4rd NRC – AERB Nuclear Safety Projects Meeting

August 30 – September 3, 2004

Passive System LOCA Frequency Development for Risk-Informed Revision of 10 CFR 50.46

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Motivation

- Determine part of the technical basis for developing alternative design basis break size for use in 10 CFR 50.46, Appendix K, and GDC 35 (Emergency Core Cooling System Rule).

Scope and Objectives

- Develop piping and non-piping passive system LOCA frequencies as a function of leak rate and operating time up to the end of the license extension period using expert elicitation.
- Determine LOCA frequency distributions for typical plant operational cycle and history.

Expert Elicitation Process

- Expert opinion (elicitation) is a formal process for providing quantitative estimates for the frequency of physical phenomena when the required data is sparse or when the subject is too complex to adequately model.
  - LOCA events are rare.
  - Number and disparity of possible failure modes is too complex to accurately model.
- Elicitation has been used at NRC previously.
  - Development of seismic hazard curves.
  - Performance assessments for high-level radioactive waste repository.
  - Determination of reactor pressure vessel flaw distributions.

Formal Elicitation Approach

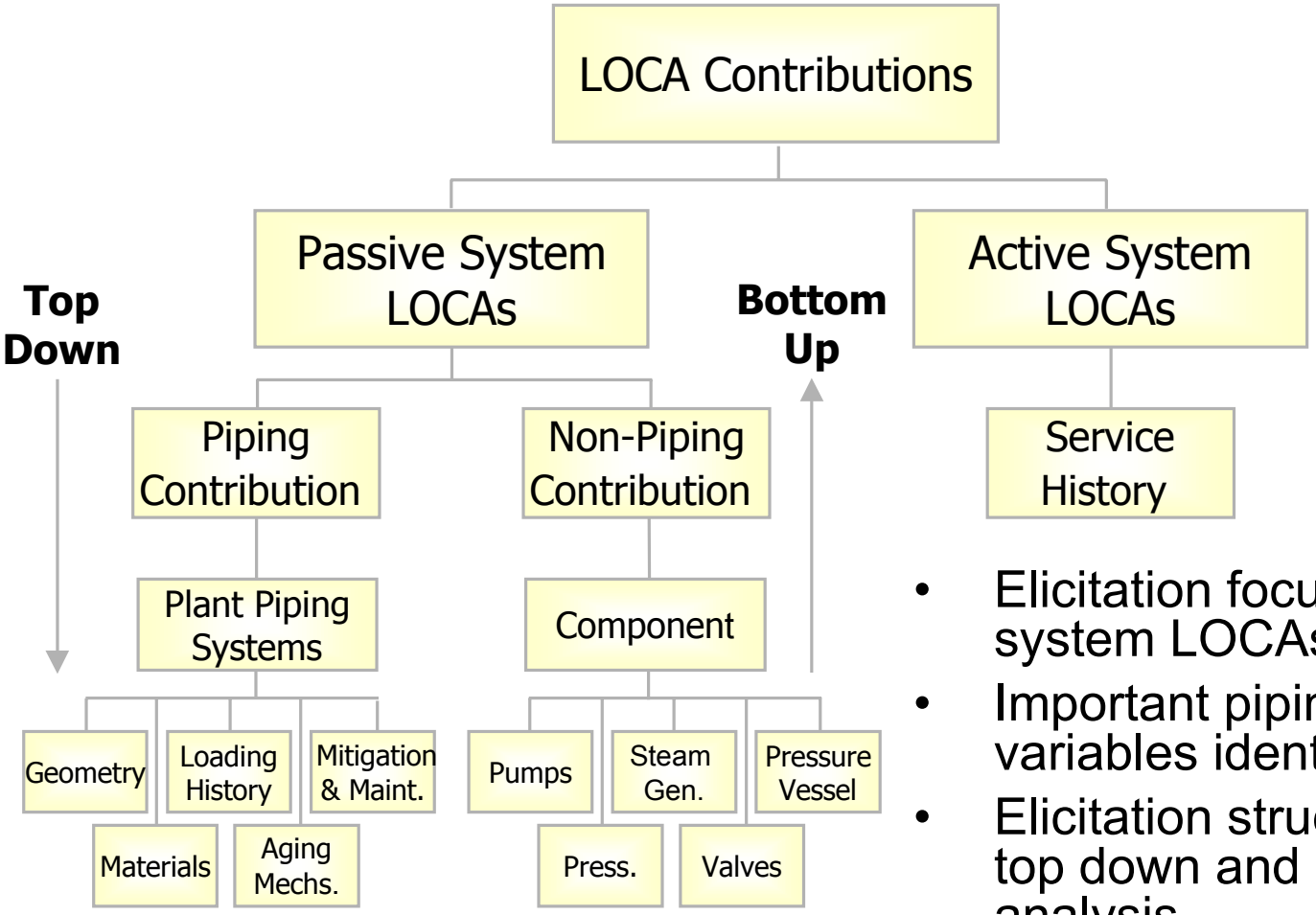
- Select panel and facilitation team.
- Develop technical issues.
- Quantify base case estimates.
  - Develop quantitative estimates for well-defined piping conditions.
  - Two estimates using PFM and two estimates from service history analysis.
  - Quantify non-piping precursors and targeted failure scenarios.
- Formulate elicitation questions.
- Conduct individual elicitations.
- Analyze quantitative results and qualitative rationale.
- Summarize and document results.

