February 6, 2005

MEMORANDUM TO: ACRS Members

FROM: Michael Snodderly, Senior ACRS Staff Engineer,

SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE ACRS SUBCOMMITTEE ON REGULATORY POLICIES AND PRACTICES, NOVEMBER 16, 2004 - ROCKVILLE, MARYLAND

The minutes of the subject meeting, issued February 2, 2005, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

electronic cc: J. Larkins
S. Duraiswamy

Issued:2/2/05
Certified: 2/6/05

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MEETING OF THE ACRS SUBCOMMITTEE ON
REGULATORY POLICES AND PRACTICES
MEETING MINUTES - NOVEMBER 16, 2004
ROCKVILLE, MARYLAND

INTRODUCTION

The ACRS Subcommittee on Regulatory Policies and Practices held a meeting on November 16, 2004, in Room T-2B1, 11545 Rockville Pike, Rockville, MD. The purpose of this meeting was to review the staff's draft proposed NUREG documenting the expert elicitation on large break loss-of-coolant accident frequencies. The meeting was open to public attendance. Mike Snodderly was the Designated Federal Official for this meeting. There were no written comments or requests for time to make oral statements. The meeting was convened by the Subcommittee Chairman at 8:02 a.m. on November 16, 2004 and adjourned at 11:13 a.m..

ATTENDEES

ACRS Members

G. Apostolakis, Acting Subcommittee Chairman
M. Bonaca, Member
R. Denning, Member
T. Kress, Member
W. Shack, Member
G. Wallis, Member
M. Snodderly, Designated Federal Official

Principal NRC Speakers

L. Abramson, RES
A. Hiser, RES
D. Lew, RES
A. Salomon, RES
R. Tregoning, RES

Other Principal Speakers

J. Butler, NEI
S. Levinson, AREVA
R. Schneider, WEC

There were no other members of the public in attendance at this meeting. A complete list of attendees is in the ACRS Office File and will be made available upon request. The presentation slides and handouts used during the meeting are attached to the office copy of these minutes.

OPENING REMARKS BY ACTING CHAIRMAN APOSTOLAKIS

George Apostolakis, Acting Chairman of the ACRS Subcommittee on Regulatory Policies and Practices convened the meeting at 8:02 a.m. Dr. Apostolakis stated that the purpose of this meeting was to review the staff's draft proposed NUREG documenting the expert elicitation on large break loss-of-coolant accident frequencies. He said the Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee. The rules for participation in the meeting were announced as part of the notice of the meeting published in the Federal Register on November 2, 2004. Dr. Apostolakis acknowledged that no written comments or requests for time to make oral statements had been received.

DISCUSSION OF AGENDA ITEMS

Discussion of LOCA Frequencies for Risk-Informed Revision of 10 CFR 50.46

Rob Tregoning, RES, stated that the objective of the meeting was to brief the Subcommittee on the LOCA elicitation that's chronicled in the draft NUREG and used as part of the technical basis supporting a risk-informed alternative to 10 CFR 50.46. Mr. Tregoning said that he would also discuss additional sensitivity analyses and internal and external reviews that have been conducted since the previous ACRS briefing on July 7, 2004. He explained that the staff had developed generic BWR and PWR piping and non-piping passive system LOCA frequency distributions as a function of break size and operating time. The elicitation considered LOCAs related to passive component aging, tempered by mitigation measures and considered time frames of 25, 40 and 60 years. The elicitation focused on normal operating loads and expected transients. Mr. Tregoning said that the primary motivation was to develop part of the technical basis for defining a transition design basis break size to support a risk-informed revision to the ECCS rule. A secondary motivation was to develop updated best estimate LOCA frequency distributions that could be used in plant PRA models as well as provide insights that could be used for risk assessment in terms of where pipes are expected to break, and systems are likely to fail.

Mr. Tregoning then explained how the expert opinions were aggregated. He said that the baseline method uses the geometric mean of the individual panelist estimates to give group estimates for all the total LOCA frequency parameters. Parameters were defined as the 5th, 50th, 95th percentiles and the mean estimates. The structure of the individual elicitation responses support a log normal structure. This baseline method assumes the estimates aren't significantly influenced by outliers because the individual estimates were distributed essentially log normally. Mr. Tregoning said that you could use other measures of central group opinion, such as the median or the trend geometric mean. If you use those measures you end up with very similar estimates as you do with just the geometric mean themselves. He mentioned that the an alternative method to the baseline, is to use or use an arithmetic mean of all the individual panelist and create a mixture distribution. This is a different viewpoint for aggregating the expert opinion. You're essentially making the assumption that the individual results are all obtained from equally credible models that are randomly picked from the population of experts. If you make this assumption, then the mixture distribution falls naturally. Mr. Tregoning went on to make the point that some of the key regulatory parameters may be dominated by the outlier. The staff saw the difference between the 5th and 95th for the mixture distribution were much wider than the baseline distribution.

Mr. Tregoning said that they had 12 panel members. The staff expected the experts to recuse themselves from areas where they did not feel they had sufficient background and knowledge. Mr. Tregoning said that the mixture distribution used the same aggregation method as NUREG-1150. He then mentioned that the staff conducted an external review with a decision analyst and a statistician. The external review focused on analysis of the expert results and the quantitative section of the draft NUREG. The decision analyst thought that the elicitation process was adequate and sound for meeting the stated objectives in Section C of the draft NUREG. The decision analyst suggested that there is some evidence that the relative ratio structure may help compensate for overconfidence. Both reviewers agreed that the overconfidence correction using the error factor approach was appropriate.

Mr. Tregoning concluded by discussing the advantages and disadvantages of the geometric mean aggregation approach which is the baseline method. The advantages are that the group estimates are more acceptable to the panel and the results are not dominated by one or two outliers. The disadvantages of the baseline approach is that you end up with less conservative mean and 95th percentile estimates compared with the mixture distribution. Also, the 5th and 95th percentile differences are not quite as wide as you get for the mixture distribution. Although, if you use the 5th with the 5th confidence bound and the 95th with the 95 confidence bound you get ranges which are similar.

General Comments and Observations From the Subcommittee Members

- Dr. Apostolakis asked if we will find a study in 5 years that criticizes your study. Mr. Tregoning hopes that the state of knowledge improves and a critical review occurs. Dr. Apostolakis said that some unquantifiable uncertainty is introduced because the frequencies have changed every four to five years because of requantification and/or improved state of knowledge. Dr. Apostolakis felt that the 14 inch break size for PWRs conservatively bounds this uncertainty.

- Dr. Kress challenged that more important than the selection of the transition break size was what impact the transition break size will have on risk. Dr. Kress felt that risk may be impacted depending on how equipment needed to mitigate breaks greater than the transition break size is treated. Dr. Kress added that what gave him confidence in the process was that there are controls on the overall risk of the plant. Mr. Tregoning said that it could have a dramatic effect depending on how you treat the beyond transition break size equipment.

- Mr. Tregoning remarked that many of the experts felt that a deficient safety culture could effect LOCA frequencies by a factor of a 100 or greater. Dr. Apostolakis asked why an average safety culture was assumed. Mr. Tregoning said that safety culture was considered a separate issue. He added that plants with known issues such as steam generator replacement, learning environments, and an aging work force were considered as part of the average responses. Safety culture was to be considered by the bounding responses.

- Dr. Denning cautioned that there is a tremendous impact on the mean, if there's a plant that's 100 times worse than any other. He used NUREG-1150 as an example where the means of the distributions were greater than the 95 percentile. Dr. Denning thought the staff was constraining this in a way that doesn't reflect the reality of the population of

plants that are out there today or will be in the future recognizing that there are always going to be bad plants. Mr. Tregoning responded that we want generic estimates that are not skewed by one plant.

- Dr. Apostolakis referenced Appendix H of the report on safety culture and he concluded that some experts considered Davis-Bessie. But the summary says the two principle conclusions from the safety culture elicitation questions are, first, safety culture effects on future LOCA frequencies are expected to be minimal and second, industry and regulatory safety culture are highly correlated. Appendix H then states, "Because of these findings no modification or adjustment was applied ..." Dr. Shack added that he thought that what they were saying was that they didn't expect changes in safety culture to change the frequency, not that safety culture can't change the frequency. Dr. Apostolakis concluded that the effect of a poor safety culture was a limitation of the study.

- Dr. Bonaca suggested that the report provide a rationale for using the distributions to define a transition break size. Mr. Tregoning responded that the statement of considerations for defining the transition break size would provide this. Dr. Bonaca felt it would also be appropriate to provide it in the executive summary.

- Dr. Shack said that when he looked through the base case, he found dependencies on the diameter of 1.5 for one group of experts and 5 for another group of experts. Dr. Shack asked why the final estimation uses an intermediate dependency on D of approximately 3.4. Mr. Tregoning responded that the base case results were developed for a specific set of conditions using a couple of different methods. This resulted in different ratios for those specific base case conditions. Each expert was allowed to choose a set of base case values. They could choose one of the four developed as part of the elicitation or could come up with something of their own. Some people amalgamated the different methods. Some people didn't use the base case estimates at all. This resulted in many different intermediate dependencies. The staff amalgamated these results by taking the geometric mean of all the experts for any given LOCA category to come up with the final result.

