced for 6" TBS

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Example Safety Benefits – Better Utilization of Equipment

- Safety Benefit (based on July 1, 2004 SRM)
  - Accumulators may no longer be needed to mitigate design basis events
    - actuation pressures may be optimized or staggered to extend accumulator usefulness in mitigating severe accidents
- Dependence of benefit on break size
  - Some accumulator mitigation needed at 2 x 14" for most plants
  - Staggering has little effect on injection times for larger breaks

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Accumulator Injection Times for the Various Break Sizes

Accumulator optimization/stagger concept (4-loop PWR, cold leg break)

	DEGB	2 x 14"	6"
Accumulator Injection Starts	12 sec	42 sec	375 sec
Accumulator Injection Ends	42 sec	87 sec	- - -
Total Injection Time (650 psi)	30 sec	45 sec	> 100 sec

Reducing injection pressure of 2 of 4 accumulators to 450 psi (for example) would extend total accumulator delivery time substantially for 6", negligibly for 2 x 14"

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Example Safety Benefits – Improved Fuel Mgt.

- Safety Benefit (based on July 1, 2004 SRM)
  - There can be increased PCT margin in the design basis analysis
    - allows increased peaking factors and improved fuel utilization
  - Increased design margin for fuel will result in improved fuel utilization and longer fuel cycles.
    - Fewer thermal cycles on the plant
    - Fewer spent fuel assemblies that require storage and transport
    - Reduce feed assemblies by 4-8 assemblies per reload for some W 4-loop plants, depending on TBS size

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Example Safety Benefits – Improved Fuel Mgt. (Cont.)

  - Increased fuel design margin may result in more economical power uprates
    - Adverse environmental emissions from non-nuclear generating plants are avoided
    - Public health and safety benefit
- Dependence of benefit on break size
  - Some 2-loop plants would not benefit at 14" break size
    - Limiting large break size is ~ 2 x 14"
    - PCT < 1200°F for 6" and smaller => peaking factor increase and/or uprate potential substantially greater

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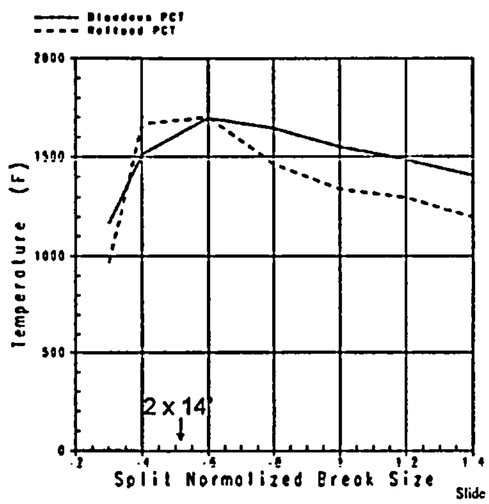
Break Spectrum Results – 2-Loop PWR (Realistic Evaluation Model)



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Example Safety Benefits – Improved Margin

- Safety Benefit (based on July 1, 2004 SRM)
  - More TS margin associated with LOCA mitigation components reduces the chance of TS required shutdown and increases reliability
    - There will be fewer challenges to the plant, which is a safety benefit
- Dependence of benefit on break size
  - Mitigation contribution of accumulators and LPSI strongly dependent on break size
    - Little relaxation available at 2 x 14", significant at 6"
  - Cooling water requirements reduced with smaller TBS

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Example Safety Benefits – Improved Equipment Reliability

- Safety Benefit (based on July 1, 2004 SRM)
  - Diesel generator start time will be increased beyond 10 seconds
    - Increases diesel reliability
    - Reduces wear
    - Reduces need for invasive troubleshooting
- Dependence of benefit on break size
  - Pumped safety injection should be available as accumulators deplete for large breaks, including 2 x 14"

	2 x 14"	6"
Est. Achievable EDG Start, 2-loop	20 s	> 1 min
Est. Achievable EDG Start, 4-loop	40 s	> 1 min

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Conclusion and Recommendation

- There is substantially more safety benefit from a six to eight-inch TBS than from a fourteen-inch TBS
- Expert elicitation panel results would support the smaller TBS

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Setting the Transition Break Size for LBLOCA Redefinition

Westinghouse Owners Group Meeting with NRC
November 18, 2004

Wayne Harrison (STP), WOG W/G Chairman
Bruce Bishop, Westinghouse Expert Panel Member

Frequency and Size of LBLOCA

- Objectives can be achieved with a break size smaller than 14".
  - The benefits envisioned by WOG were based on a 6-8" break size.
  - Break size should have enough conservatism to address uncertainties so that there is confidence that there won't be a change to the transition break size in the future.

