

December 12, 2005

MEMORANDUM TO: Mark A. Cunningham, Director  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

THROUGH Jennifer L. Uhle, Chief /RA/  
Materials Engineering Branch  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

FROM: Charles A. Greene /RA/  
Component Integrity Section  
Materials Engineering Branch  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

SUBJECT: PUBLIC WORKSHOP ON "ESTIMATING LOSS-OF-COOLANT  
ACCIDENT (LOCA) FREQUENCIES THROUGH THE ELICITATION  
PROCESS - DRAFT REPORT FOR COMMENT," NUREG-1829

The U.S. Nuclear Regulatory Commission (NRC) staff met with the public and interested stakeholders on November 9, 2005, to present an overview and discuss clarification questions from the public, on NUREG-1829, "Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process." The purpose of this meeting was to facilitate the comment process. The public comment period for NUREG-1829 began on October 4, 2005 and is scheduled to close on November 30, 2005. The attendance list is shown as Attachment 1. The overview slides presented by the NRC staff are shown as Attachment 2 and are available through a web link at <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1829/>.

As stated in the workshop, the purpose was not to respond to technical issues raised by the public in the meeting, but to clarify understanding of the NUREG contents. Some technical issues were discussed in the course of the public meeting, but such responses are not to be construed as the NRC final response. NRC will respond to all comments once the public comment period closes. The schedule for that response will depend on the number of public comments. Additionally, the LOCA frequency estimates in the NUREG are intended for use within specific applications. The use of these estimates in any specific application was beyond the intended scope of this meeting.

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During the overview, some of the key points raised by NRC staff included:

1. The elicitation results discussed in the NUREG are part of the technical basis for the proposed Title 10 of the Code of Federal Regulations Part 50.46 (10 CFR 50.46) rule change; there are other considerations that were used to form the technical basis.
2. An important step in the overall elicitation process was the selection of the panel members.
3. The elicitation did not consider the potential effect that significant changes to the plant operating profiles may have on the LOCA frequencies. The panel members did not consider power uprates because they lacked the technical basis for making such an assessment.
4. The results in the draft NUREG report of the LOCA frequencies do not consider the effect of a seismic event. The LOCA frequencies cited are the result of normal operating loads plus any expected transient events, i.e., transients that are reasonably expected to occur over the planned extended operating life of a plant.
5. There are a large number of comments provided by NRR on the NUREG that are currently being addressed. Additional public comments will also be addressed.
6. NRC staff would like to receive both positive and negative comments on the NUREG. Specifically, if some aspects of the study are particularly noteworthy, then the NRC staff would appreciate feedback about those aspects.

NRC staff then solicited feedback from the audience regarding the three questions published in the Federal Register Notice intended to focus comments on key aspects of the NUREG (Slide 10 of the presentation). As part of this discussion, the following clarifications were made:

1. The elicitation facilitation team solicited uncertainties from the expert panel members as well as their best estimate responses.
2. The authors of the NUREG chose to aggregate the results using the geometric mean instead of the arithmetic mean so that the results from a single panel member, with a single exceedingly high or low value, did not dominate the final results.

As the result of a discussion with one of the elicitation panel members, a member of the public asked if the panelists considered the effect of a seismic event and concluded that the risk contribution was less than 10% of the total LOCA risk. NRC staff responded that no group conclusion was reached regarding the magnitude of the seismic contribution. The facilitation team did ask the experts a separate series of questions that attempted to quantify the conditional seismic contribution to the total LOCA frequency estimates. However, the responses to those questions were not analyzed or included in the NUREG because it was determined that the experts were not responding in a consistent manner to this series of questions. Additionally, seismic responses were only received from a very small subset of the group. However, there were several good qualitative insights provided that were utilized in the ongoing NRC-sponsored effort to estimate seismically-induced LOCA frequencies.

A member of the public expressed concern that the seismic LOCA risk may dominate the NUREG LOCA frequencies and derail the proposed rule changes to 10 CFR 50.46. NRC staff responded that the approach being followed by the staff regarding the seismic effect on LOCA frequencies is addressed in the Statement of Consideration for the proposed rule as posted on the NRC web site ([http://ruleforum.llnl.gov/cgi-bin/rulemake?source=ECCS\\_risk&st=prule](http://ruleforum.llnl.gov/cgi-bin/rulemake?source=ECCS_risk&st=prule)). An interim report on the seismic efforts will be available in December on the NRC web site.

In response to a public comment at the meeting, NRC staff indicated that the aggregation method has received the most comments to date from prior reviews. The aggregation technique appears to be the most controversial aspect of NUREG. However, NRC staff pointed out that the NUREG does not make a recommendation as to whether the LOCA frequency estimates based on any particular aggregation scheme or other statistical treatment of the responses should be used in any particular application. (See concluding paragraph in Executive Summary.) NRC staff indicated that the lack of firm recommendations for particular applications was criticized by ACRS. The staff's current position is that it is inappropriate to make a definitive recommendation without explicit knowledge of the details of the application. Staff further pointed out that there is no standardized approach for analyzing expert elicitation responses.

Another member of the public asked if it was possible to broadly characterize the results from the elicitation effort in comparison with past studies. The NRC staff response was that with respect to the NUREG/CR-5750 results, the small break results from the elicitation are fairly consistent with the results from NUREG/CR-5750 for the BWRs and PWRs although the expert elicitation PWR frequencies also include steam generator tube ruptures. The medium break LOCA estimates tend to be higher than in NUREG/CR-5750 while the large break LOCA estimates are somewhat lower for equivalent pipe break sizes.