- Dr. Shack suggested an alternative base case where the conditional probabilities from fracture mechanics were added with the empirical occurrence of cracks from Galyean and Lydell. Mr. Tregoning said the could have done that but they wanted to be simpler.

- Dr. Bonaca asked how they got the results on Slide 11 to converge. Mr. Tregoning said some of the difference was due to limitations on the current modeling procedures. He added that all of the experts recognized that the differences in the base case evaluations were exaggerated. Dr. Wallis thought that the results converged because they were being forced to be log normal. Dr. Shack felt that the divergence was due to what the expert considered. For example, in the BWR2 case, the 10^{-16} point considered only thermal fatigue while the higher number considered flow assisted corrosion. Dr. Shack felt it was unfair to compare these two points.

- Dr. Denning was bothered that the error factor correction was only used for estimates below the median. He thought that if it were applied to all the estimates it would have a dramatic impact. Mr. Tregoning said they applied a blanket adjustment that adjusted

everyone's responses by the same degree. It's not an error factor adjustment. They adjusted the individual responses from a 90 percent confidence level to 50 percent.

- Dr. Apostolakis pointed out that the executive summary doesn't tell the decision maker what to use for defining a transition break size. Dr. Apostolakis suggested that the executive summary portray the large uncertainty and diversity of opinion.

- Dr. Bonaca asked if the experts considered the impact of recent relaxations, such as 10 CFR 50.69. Mr. Tregoning acknowledged that relaxations to the current regulatory framework could undermine the elicitation but he added that the experts were specifically told not to consider these possible impacts unless the staff had seen specific impacts. Mr. Tregoning gave the example of BWR power uprates. The staff started seeing more vibration failures than in the past. Mr. Tregoning said the staff will evaluate these phenomenon as they are identified as part of the reevaluation process described in the SRM.

- Dr. Apostolakis emphasized that the experts assumed that the programs that we have in place now to control aging mechanisms will remain in place.

- Dr. Denning asked what evidence there was that the draft NUREG represents a consensus among the experts. Mr. Tregoning said that the philosophy of the elicitation was to come up with central estimates and a group opinion. He said that the experts had reviewed the report and the staff held a two day video teleconference to discuss the experts' comments.

- Dr. Shack agreed with the notion of using the geometric mean aggregation because with an arithmetic average you are dominated by the most conservative opinion.

- Dr. Ford was concerned about the composition of the panel. He would have liked to have seen more chemistry and corrosion expertise on the panel. He was also concerned about outlier plants. He mentioned that a plant that does not effectively implement its H_2 water chemistry program could be a significant outlier.

- Dr. Denning was concerned about the application and the treatment of aggregation. He disagreed with Mr. Abramson that the purpose of the elicitation was to come up with a consensus of judgment. He thought it was to try to characterize the state of knowledge. He thought that the arithmetic average was better than weighting the different experts. He also thought that variability across plants was critical.

- Dr. Bonaca was concerned about the range of uncertainty and plant to plant variability. He felt that these limitations needed to be highlighted in the report.

- Dr. Kress said that he had no real preference for which aggregation method was used but that he preferred the arithmetic mean. He was not sure how to address plant to plant variability. He liked the fact that they had quantified uncertainty. He thought that it represented the uncertainty in the state of knowledge and you can make decisions with it. Finally, he believed that the curves in Appendix H are the ones that should be used for decision making and they ought to be brought forward into the executive summary.

- Dr. Ransom felt that the safety benefits associated with a risk-informed revision to ECCS requirements were unclear. He felt that a degree of consensus among the experts should be pursued to enhance public confidence.

- Mr. Sieber was struck by the fact that the elicitation was focused on an average plant when it is more likely for a LOCA to occur at an outlier plant. He felt this raised the importance of safety culture. He thought the initiating event would be something like faulty inspections, lack of inspections or tolerance of leaks. He was also concerned that we do not have an appreciation for how this rule may be used in the future and its impact on the LOCA frequency estimation.

- Dr. Apostolakis questioned how the staff went from 8 inches, 95th percentile of the baseline distribution, to 14 inches. He postulated it was due to uncertainties. He said that the choice of how much conservative defense-in-depth to impose rests on what kind of uncertainties you have.

SUBCOMMITTEE DECISIONS AND ACTIONS

The Full Committee will review and comment upon the draft NUREG documenting the expert elicitation on large break loss-of-coolant accident frequencies.

BACKGROUND MATERIALS PROVIDED TO THE SUBCOMMITTEE PRIOR TO THIS MEETING

1. Subcommittee status report, including agenda.
2. Memorandum dated November 4, 2004, from Michael E. Mayfield, Director, Division of Engineering Technology, RES, to John T. Larkins, Executive Director, ACRS, Subject: Transmittal of Draft NUREG on Passive System LOCA Frequency Development for use in Risk-Informed Revision of 10 CFR 50.46, Appendix K to Part 50, and GDC and Appendices (Pre-Decisional for Internal ACRS use only)
3. Staff Requirements Memorandum dated July 1, 2004, from Annette L. Vietti-Cook, SECY, NRC, to Luis A. Reyes, EDO, NRC, Subject: Staff Requirements - SECY-04-0037, "Issues Related to Proposed Rulemaking to Risk-Inform Requirements Related to Large Break Loss-of-Coolant-Accident (LOCA) Break Size and Plans for Rulemaking on LOCA With Coincident Loss-of-Offsite Power"

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Note: Additional details of this meeting can be obtained from a transcript of this meeting available for downloading or viewing on the Internet at "http://www.nrc.gov/ACRSACNW' or can be purchased from Neal R. Gross and Co., Inc., (Court Reporters and Transcribers) 1323 Rhode Island Avenue, NW., Washington, DC 20005 (202) 234-4433.

MEMORANDUM TO: M. R. Snodderly, Senior ACRS Staff Engineer

FROM: G. E. Apostolakis, Acting Chairman
Regulatory Policies and Practices Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE ACRS SUBCOMMITTEE ON REGULATORY POLICIES AND PRACTICES, NOVEMBER 16, 2004 - ROCKVILLE, MARYLAND

I do hereby certify that, to the best of my knowledge and belief, the minutes of the subject meeting on November 16, 2004, are an accurate record of the proceedings for that meeting.

2/6/05

George E. Apostolakis, Date
Acting Subcommittee Chairman

PRE-DECISIONAL

February 2, 2005

MEMORANDUM TO: G. E. Apostolakis, Acting Chairman
Regulatory Policies and Practices Subcommittee

FROM: M. R. Snodderly, Senior ACRS Staff Engineer

SUBJECT: WORKING COPY OF THE MINUTES OF THE MEETING OF THE ACRS SUBCOMMITTEE ON REGULATORY POLICIES AND PRACTICES, NOVEMBER 16, 2004 - ROCKVILLE, MARYLAND

A working copy of the minutes for the subject meeting is attached for your review. Please review and comment on them. If you are satisfied with these minutes please sign, date, and return the attached certification letter.

Attachment: Minutes (DRAFT)

cc: Regulatory Policies and Practices Subcommittee Members
G. Apostolakis
M. Bonaca
P. Ford
S. Rosen
J. Sieber
G. Wallis
S. Duraiswamy
J. Larkins

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MEETING OF THE SUBCOMMITTEE ON
REGULATORY POLICIES AND PRACTICES
ROOM T-2B1, 11545 ROCKVILLE PIKE, ROCKVILLE MD
NOVEMBER 16, 2004

Contact: Michael Snodderly (301-415-6927, mrs1@nrc.gov)

-PROPOSED SCHEDULE-

	TOPICS	PRESENTERS	TIME
I.	**Opening Remarks**	G. Apostolakis, ACRS	8:01 8:00-8:05 a.m.
II.	**Discussion of LOCA Frequencies for Risk-Informed Revision of 10 CFR 50.46**	R. Tregoning, NRR L. Abramson, RES	8:05-9:15 a.m.
	BREAK		9:30-9:44 a.m. ~~**9:15-9:30 a.m.**~~
III.	**Discussion of LOCA Frequencies for Risk-Informed Revision of 10 CFR 50.46 (Cont.)**	R. Tregoning, RES L. Abramson, RES	9:30-10:45 a.m.
IV.	**General Discussion-Including Material to be presented to the Full Committee**	G. Apostolakis, ACRS	10:45-11:00 a.m.
V.	**Adjourn**	G. Apostolakis, ACRS	11:00 a.m.

NOTE:

- Presentation time should not exceed 50 percent of the total time allocated for specific item. The remaining 50 percent of the time is reserved for discussion.
- 35 copies of the presentation materials to be provided to the Subcommittee

Dated: October 27, 2004.

John H. Flack,

Acting Branch Chief, ACRS/ACNW.

[FR Doc. 04–24381 Filed 11–1–04; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards, Meeting of the ACRS Subcommittee on Regulatory Policies and Practices; Notice of Meeting

The ACRS Subcommittee on Regulatory Policies and Practices will hold a meeting on November 16, 2004, Room T–2B1, 11545 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows:

Tuesday, November 16, 2004—8 a.m. until 11 a.m.