Approach to Alternate Transition Break Size (TBS)

- Break size that meets Commission guidance
- Break size that addresses uncertainties in Expert Elicitation
- Break size that appropriately considers materials issues
- Break size that provides safety and operational benefits

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Frequency and Size of LBLOCA (continued)

- WOG proposes a TBS of 8" Nominal Pipe Diameter
  - 6.8" ID for Schedule 160 pipe
  - This size is more aligned to the 1E-05/yr initiating event frequency recommended in the Commission's SRM.
    - Factor of 5 margin over SRM Guidance
  - Based on relating frequency of break sizes from Expert Elicitation to commonly used nominal pipe sizes in PWR RCS piping
  - Addresses areas of uncertainty
  - The requirement to be able to mitigate breaks beyond the TBS substantially addresses a large degree of uncertainty

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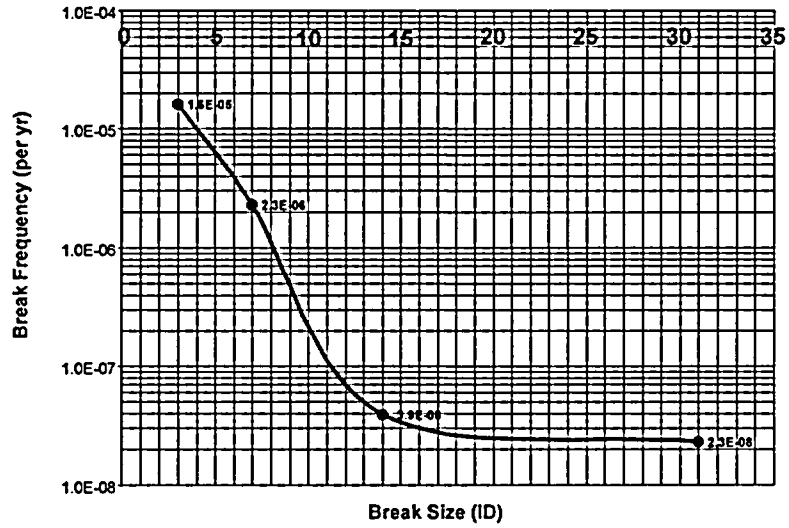
PWR Mean Break Frequency



Source: SECY 04-0060 Table 3 Current Day Estimates

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Basis for WOG Transition Break Size

Nominal Pipe Size	Inside Diameter (Sch. 160)	Estimated Mean Break Frequency	Comments
6"	5.2"	6E-06	Consistent with SRM guidance with margin
8"	6.9"	2E-06	Factor of 5 margin over SRM guidance
10"	8.5"	7E-07	
14"	11.2"	1E-07	
16" (STP surge line)	12.8"	5E-08	
NRC Proposal	14"	4E-08	Factor of 250 margin over SRM guidance

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NRC's Additional Conservatism Is Included In The Expert Panel LOCA Frequencies

- Westinghouse supported Expert Panel and PFM Task Team
- Experience at 7 plants using WOG RI-ISI for piping
- Expert Panel frequencies - much higher than RI-ISI
- Factors/adjustments were made by Expert Panel to consider NRC concerns
  - Discussed at four (4) meetings of all panel members.

Uncertainties Were Well Treated In The Expert Elicitation Process

- Experts provided 5 and 95% bounds plus best estimate frequencies for 6 LOCA sizes and 3 time periods (25, 40 and 60 years of operation)
- Uncertainty ranges (5 - 95% bounds) were adjusted by NRC to account for expected under-estimation
- Adjusted uncertainties were used to calculate a factor of 2 frequency increase for the mean value relative to the median

Uncertainties Were Well Treated In The Expert Elicitation Process (cont.)

- 95% upper bound value about 4 times the mean value
- Sensitivity studies determined effects of how results of all expert panel members were aggregated
- The NRC analysis methods were subject to an external peer review

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LOCAs Due To Inadvertent Actuation Of Active Components

- Active component failures not considered directly
- Much effort was spent in properly correlating leak rate with break size
- LOCA due to inadvertent depressurization would come from actuation of the safety relief valve
  - Leak rate for this LOCA corresponds to a pipe break size of only 2 to 4 inches
- Therefore, active component failures are not considered significant for TBS > 4 inches

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LOCAs Due To Large Piping Loads: Heavy Shut-down Loads, Seismic Loads And Water Hammer

- Piping loads significantly larger than those for normal operation could increase the conditional failure probabilities by factors from 10 to 100
- The larger increases would be in the smaller pipes with the smaller increases in the larger pipes
- However, with the very low frequency of occurrence for the much larger piping loads, the increase in LOCA frequency would be less than a factor of 2
- Heavy load drops are not a factor during operation.

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Treatment Of Degradation In Specific Piping Systems And Pipe Sizes

- Expert Panel considered potential degradation mechanisms
  - Effects of pipe size were explicitly considered for each potential degradation mechanism
  - vibration of socket welds and turbulent penetration for small pipe sizes
  - thermal stratification and striping for the larger pipe sizes
  - number of pipes in a plant that could contribute to a given size LOCA was considered in frequency estimates
  - new "unknown mechanisms" (about every 7 years)

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LOCAs Due To Failure Of Other Passive Components, Such As Manway Bolts

- Expert Panel baseline LOCA frequencies include the contributions of both piping and non-piping components
- Failure experience of RV Head Penetrations due to PWSCC significantly increased the frequency of non-pipe breaks that are < 3 inches
- Failures for all other non-piping components only affected the frequency of the smallest size LOCA (100 GPM or 1/2 inch break size)

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Conclusions and Recommendation

- Expert Panel frequencies support smaller TBS
- Expert Panel considered sources of uncertainty and other NRC concerns
- Retaining mitigation capability for breaks beyond the "transition break size" maintains defense in depth
- RG 1.174 requirements will assure that the change in risk is adequately controlled
- WOG recommends a TBS of 8-inch Nominal Pipe Size (6.8 inch break size for Sch. 160)

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