Another question asked if substantial changes to the NUREG based on the public comments could impact the proposed 10 CFR 50.46 rule change. NRC staff responded that it was possible, but not likely. Additionally, NRC staff informed the audience that there was a staff requirements memorandum (SRM) to review these results every 10 years.

A final question inquired whether the NRC had reviewed LOCA frequency estimates provided by Professor Larry Hochreiter from the Pennsylvania State University who has been quite critical of the proposed rule change to 10 CFR 50.46. These estimates are contained in a series of reports (ADAMS accession number ML051330475). The NRC staff responded that the reports provided by Professor Hochreiter were submitted to the NRC before the draft NUREG was published. Review of Professor Hochreiter's reports by the NRC did not invalidate the approach used or the conclusions drawn in the NUREG. NRC responded to Professor Hochreiter in a letter of December 12, 2005 (ADAMS accession number ML053410452).

Staff indicated that any additional questions and public comments should be forwarded to Charles Greene (CAG2@nrc.gov) and Robert Tregoning (RLT@nrc.gov).

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Public Workshop

Project No. 669

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PUBLIC WORKSHOP ON "ESTIMATING LOSS-OF-COOLANT ACCIDENT (LOCA)  
FREQUENCIES THROUGH THE ELICITATION PROCESS - DRAFT REPORT FOR  
COMMENT," NUREG-1829  
WEDNESDAY, NOVEMBER 9, 2005 9:00 A.M. - 12:00 P.M.  
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## **NUREG-1829: "Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process"**



**Robert L. Tregoning  
Lee Abramson  
Charles Greene  
RES**

**Paul Scott  
Battelle**

**Workshop on NUREG-1829 Public Comment  
Rockville, MD  
November 9, 2005**



### **Motivation**



- Develop part of the technical basis for establishing 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.

### **Limitations of Previous Studies**

- LOCA frequencies previously based solely on operating history
  - Comprehensive database required to accurately assess importance of rare events (No LBLOCA in LWR operating history).
  - Not necessarily representative of future system performance.
  - Methodology based on existence of precursor event prior to failure.



## 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.
  - Small, medium, and large-break LOCAs examined. Large break category further subdivided to consider 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.

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## LOCA Contributions Not Addressed by Expert Elicitation

- Active LOCAs
  - Stuck-open valves, failure of seals and gaskets.
  - Interfacing system LOCAs.
- Seismically Induced LOCAs
- Other Rare Event LOCAs
  - Rare water hammer events
  - Heavy load drops

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## Expert Elicitation Process

- Standard approaches.
  - Operating experience: LOCA events are rare.
  - Plant modeling: Number and disparity of possible failure modes are too complex to accurately model.
- 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 phenomena is too complex to adequately 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

- Conduct preliminary elicitation: Apr. – May, 2002.
- Select panel and facilitation team: Jun. – Nov., 2002.
- Formulate technical issues: May, 2002 – Jul., 2003.
- Quantify base case estimates: Feb. – Sep., 2003.
  - Develop quantitative estimates for well-defined piping conditions.
  - Quantify non-piping precursors and targeted failure scenarios.
- Formulate elicitation questions: Mar. – Sep., 2003.
- Conduct individual elicitations: Aug. – Nov., 2003.
- Analyze quantitative results and rationale: Dec. 2003 – Nov. 2004.
- Summarize and document results: Apr. 2004 – Feb. 2005
- Conduct internal and external reviews: Jul. – Dec., 2004



## Internal and External Reviews.

- Draft NUREG on expert elicitation has been extensively reviewed.
- Expert panelists:
  - Individual responses, calculations, and analysis conducted by the facilitation team.
  - General qualitative and quantitative findings and conclusions.
- External peer review:
  - Analysis procedure and framework.
  - Aggregation and sensitivity analyses.
  - General elicitation structure.
- ACRS review:
  - Elicitation process, structure, analysis, and results.
- Internal staff review:
  - Analysis procedure and framework, aggregation and sensitivity analyses.
- Public review and comment.



## Draft NUREG Organization: Main Body

- Front Matter.
  - Abstract.
  - Forward.
  - Executive Summary.
- 1. Background
- 2. Objective and Scope
- 3. Elicitation Approach
- 4. Base Case Results
- 5. Analysis of Elicitation Responses
- 6. Qualitative Results and Discussion
- 7. Quantitative Results
- 8. Ongoing Work
- 9. Summary of Results and Conclusions



## Draft NUREG Organization: Appendices



- A. Panel Member Qualifications
- B. Meeting Minutes from Group Panel Meetings
- C. Elicitation Training Exercise Results
- D. Piping Base Case Results of Bengt Lydell
- E. Piping Base Case Results of William Galyean
- F. Piping Base Case Results of David Harris
- G. Piping Base Case Results of Vic Chapman
- H. Description of Non-Piping Database
- I. Reactor Vessel LOCA Probability Base Case Analyses (BWR Vessels and PWR Top Head Nozzles)
- J. Elicitation Questions
- K. General Approach and Philosophy of Each Panel Member
- L. Detailed Results



## Draft NUREG: Public Comment Solicitation



- The NRC seeks comments on the report and is especially interested in the following questions:
  1. Is the structure of the expert elicitation process appropriate for the stated problem and goals of the study?
  2. Are the assumptions and methodology of the analysis framework used to process the panel responses appropriate and reasonable? Are they consistent with the type of information provided by the expert panel and the goals of the study?
  3. Is the geometric mean aggregation methodology appropriate for the panel responses and the study goals? Should other aggregation methodologies be considered and what are their advantages and disadvantages?