The purpose of this meeting is to review the draft proposed NUREG documenting the expert elicitation on large break loss-of-coolant accident frequencies. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff and other interested persons regarding this matter. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Official, Mr. Michael R. Snodderly (Telephone: 301–415–6927) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted during the meeting.

Further information regarding this meeting can be obtained by contacting the Designated Federal Officials between 7:30 a.m. and 4:15 p.m. (e.t.). Persons planning to attend this meeting are urged to contact the above named individual at least two working days prior to the meeting to be advised of any potential changes to the agenda.

Dated: October 27, 2004.

John H. Flack,

Acting Branch Chief, ACRS/ACNW.

[FR Doc. 04–24382 Filed 11–1–04; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Sunshine Act Meeting

DATE: Weeks of November 1, 8, 15, 22,29, December 6, 2004.

PLACE: Commissioners' Conference Room, 11555 Rockville Pike, Rockville, Maryland.

STATUS: Public and closed.

MATTERS TO BE CONSIDERED:

Week of November 1, 2004

There are no meetings scheduled for the week of November 1, 2004.

Week of November 8, 2004—Tentative

Monday, November 8, 2004

9 a.m. Briefing on Plant Aging and Material Degradation Issues—Part One (Public Meeting) (Contact: Steve Koenick, 301–415–1239)

1:30 p.m. Briefing on Plant Aging and Material Degradation Issues—Part Two (Public Meeting) (Contact: Steve Koenick, 301–415–1239)

This meeting (both parts) will be webcast live at the Web address—*http://www.nrc.gov.*

Wednesday, November 10, 2004

2:30 p.m. Affirmation Session (Public Meeting) (Tentative)

a. U.S. Department of Energy (High Level Waste Repository: Pre-Application Matters); DOE's appeal of LBP–04–20 (Tentative)

b. Exelon Generation Company, LLC (Clinton ESP Site), LBP–04–17 (August 6, 2004) (Tentative)

Week of November 15, 2004—Tentative

Tuesday, November 16, 2004

1:30 p.m. Briefing on Threat Environment Assessment (Closed—Ex. 1)

Thursday, November 18, 2004

1:30 p.m. Discussion of Security Issues (Closed—Ex. 1)

Week of November 22, 2004—Tentative

There are no meetings scheduled for the week of November 22, 2004.

Week of November 29, 2004—Tentative

There are no meetings scheduled for the week of November 22, 2004.

Week of December 6, 2004—Tentative

Tuesday, December 7, 2004

9:30 a.m. Briefing on Equal Employment Opportunity (EEO) Program (Public Meeting) (Contact: Corenthis Kelley, 301–415–7380)

1 p.m. Discussion of Nuclear Fuel Performance (Public Meeting) (Contact: Frank Akstulewicz, 301–415–1136)

This meeting will be webcast live at the Web address—*http://www.nrc.gov.*

Wednesday, December 8, 2004

1 p.m. Briefing on Status of Davis Besse Lessons Learned Task Force Recommendations (Public Meeting) (Contact: John Jolicoeur, 301–415–1724)

This meeting will be webcast live at the Web address—*http://www.nrc.gov.*

Thursday, December 9, 2004

1 p.m. Briefing on Reactor Safety and Licensing Activities (Public Meeting) (Contact: Steve Koenick, 301–415–1239)

This meeting will be webcast live at the Web adderss—*http://www.nrc.gov.*

*The schedule for Commission meetings is subject to change on short notice. To verify the status of meetings call (recording)—(301) 415–1292. Contact person for more information: Dave Gamberoni, (301) 415–1651.

* * * * *

The NRC Commission Meeting Schedule can be found on the Internet at: *http://www.nrc.gov/what-we-do/policy-making/schedule.htm.*

* * * * *

The NRC provides reasonable accommodation to individuals with disabilities where appropriate. If you need a reasonable accommodation to participate in these public meetings, or need this meeting notice or the transcript or other information from the public meetings in another format (*e.g.*, braille, large print), please notify the NRC's Disability Program Coordinator, August Spector, at 301–415–7080, TDD: 301–415–2100, or by e-mail at *aks@nrc.gov.* Determinations on requests for reasonable accommodation will be made on a case-by-case basis.

* * * * *

This notice is distributed by mail to several hundred subscribers; if you no longer wish to receive it, or would like to be added to the distribution, please contact the Office of the Secretary, Washington, DC 20555 (301–415–1969). In addition, distribution of this meeting notice over the Internet system is available. If you are interested in receiving this Commission meeting schedule electronically, please send an electronic message to *dkw@nrc.gov.*

Dated: October 28, 2004.

Dave Gamberoni,

Office of the Secretary.

[FR Doc. 04–24492 Filed 10–29–04; 9:23 am]

BILLING CODE 7590–01–M

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON REGULATORY POLICES

AND PRACTICES

November 16, 2004
Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

	NAME	NRC ORGANIZATION
	Allen Hiser	RES/MEB
	ROB TREGONING	RES/DET/MEB
	LEE ABRAMSON	RES
	Arthur Salomon	RES/DRAA/PRAB
(afternoon)	Mary Drouin	RES/DRAA/PRAB
(afternoon)	Gareth Parry	NRR/DSSA
(afternoon)	J.S. Hyslop	RES/PRAB
(afternoon)	Charles Ada	RES/DRAA
(afternoon)	DAVID LEW	RES/PRAB

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON REGULATORY POLICIES AND PRACTICES

November 16, 2004
Date

PLEASE PRINT

	NAME	AFFILIATION
	John Butler	NEI
	Stanley Levinson	AREVA
	Ray Schneider	WEC
(afternoon)	John Lehner	BNL
(afternoon)	Gene Hughes	Exelon - Erin
(afternoon)	Doug True	Erin

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

Robert L. Tregoning
Lee Abramson
RES

ACRS Subcommittee on Regulatory Policies and Practices
November 16, 2004

Presentation Objectives

1. Outline LOCA elicitation chronicled in draft NUREG and used as part of the technical basis supporting the proposed 50.46 rule revision.

2. Communicate research conducted since the previous ACRS discussion (July 7, 2004).
   - Additional sensitivity analyses.
   - Internal and external review.

Previous ACRS Briefings and Recent Program Milestones

- Previous ACRS briefings
  - July 2004: Main Committee on results, sensitivity analyses and use of results for transition break size selection.
  - March/April, 2004: RPP Subcommittee and Main Committee on expert elicitation results.
  - November, 2003: RPP Subcommittee on expert elicitation approach and base case development.
  - July, 2003: Main Committee on the status and approach of expert elicitation.
  - May, 2002: Combined M&M, THP, R&PRA subcommittee briefing on interim LOCA frequency elicitation and LOCA break size redefinition plans.
  - June, July, November, 2001: Overviews of LOCA frequency and break size redefinition effort provided to outline its importance within 10 CFR 50.46 revision framework.
  - March, 2001: Technical issues necessitating LOCA reevaluation.
- Program milestones since July 2004
  - Completed initial review of draft NUREG by elicitation panelists: August 30th.
  - Completed external review of elicitation response analysis: September 30th.
  - Submitted draft NUREG for ACRS review: November 5th.

Executive Summary

- Formal elicitation process used to estimate generic BWR and PWR passive-system LOCA frequencies associated with material degradation.
- Developed quantitative estimates for piping and non-piping base cases for anchoring elicitation responses.
- Panelists provided quantitative estimates supported by qualitative rationale for underlying technical issues in individual elicitations.
  - Generally good agreement about LOCA contributing factors.
  - Large individual uncertainty and panel variability in quantifying estimates.
- Quantitative results determined by aggregating individual panelists' estimates.
  - Geometric mean aggregation results are consistent with elicitation philosophy and results comparable to NUREG/CR-5750 estimates.
  - Alternative aggregation schemes can result in higher LOCA frequencies.
- LOCA elicitation provides a sufficient technical basis to support transition break size development.

Motivation

- Develop 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).

- Determine LOCA frequency distributions for plant PRA modeling.

Elicitation Objectives and Scope

- Develop generic BWR and PWR piping and non-piping passive system LOCA frequency distributions as function of break size and operating time.
  - LOCAs which initiate in unisolable portion of reactor coolant system.
  - LOCAs related to passive component aging, tempered by mitigation measures.
  - Small, medium, and large-break LOCAs examined. Large break category further subdivided to consider LOCA sizes up to complete break of largest RCS piping.
  - Time frames considered: 25 years (current day), 40 years (end of original license), and 60 years (end of life extension).
- Primary focus: frequencies associated with normal operating loads and expected transients.
- Assume that no significant changes will occur in the plant operating profiles.

