UNITED STATES
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February 7, 2023

MEMORANDUM TO: Raj M. Iyengar, Chief
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Division of Engineering
Office of Nuclear Regulatory Research

FROM: Christopher Nellis, Reactor Engineer
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Office of Nuclear Regulatory Research

Chris Nellis Signed by Nellis, Chris on 02/07/23

SUBJECT: SUMMARY OF THE JANUARY 19, 2023 PUBLIC MEETING WITH EPRI AND STAKEHOLDERS TO DISCUSS USE OF THE EXTREMELY LOW PROBABILITY OF RUPTURE CODE FOR LOSS-OF-COOLANT ACCIDENT FREQUENCY ESTIMATES

The U.S. Nuclear Regulatory Commission (NRC) staff held a meeting on January 19, 2023, with representatives of the Electric Power Research Institute (EPRI) to discuss technical aspects concerning use of the Extremely Low Probability of Rupture (xLPR) probabilistic fracture mechanics (PFM) code to inform loss-of-coolant accident (LOCA) frequency estimates and related regulatory applications.

The agenda and slide presentations for the meeting are available in the NRC's Agencywide Documents Access and Management System under Accession Numbers ML22363A572 and ML23019A148, respectively. Enclosed is a list of the meeting participants.

A summary of the meeting's discussions follows by agenda topic.

1. Review of June 14, 2022, Public Meeting on Use of xLPR for LOCA Frequency Estimates

The NRC staff reviewed the topics discussed at a public meeting held previously on June 14, 2022 (ML22173A222). The benefits of using the xLPR code to estimate loss-of-coolant accident frequencies from piping integrity failures were reiterated. The staff highlighted how the topics from that meeting related to the present discussions.

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2. Scope Change on Work Using the xLPR Code to Develop LOCA Frequency Estimates

An EPRI representative discussed the original scope of an EPRI project aimed to broadly compare LOCA frequencies from NUREG-1829 with those generated from the xLPR code that would support EPRI's proposed alternative licensing strategy (ALS) for high burnup fuels. The EPRI representative informed the NRC staff that further development of the ALS has narrowed the scope of line sizes that needed to be analyzed. The new scope was highlighted to provide context for the subsequent agenda topic, which presented results of the study.

3. Updates on Full-Scope Study Using the xLPR Code to Develop LOCA Frequency Estimates

An EPRI contractor detailed results from EPRI's study using the xLPR code to develop LOCA frequency estimates with xLPR's probability of rupture output used as a surrogate for LOCA frequencies. EPRI found that, when crediting in-service inspection (ISI) and leak-rate detection (LRD), the probabilities of rupture as calculated by the xLPR code were on the same order of magnitude as the LOCA frequency estimates from NUREG-1829. The probability of rupture with ISI and LRD was zero for almost all the cases considered, except in a few sensitivity studies that were not representative of typical plant conditions and operations. However, these cases are planned to be further investigated by the EPRI contractor as they can provide a supporting basis for ALS applications. In cases analyzing the time between 1 gallon per minute (gpm) detectable leakage and rupture (i.e., the lapse time), the minimum was found to be at least 14 months for all base cases and at least 1 month for all sensitivity study cases. As the simulation timestep used in these evaluations was 1 month, the EPRI contractor indicated that it would rerun the limiting sensitivity study cases with a shorter timestep. The NRC staff suggested additional sensitivity studies that could be of value.

4. Treatment of Non-xLPR-Modeled Failures

As related to ALS initiatives, an EPRI contractor reviewed contributions to LOCAs by non-piping related failures such as bolted components and component bodies as well as piping failure contributions that are not modeled by the xLPR code. He stated that, for piping in the small to intermediate range, fuel cladding burst is not expected using conventional LOCA analysis. However, leak-before-break analysis should also be applied to large-bore piping to evaluate associated failure frequencies or demonstrate an acceptable margin. Failure of non-piping components cannot cause a leak rate larger than the failure of the pipes they are connected to. The EPRI contractor also stated that Regulatory Guide 1.45, Revision 1 *Guidance on Monitoring and Responding to Reactor Coolant System Leakage* (ML073200271) was reviewed to describe the anticipated timeframe of operator actions in response to an unidentified leak.

5. Use Cases for LOCA Frequency Estimates

Representatives from the NRC staff and EPRI reviewed applicable use cases for xLPR-generated LOCA frequency estimates. An EPRI representative described a roadmap for

finding opportunities to use the xLPR code by compiling a list of regulatory requirements and licensing and design bases that use LOCA frequency estimates.
He described plans to perform risk-benefit analyses to identify which would be the most promising to pursue. An EPRI report on the outcome of these analyses is planned to be published in 2023. The NRC staff reviewed the NRC's core regulatory processes and discussed how LOCA frequency estimates are used as input in its standardized plant analysis risk models.

6. Perspectives on EPRI Pilot Study Using the xLPR Code to Develop LOCA Frequency Estimates

The NRC staff presented its perspectives on EPRI's pilot study to investigate use of the xLPR code for developing LOCA frequency estimates, which was introduced at the June 14, 2022, public meeting. Overall, the staff was satisfied with the sample size but suggested increasing it for certain analyses. The NRC staff also cautioned against treating rupture probabilities as a direct equivalent to LOCA frequencies at 80 years of plant operation. Additional recommendations were provided to check for non-conservatisms in post-processing and treatment of weld residual stress uncertainties.

7. Updates to Example xLPR LOCA Frequency Estimates Compared to NUREG-1829 Expert Elicitation Results

The NRC staff provided updates on work it presented at the June 14, 2022, public meeting comparing xLPR LOCA frequency results to those in NUREG-1829. The NRC staff provided more details on the progression from leak to LOCAs to rupture for the previously completed analyses for small, medium, and large breaks. When developing LOCA frequencies with LRD, the staff found no occurrences of LOCA when simulating 100,000 realizations. A statistical extrapolation method was explored to estimate sample sizes for cases with extremely low probabilities.

Participant List

JANUARY 19, 2023, PUBLIC MEETING WITH EPRI AND STAKEHOLDERS TO DISCUSS USE OF THE EXTREMELY LOW PROBABILITY OF RUPTURE CODE FOR LOSS-OF-COOLANTACCIDENT FREQUENCY ESTIMATES

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Kevin Heller	NRC
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Cindy Rosales-Cooper	NRC
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Scott Krepel	NRC
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John Tsao	NRC
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Nathan Glunt	EPRI
Craig Harrington	EPRI
Fred Smith	EPRI
Kurshad Muftuoglu	EPRI
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Storm Kauffman	MPR Associates
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Markus Burkardt	Dominion Engineering, Inc.

Cedric Sallaberry	Engineering Mechanics Corporation of Columbus
DJ Shim	EPRI
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Jay Leininger	PowerLein LLC
Brian Mount	Dominion Energy
Don Algama	U.S. Department of Energy
Jeffrey Kobelak	Westinghouse

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