LOCA Size Classification

- LOCA sizes based on leak rate to group plant system response characteristics.
- First three categories encompassed traditional definitions utilized in NUREG-1150 and NUREG/CR-5750.
- Three more LBLOCA categories added to examine trends with larger break sizes.

Category	Leak Rate Threshold (gpm)	LOCA Size
1	> 100	SB
2	> 1500	MB
3	> 5000	LB
4	> 25,000	LB a
5	> 100,000	LB b
6	> 500,000	LB c

General Issue Classification



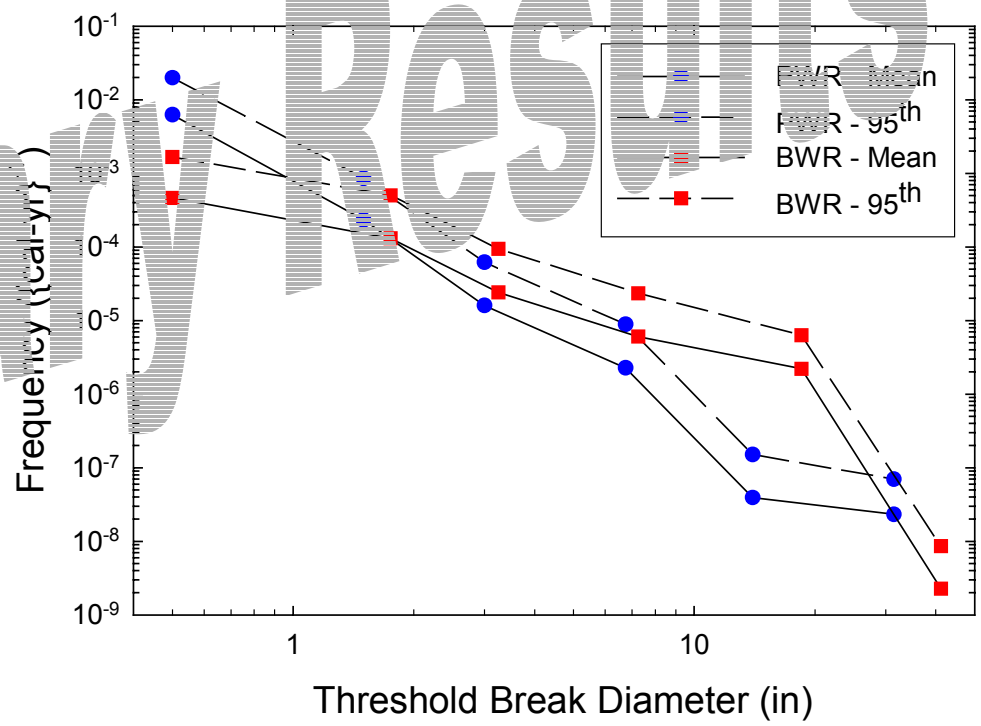
- Elicitation focuses on passive system LOCAs.
- Important piping and non-piping variables identified.
- Elicitation structures supports top down and bottom up analysis.