Formal Elicitation Approach

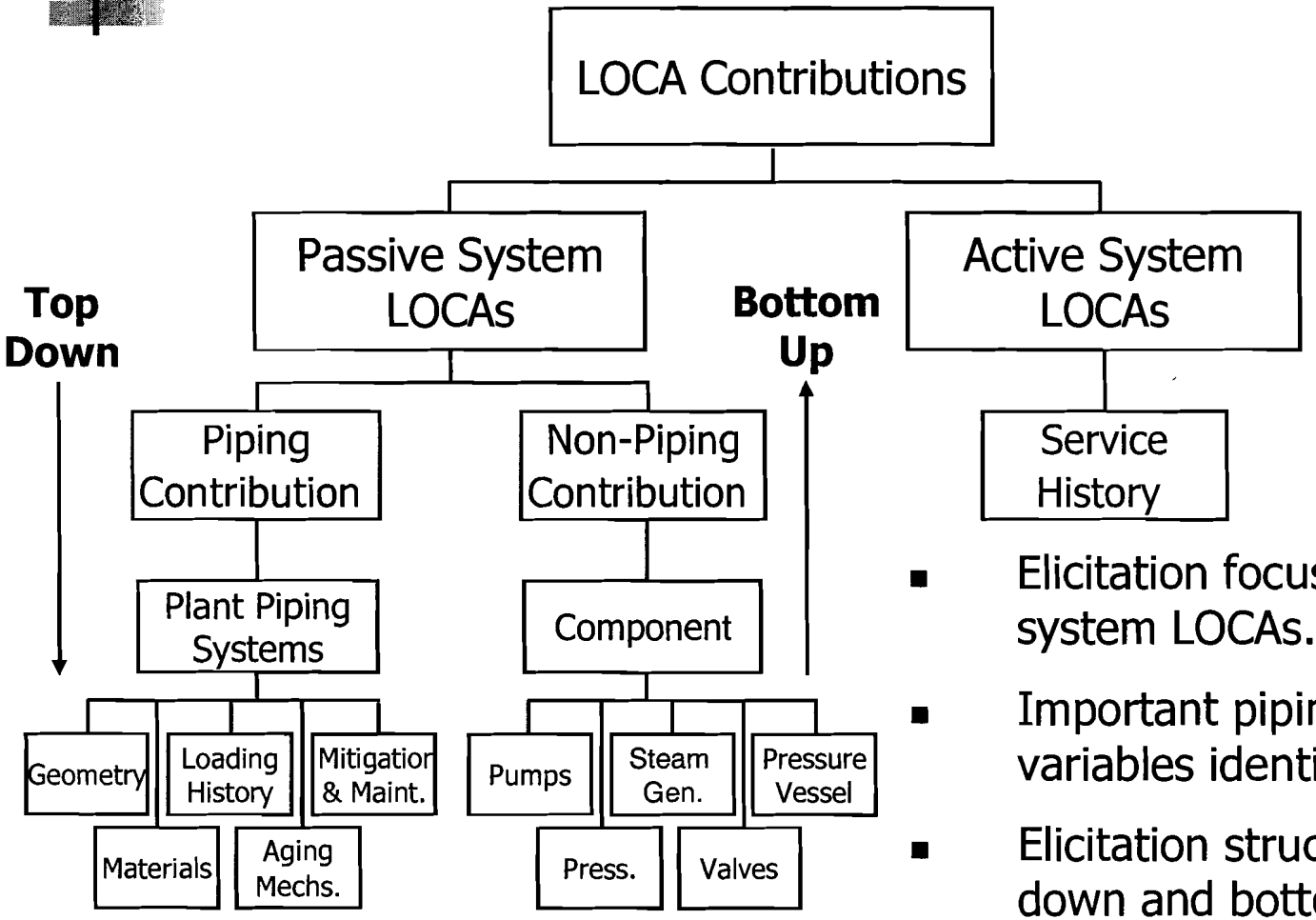
- Conduct preliminary elicitation.
- Select panel and facilitation team.
- Develop technical issues.
- Quantify base case estimates.
- Formulate elicitation questions.
- Conduct individual elicitations.
- Analyze quantitative results and qualitative rationale.
- Summarize and document results.
- Conduct internal and external review of process and results.

LOCA Size Classification

- LOCA sizes based on leak rate to group into classes having similar mitigation measures.
  - First three categories similar to NUREG-1150 and NUREG/CR-5750.
  - Three additional LBLOCA categories used to determine larger break size frequencies.
- Correlations developed to relate flow rate to effective break area.
- Three time periods evaluated.
  - Current (average 25 years of operating experience.
  - End of design life (40 years of operation).
  - End of life extension (60 years of operation).

Category	Flow 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

Technical Issues Structure

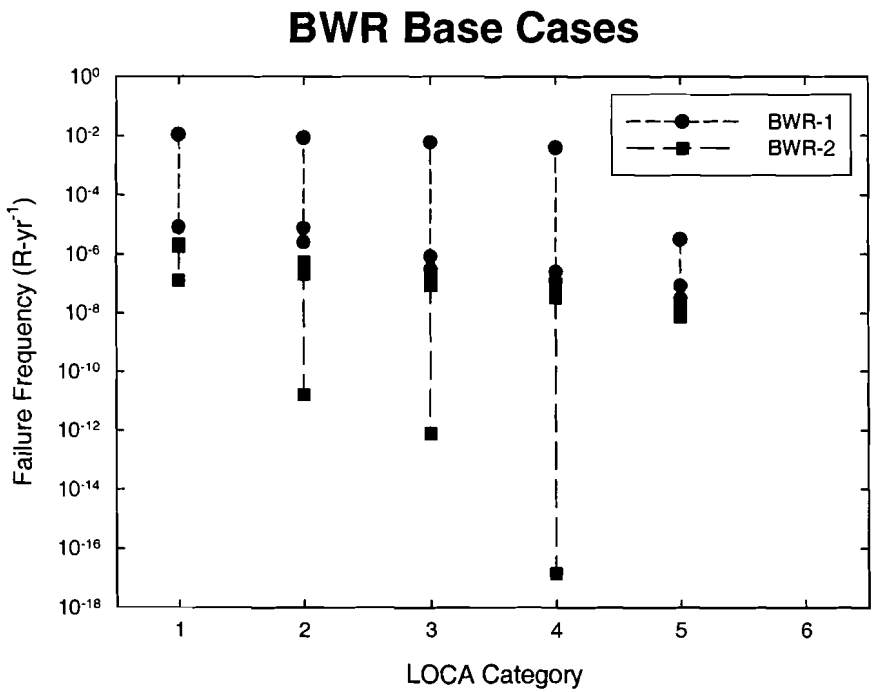


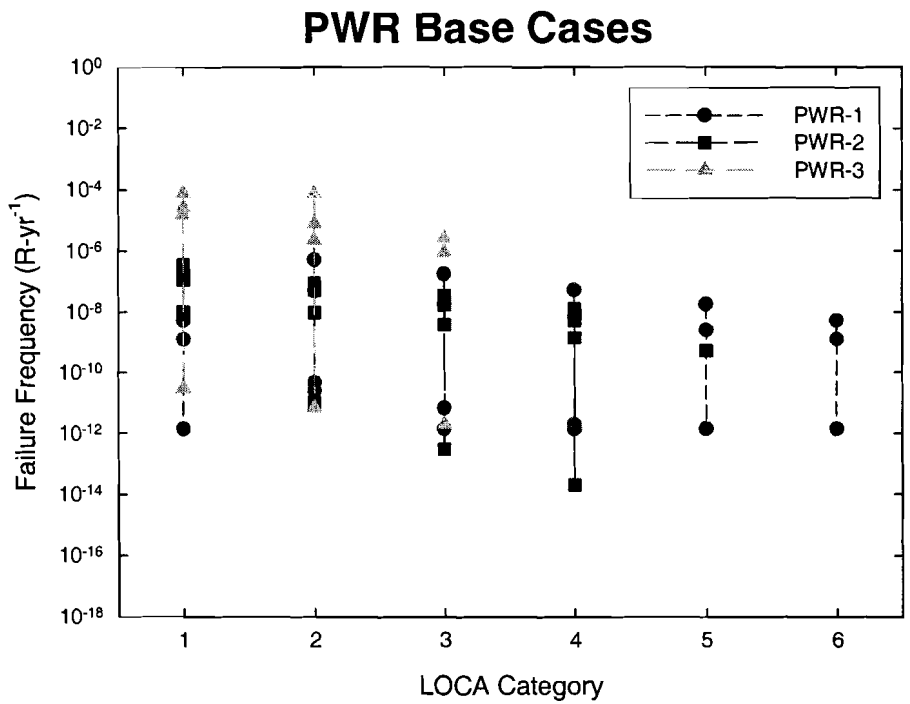
- Elicitation focuses on passive system LOCAs.
- Important piping and non-piping variables identified.
- Elicitation structure supports top down and bottom up analyses.

Piping Base Case Development

- All elicitation responses relative to the base cases.
- Base case conditions specify the piping system, piping size, material, loading, degradation mechanism(s), and mitigation procedures.
- Five Base Cases Defined.
  - BWR
    - Recirculation System (BWR-1)
    - Feedwater System (BWR-2)
  - PWR
    - Hot Leg (PWR-1)
    - Surge Line (PWR-2)
    - High Pressure Injection makeup (PWR-3)
- The LOCA frequency for each base case condition is calculated as a function of flow rate and operating time.
- Four panel members individually estimated frequencies: two using operating experience and two using probabilistic fracture mechanics.

Piping Base Case Summary Results: 25 Year Operating Period





- Large variability due to inconsistencies in both the conditions evaluated and differences in approaches.
- Each base case participant presented their approach and results to entire panel.
- Each panel member was asked to critique approaches & results during their elicitation session.

Non-Piping Base Case Development

- The variety and complexity of the non-piping failure mechanisms mades the piping base case approach intractable.
- Approach.
  - Develop general non-piping precursor database.
  - Use PFM modeling to develop LOCA frequencies for targeted degradation mechanisms.
    - CRDM ejection.
    - BWR vessel rupture: normal operating and LTOP.
    - PWR vessel rupture: PTS.
- Analysis requirements.
  - Choose appropriate base case: non-piping precursor, piping precursor, piping base case, or non-piping base case.
  - Determine relative likelihood of failure for other non-piping failure scenarios.

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.
- Quantitative Responses:
  - Questions are relative to a set of chosen base case conditions.
  - Each question asks for mid, low, and high values.
  - Questions can be answered using a top-down or bottom-up approach.
- Qualitative Rationale:
  - Rationale is provided and discussed for important issues to support quantitative values provided by each panelist.
  - Possible inconsistencies between answers and rationales brought to panelists' attention.

Analysis of Elicitation Responses: Framework

- Calculate individual estimates for each panelist.
  - Total BWR and PWR LOCA estimates.
  - Approach is most self-consistent.
- Aggregate individual estimates: Philosophy.
  - Group results should be near center of individual estimates.
  - Outliers should not dominate quantitative estimates.
- Aggregate individual estimates: Approach.
  - Aggregate parameters (mean, median, 5th & 95th percentiles) of individual distributions.
  - Calculate confidence bounds associated with each group parameter estimate.
- Final LOCA distributions reflect uncertainty and variability.
  - Uncertainty: Individual panel member responses.
  - Variability: Range of individual responses.

Elicitation Insights: BWR & PWR Plants

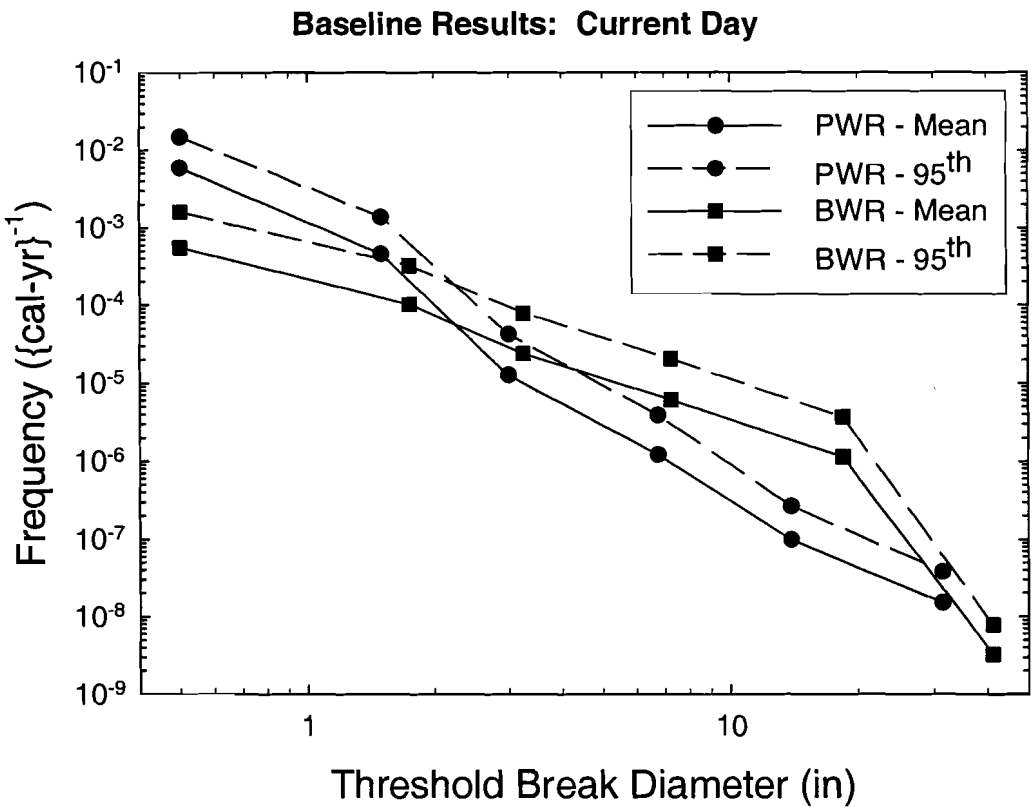
- BWR Plants
  - Thermal fatigue, intergranular stress corrosion cracking (IGSCC), mechanical fatigue, flow accelerated corrosion (FAC) identified as important degradation mechanisms.
  - Increased operating transients (e.g., water hammer) compared to PWR plants.
  - BWR community has more experience identifying and mitigating degradation due to IGSCC experience in the early 1980s.
  - BWR service experience must be carefully evaluated due to preponderance of pre-mitigation IGSCC precursor events.
- PWR Plants
  - Primary water stress corrosion cracking (PWSCC), thermal fatigue, and mechanical fatigue identified as important degradation mechanisms.
  - PWSCC concerns paramount for panel.
    - Near-term frequency increases due to PWSCC are likely before effective mitigation is developed.
    - Most panelists believe that issue will be successfully resolved within the next several years.

Elicitation Insights: Piping & Non-Piping

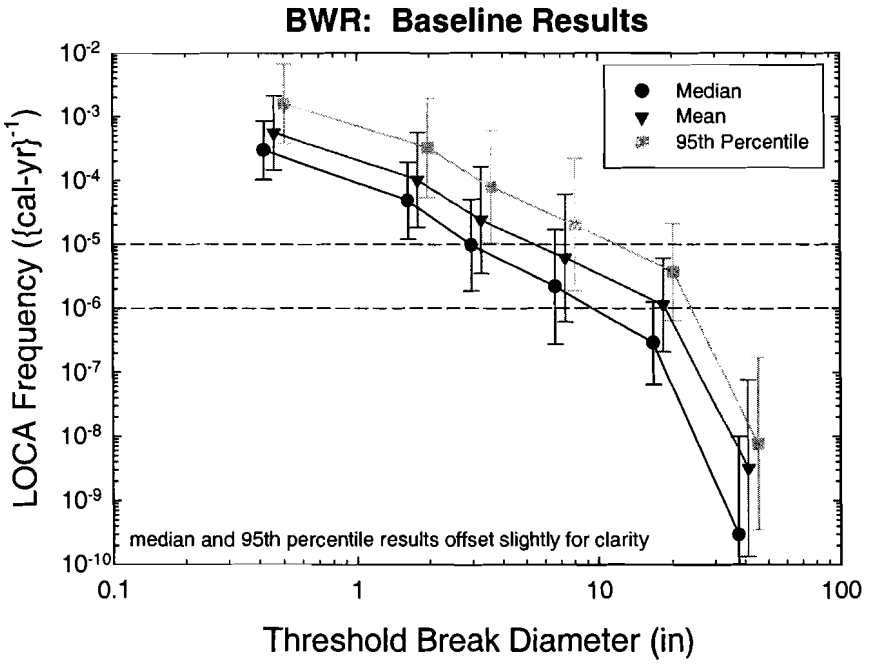
- Piping
  - Complete failures of smallest piping are more likely than partial failure of larger piping.
  - Aging may have greatest effect on intermediate-size piping (6″ – 14″).
    - Smallest piping is governed by service history failure rates.
    - Largest piping is subject to higher quality inspections and has increased leak-before-break margin.
- Non-Piping.
  - Estimation of non-piping failure frequencies is more challenging than piping.
    - Widely varying operating requirements, design margins, materials, and inspectability.
    - Widely varying failure modes and scales.
    - Generally not same wealth of precursor information as piping.
  - Larger non-piping components (e.g., pressurizer, valve bodies, pump bodies, etc) have increased design margin compared to piping, but decreased inspection quantity and quality.
  - Smaller non-piping components (e.g., steam generator tubes, CRDM nozzles) are expected to benefit most from improved inspection methods and mitigation programs.