Elicitation Questions

- Questions on the following topic areas.
  - Base Case Evaluation.
  - Regulatory and Utility Safety Culture pertaining to LOCA initiating events.
  - LOCA frequencies of Piping Components.
  - LOCA frequencies of Non-Piping Components.
- Questions are asked relevant to a set of conditions and quantitatively linked to the base case results.
- Each question asks for mid, low, and high values.
- Rationale is provided and discussed for important issues and values provided by each expert.

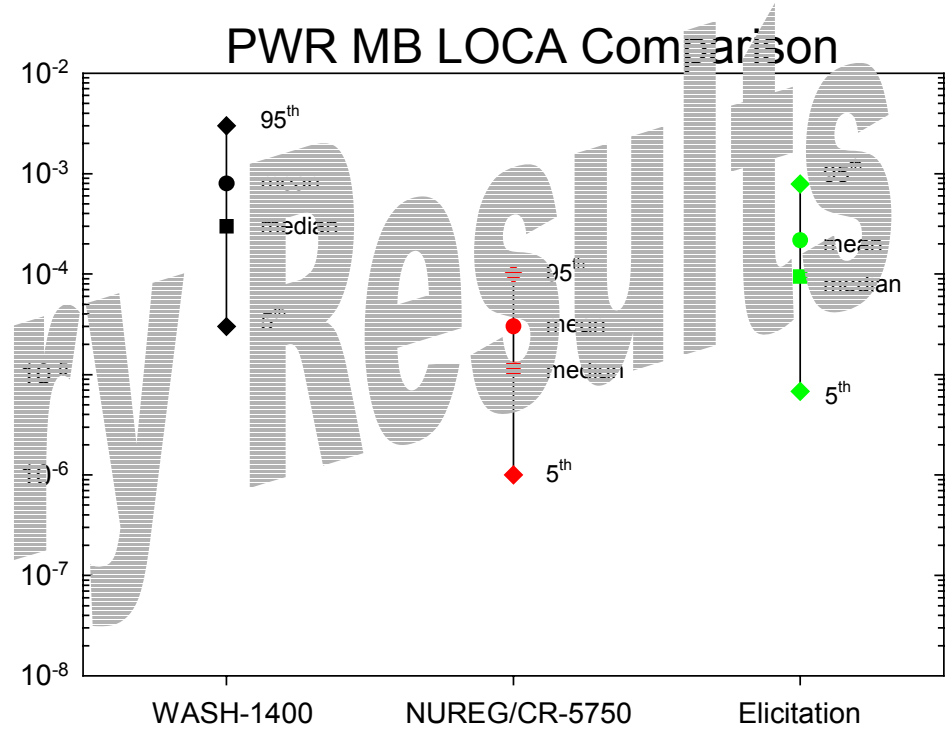
Total LOCA Frequencies

- BWR.
  - Decreases are gradual with LOCA size due to IGSCC concerns.
  - Only non-piping failures contribute to largest breaks.
- PWR.
  - Smallest LOCA frequencies are high due to steam generator and CRDM concerns.
  - Non-piping frequency contributions are also important largest LOCA sizes.



Comparison with Prior Studies

Plant Type	LOCA Size	Current Day (25 yrs) Comparison with NUREG/CR-5750 (Current/CR-5750)
BWR	SB	0.7
	MB	2.6
	LB	0.3
PWR	SB	0.8
	MB	7.2
	LB	0.6



- Frequencies are lower than WASH-1400 estimates.
- Elicitation and NUREG/CR-5750 results are comparable.

Summary

- Formal elicitation process used to estimate generic BWR and PWR passive-system LOCA frequencies.
- Developed quantitative estimates for piping and non-piping base cases for anchoring elicitation responses.
- Panelists provided quantitative estimates supported by qualitative rationale.
- Results.
  - Generally good agreement about LOCA contributing factors.
  - Large individual uncertainty and panel variability in quantifying estimates.
  - Results are comparable to NUREG/CR-5750 estimates.