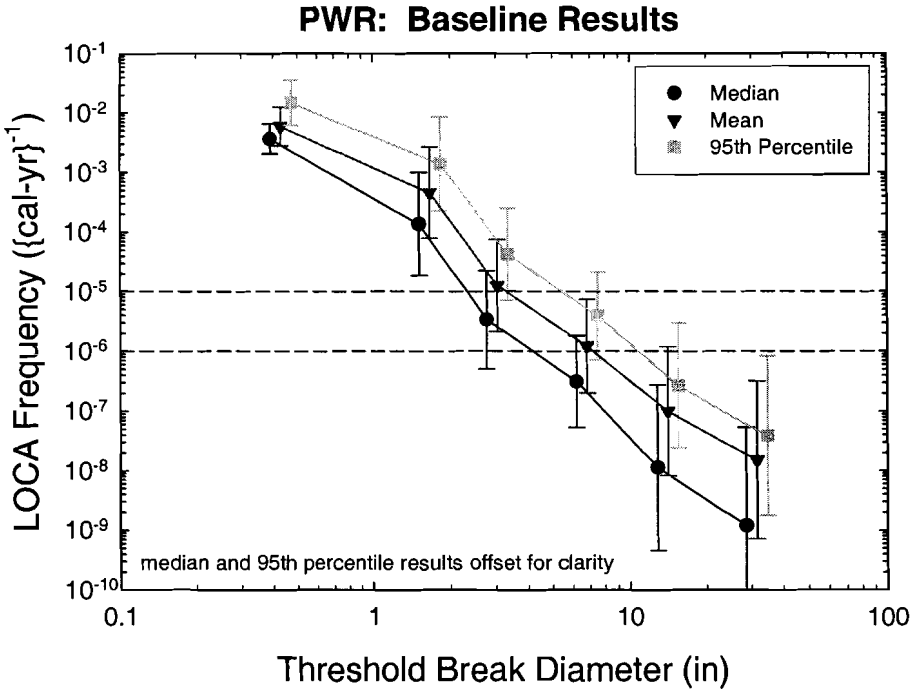
Total LOCA Frequencies

- 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 for largest LOCA sizes.



Total LOCA Frequencies: Current Day

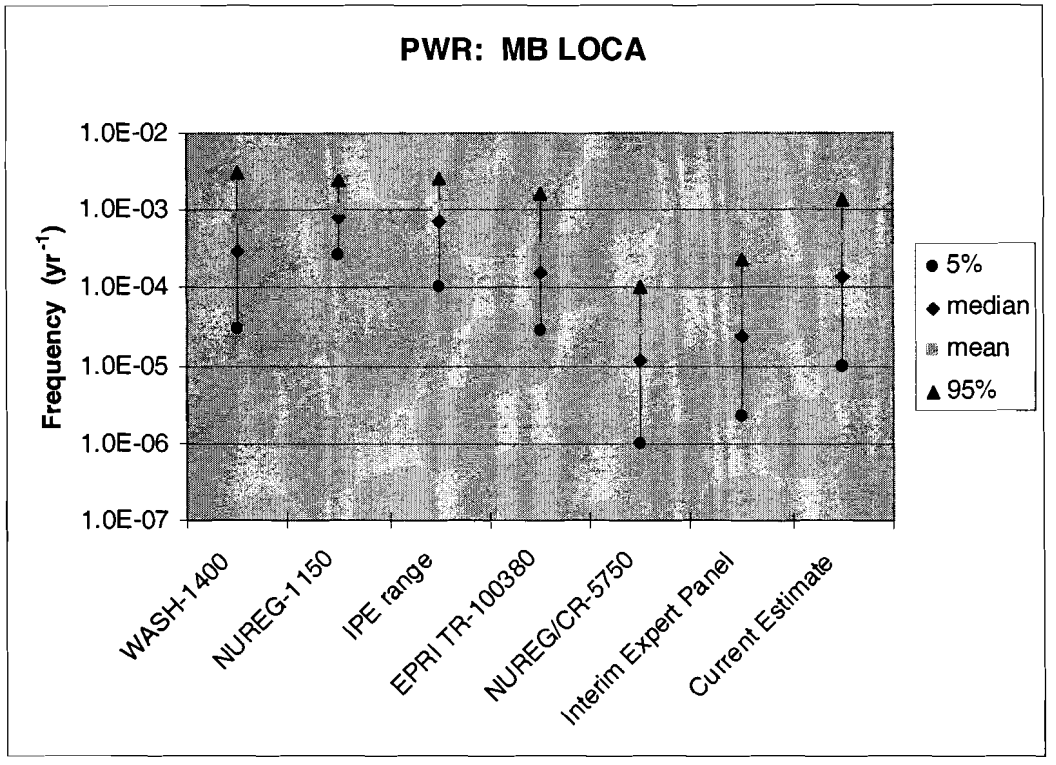




- Error bars represent 95% confidence bounds accounting for variability among panelist responses.
- Differences between median and 95th percentile estimates reflect individual panelist uncertainty.

Comparison with Prior Studies

Plant Type	LOCA Size	NUREG/CR-5750/Elicitation Current Day
BWR	SB	0.89
	MB	0.32
	LB	3.28
PWR	SB	1.37
	MB	0.07
	LB	3.33



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

Analysis of Elicitation Responses: Sensitivity Analyses

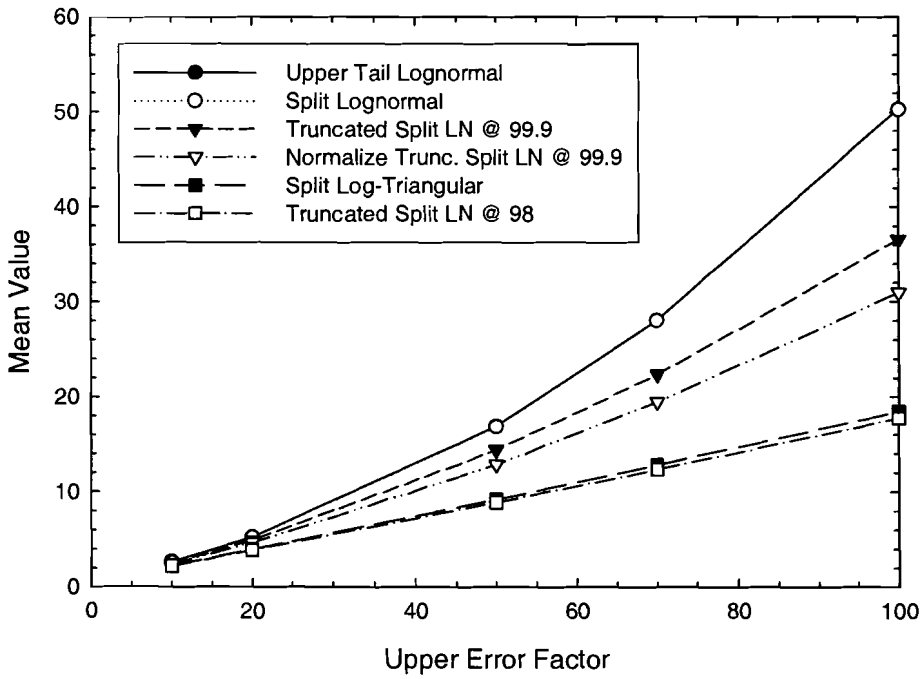
- Determine effect of different assumptions on the LOCA frequency estimates.

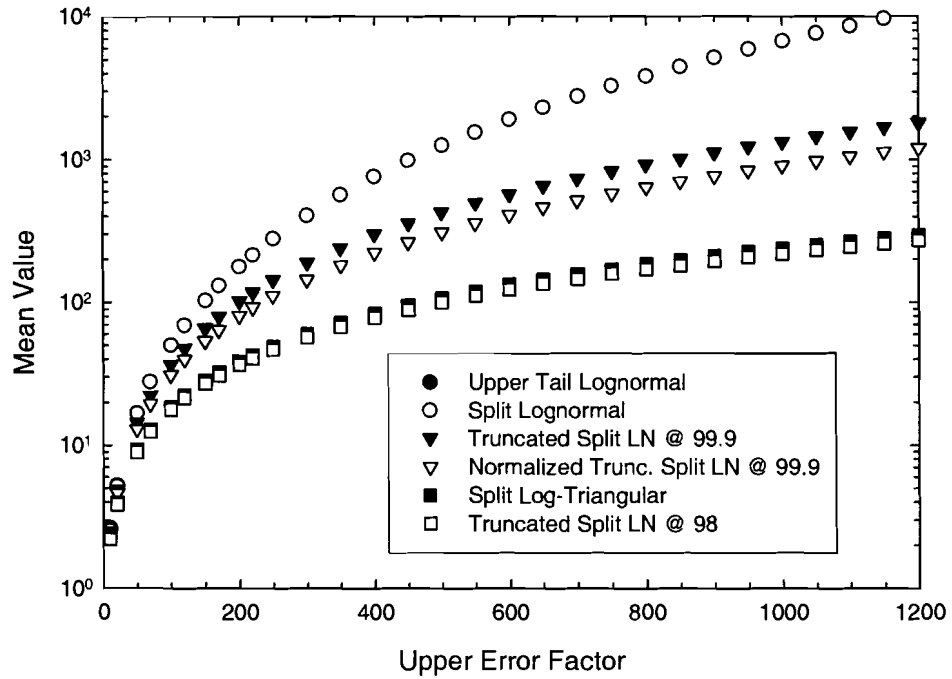
- Sensitivity analyses conducted in five broad areas of analysis.
  - Effect of distribution shape on mean.
  - Overconfidence adjustment.
  - Correlation structure of panelist responses.
  - Aggregating expert opinion.
  - Panel diversity measurement.

Sensitivity Analyses: Effect of Distribution Shape on Mean.

- Observation: Some elicitation responses have large error factors (1000).
- Objective:
  - Maintain integrity of panelist 5th, 50th, and 95th percentile estimates.
  - Evaluate effect on mean of the distribution shape and select a reasonably conservative shape.
- Approach:
  - Distributions evaluated: lognormal, split lognormal, split log-triangular, various split lognormals truncated between the 95th and 99.99th percentile.
  - Evaluate initial bounding distributions and select credible upper and lower bounds.
- Results:
  - Means from untruncated lognormal distributions are too dependent on the area beyond the 95th percentile for large error factors. Panelists provided no information beyond the 95th percentile.
  - Distributions truncated just past the 95th percentile assume panelist's 95th percentile is bounding, contrary to elicitation instructions.
  - The split log-triangular and split lognormal distribution truncated at the 99.9th percentile provide reasonable bounds.

Sensitivity Analyses: Effect of Distribution Shape on Mean.





- Insignificant differences (< factor of 2) among all distributions when error factor is less than 50.
- Large differences (factor of 80) between lognormal and lognormal truncated at the 95th percentile; smaller differences (factor of 5.5) between lognormal truncated at 99.9th and split log-triangular.
- Use of split lognormal distribution truncated at the 99.9th percentile is reasonably conservative.

Sensitivity Analyses: Overconfidence Adjustment

- Experts are generally overconfident about their uncertainty.
  - Demonstrated using almanac-type questions with known answers.
  - Rule of thumb: true coverage level is approximately half the nominal coverage level.
    - Nominal elicitation coverage level: 90% (95th – 5th percentiles)
    - Implication is that true coverage level is about 50% (75th – 25th percentile).
- Evaluate the effect of adjusting the nominal coverage level.
  - No change in the mid value responses
  - Evaluate adjustments of error factors associated with bottom line responses for each panelist.
  - More ad hoc broad and targeted adjustment schemes evaluated and discussed in NUREG, but not as attractive.

Sensitivity Analyses: Overconfidence Adjustment

- Philosophy:
  - Comparison with group estimate determines which results are adjusted and degree of adjustment.
  - Adjustment factor varies by LOCA Category.
- Approach:
  - Determine the geometric mean of the error factors for BWR and PWR total results.
  - Adjust error factors which are less than the geometric mean up to the geometric mean.
  - No adjustment of error factors above the geometric mean.
  - No change in the medians.
  - Recalculate the mean and percentiles.

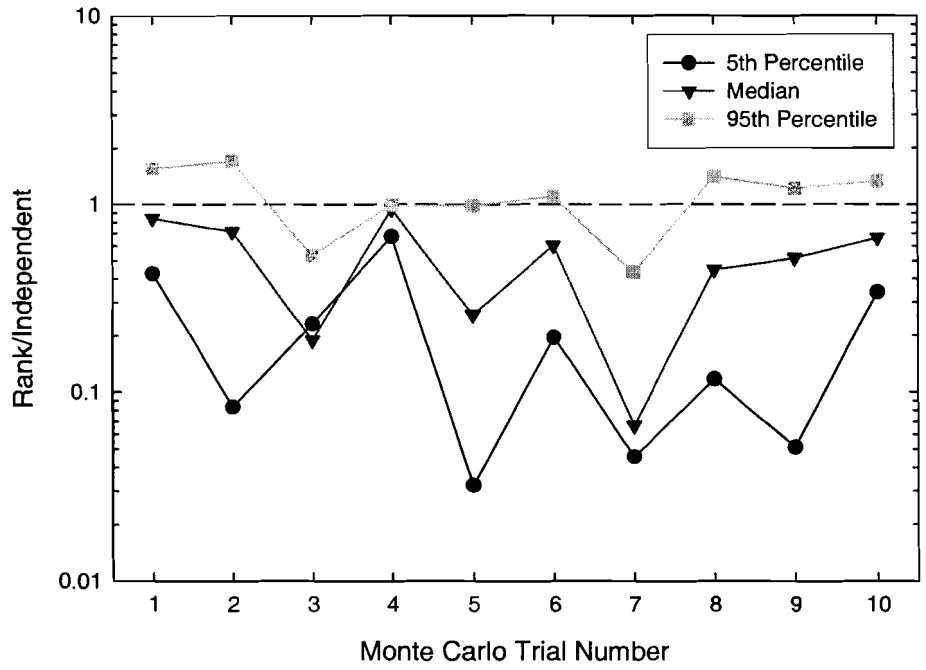
Geometric Mean of Panelist's Total Error Factors

LOCA Category	BWR Plants		PWR Plants	
	Lower EF	Upper EF	Lower EF	Upper EF
1	7	5	5	4
2	13	7	14	10
3	13	8	13	12
4	18	9	16	12
5	24	13	21	24
6	30	26	26	32

- Results:
  - Correction leads to modest increases in mean and 95th percentile estimates which increase with LOCA size.
  - BWR: < factor of 2 difference with baseline.
  - PWR: < factor of 3 difference with baseline.
- This overconfidence adjustment scheme is reasonable.

Sensitivity Analyses: Correlation Structure of Panelist Responses

- Motivation:
  - Correlation structure needed to calculate percentiles associated with piping component (and non-piping subcomponent) responses.
  - Perfect rank and independent structures bound variance.
- Approach:
  - Monte Carlo simulations of elicitation responses which make up selected bottom line estimates.
  - Choose responses with characteristics which span the population.
- Results: Perfect Rank vs. Independent.
  - 95th percentile: < factor of 2 difference.
  - Median: < factor of 10 difference.
  - Differences are largest for the high error factor distributions.
  - Rank correlation:
    - Lower bound for median and 5th
    - Upper bound for 95th except for large EF.

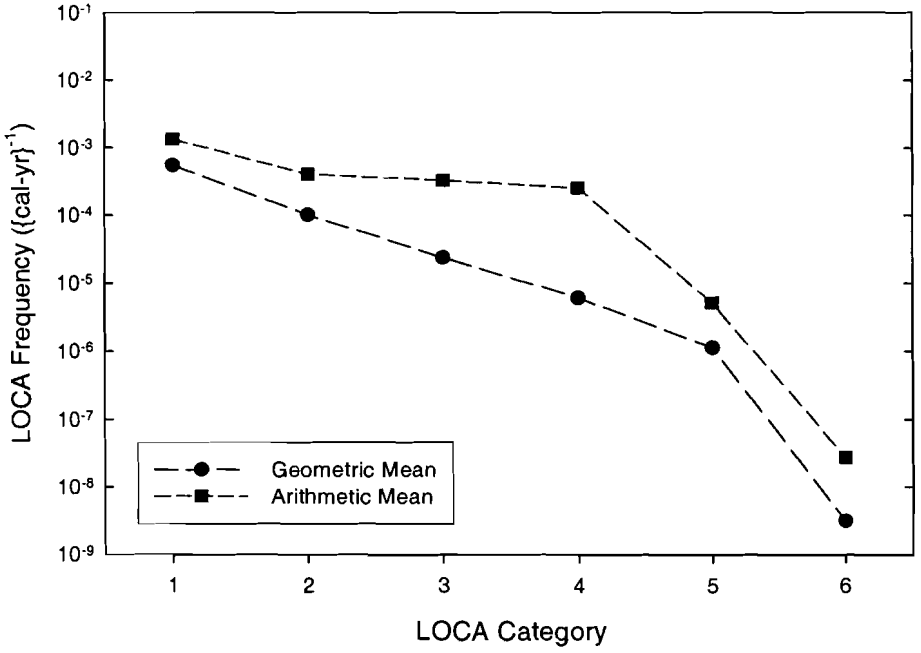


Sensitivity Analyses: Aggregating Expert Opinion

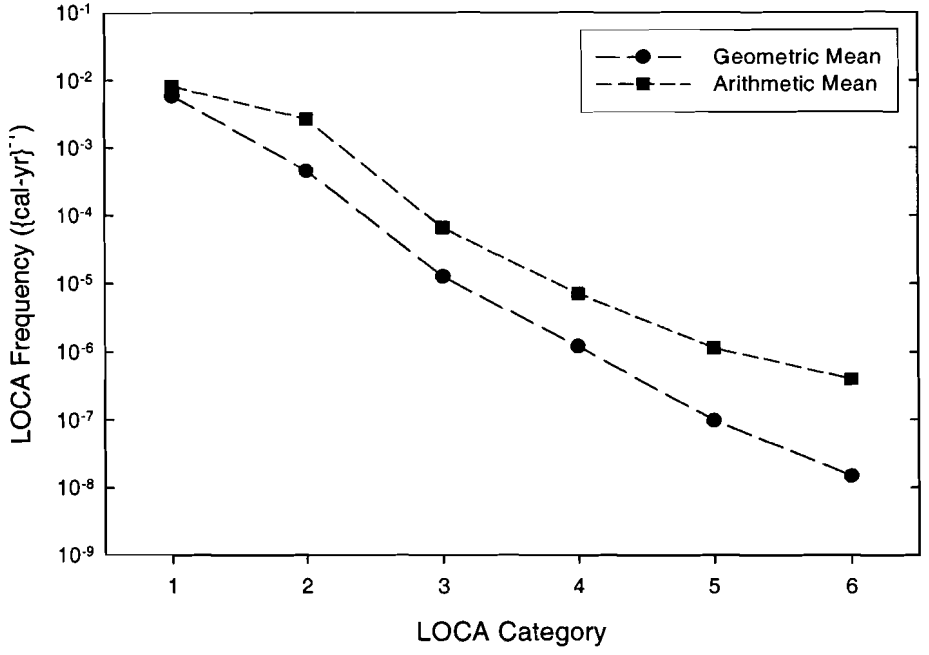
- Baseline method uses geometric mean of the individual panelist estimates to determine group estimates for all total LOCA frequency parameters: 5th, 50th, 95th, mean.
  - Based on assumed lognormal structure of individual estimates.
  - Ensures estimates are not significantly influenced by outliers.
  - Results using median or trimmed geometric mean are similar to baseline method.
- Alternative method is to use the arithmetic mean all the individual panelist distributions (mixture distribution).
  - Assumes that individual results are obtained from equally credible models that are randomly sampled from population of models.
  - Key regulatory parameters may be dominated by outliers.
  - Difference between 5th and 95th percentiles is much wider.

Aggregating Expert Opinion: Arithmetic (AM) vs. Geometric (GM) Mean

BWR Current Day Estimates: Mean Frequency



PWR Current Day Estimates: Mean Frequency



- Aggregated estimates can be significantly affected by approach.
- Similar difference among 95th percentile estimates.

Aggregating Expert Opinion: Mixture Distribution Comparison

Ratio of Mixture Distribution to Geometric Mean Aggregation

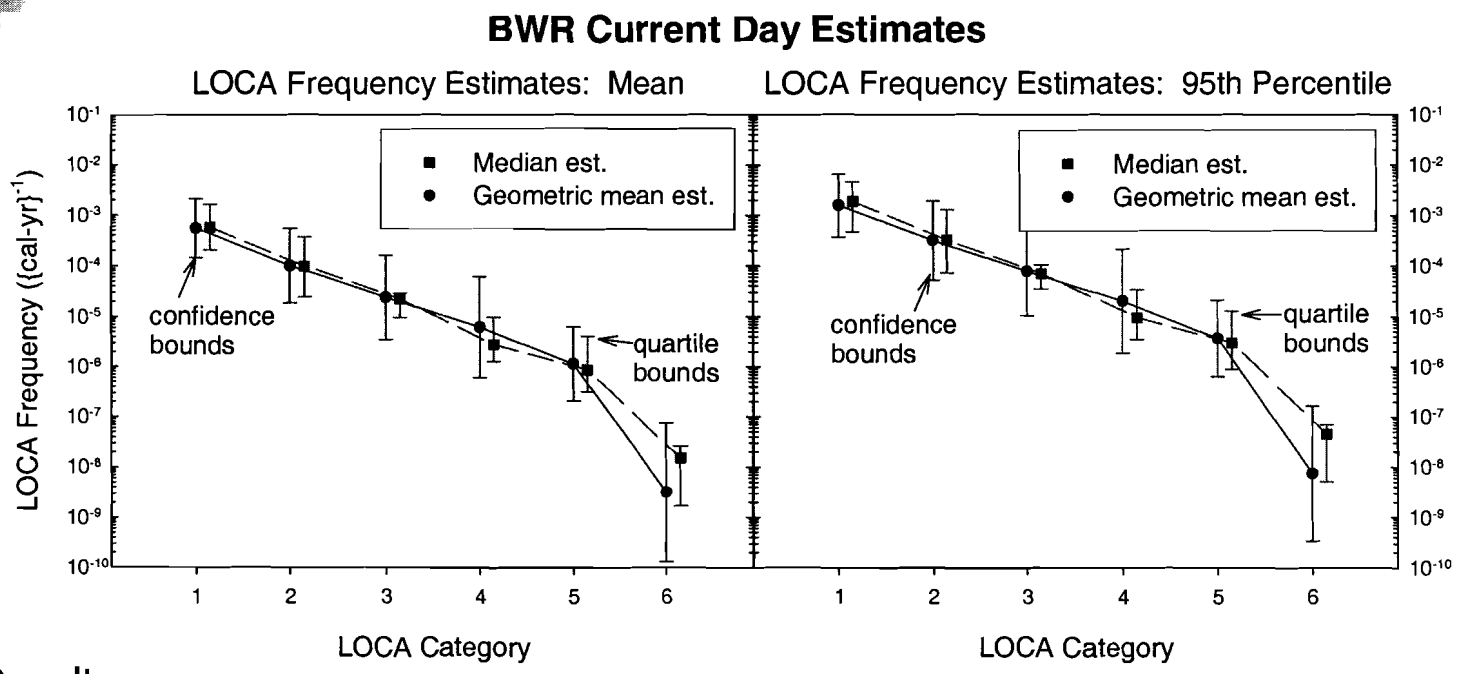
BWR: Current Day			PWR: Current Day		
LOCA Category	Mean	95th Percentile	LOCA Category	Mean	95th Percentile
1	2	3	1	1	2
2	4	4	2	6	6
3	14	17	3	5	5
4	42	50	4	6	5
5	5	5	5	12	7
6	9	6	6	27	20

- Mixture distribution mean and 95th percentiles are always highere.
  - Increases often less than a factor of ten.
  - Sometime greater than factor of 10.
- Difference from geometric mean aggregation is a function of the spread among panelists.
  - Largest differences occur when 1 or 2 panelists have significantly higher frequencies.

Sensitivity Analyses: Panel Diversity Measurement

- Individual panelist uncertainty is captured by the 5th and 95th percentiles estimates of the LOCA frequency distribution.
- Variability among the individual panelist estimates leads to uncertainty in the mean, 5th and 95th percentiles.
- This variability is measured using two methods.
  - Confidence bound calculations.
    - Assume lognormal distribution of individual estimates.
    - Use t-distribution to calculate confidence bounds for geometric mean (group estimate).
    - Determine 95% confidence interval (2.5% and 97.5% confidence bounds) for the median, mean, 5th and 95th percentile estimates.
  - First (25th) and third (75th) quartiles of the individual estimates (interquartile range).
    - Standard box plot measure.
    - Less sensitive to outliers than the range.

Sensitivity Analyses: Panel Diversity Measurement



- Results
  - Confidence and quartile bounds are generally comparable.
  - Confidence bound estimates are more conservative.
  - The elicitation panel results are consistent with the assumption of a lognormal structure.
- Therefore, confidence bounds are used as measures of panel diversity.

Elicitation Panel Review

- Preliminary version of draft NUREG reviewed by elicitation panel members.
  - First version distributed in July.
  - Video teleconference held over two days with all panel members in attendance.
  - Received over 50 revision suggestions.
  - Suggestions focused on background, approach, base case results, analysis, qualitative insights, and quantitative results sections.
- All but a few revision suggestions were incorporated in the current version of the NUREG.
- Updated version also circulated for review and comment. Few additional comments have been received to date.

External Review

- Two reviewers selected: a decision analyst (A. Brothers, PNNL) and a statistician (C. Atwood, Statwood Consulting).
- Objective: Review analysis and quantitative results sections of the NUREG with emphasis on the methods of aggregating group opinion. Comments on other NUREG sections welcome, but not focus of review.
- Approach
  - Provide reviewers with preliminary draft NUREG: early July 2004.
  - Two day kick-off meeting: August 2-3, 2004.
  - Received initial informal comments: August 13, 2004.
  - Received individual draft review reports: September 17, 2004.
  - Conducted wrap-up meeting to discuss draft review reports: September 27, 2004.
  - Finalize external review reports: November 2004.
- Final review reports are referenced in the draft NUREG and will be publicly available after they are finalized.

External Review: Selected Conclusions

- Elicitation process appears adequate and sound for determining the stated objectives (A. Brothers).
- Reviewers concurred with many specific aspects of analysis procedure.
  - Use of relative ratio structure to examine technical issues.
  - Overconfidence correction using error factor approach.
- Several corrections suggested by reviewers incorporated into NUREG.
  - Developed improved upper bound correlation structure (perfect rank correlation) adopted.
  - Evaluated of the effect of the distribution shape on the mean which led to use of truncated distributions.
  - Utilized exact calculation of means for split and truncated lognormal distributions.
  - Conducted Monte Carlo simulation to analyze affect of correlation structure and verify the approximate rank correlation calculation.
  - Utilized mixture distribution as an alternative aggregation scheme.
  - Incorporated suggestions for clarifying exposition.

External Review: Selected Conclusions, cont.

- No agreement reached on the most appropriate aggregation scheme.
- Each of the following schemes favored by one reviewer.
- Geometric mean aggregation (baseline method).
  - Advantages:
    - Group estimates more acceptable to panel.
    - Appropriate for low frequency events when the variability among panelists may span several orders of magnitude.
    - Results are not dominated by outliers.
  - Disadvantages:
    - Less conservative than mean and 95th determined using mixture distribution.
    - 5th and 95th percentile differences are not as wide as for the mixture distribution.
- Report authors and some panelists strongly favor baseline method.

Elicitation 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 in individual elicitations.
- Baseline results determined by aggregating individual panelists' estimates.
- Baseline results.
  - Generally good agreement on LOCA contributing factors.
  - Large individual uncertainty and panel variability in quantifying estimates.
  - Results are comparable to NUREG/CR-5750 estimates.
- LOCA frequency estimates are sensitive to the method used to aggregate individual results to obtain group estimates.