UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 23, 2021

MEMORANDUM TO: Dennis C. Morey, Chief
Licensing Processes Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Michael D. Orenak, ATF Lead Project Manager ***/RA/***
Licensing Processes Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF THE JUNE 2, 2021, PUBLIC MEETING WITH NEI AND EPRI ON THE EPRI APPROACH TO LICENSING HIGHER BURNUP FUEL (EPID L-2021-TOP-0012)

On June 2, 2021, the U.S. Nuclear Regulatory Commission (NRC) staff held a meeting with representatives from the nuclear industry, including the Nuclear Energy Institute (NEI), Westinghouse Electric Company (Westinghouse), Framatome Inc. (Framatome), and the Electric Power Research Institute (EPRI). NEI provided an original meeting purpose of discussing EPRI Technical Report 3002018457, "Alternative Licensing Approaches for Higher Burnup Fuel" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21139A326), an alternative licensing strategy for higher burnup fuel, which includes a risk-informed analysis of loss-of-coolant-accident-induced fuel fragmentation, relocation, and dispersal (FFRD). However, the actual meeting content was more focused on the EPRI licensing approach to licensing higher burnup fuel and not specifically the contents of Technical Report 3002018457. The meeting notice can be found in ADAMS at Accession No. ML21152A063. The meeting slides can be found at ADAMS Accession No. ML21152A012.

Joe Donoghue, Director of the Division of Safety Systems, Office of Nuclear Reactor Regulation (NRR), made opening remarks and Ben Holtzman from NEI provided industry's opening remarks. The first presentation, given by EPRI representatives, provided an overview of licensing strategy for risk-informing FFRD. The NRC staff asked several questions during this presentation. The staff stated that the method appears to credit the difference in probability between different loss-of-coolant-accident (LOCA) scenarios, but presumes the same consequences for all scenarios. The EPRI representatives answered that this technical detail has not been fully resolved yet; however, the use of the extra low probability of rupture analysis methodology (xLPR) demonstrates that the probability of a LOCA becomes very small as the break size becomes large. The NRC staff also asked about the back-up strategy for addressing fuel dispersal discussed in the slides, whether it was just for small-break (SB) and intermediate-break (IB) LOCAs, and what are the distinguishing characteristics between SB, IB, and large-break (LB) LOCAs. The EPRI representatives responded that it expects to address LB LOCAs using a risk-informed approach, and to use LOCA evaluation models to demonstrate no rupture for other break sizes. The EPRI representatives further stated that it expects that the

combination of these approaches will address the entire break spectrum, but that the back-up strategy for dispersal would be used if necessary.

The next presentation was by the Westinghouse representative and was on its approach to SB LOCA calculations to support EPRI's methodology. The NRC staff asked Westinghouse about how assurance of continuing to satisfy all criteria in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46(b), including maintaining a coolable core geometry, would be provided for in LB LOCAs, since its presentation only discussed SB and IB LOCAs. Westinghouse representatives stated that the analysis plan discussed in its slides were focused on the SB and IB LOCAs in support of the EPRI methodology, and that satisfaction of regulatory criteria is a separate topic. The NRC staff also asked how Westinghouse is going to use the EPRI report. The Westinghouse representative stated that it will docket the codes and methods necessary to utilize the EPRI methodology. EPRI will request approval for its topical report (TR) to be referenced by utilities. EPRI stated that all power reactor licensees will be able to reference the EPRI report for use, not just NEI members.

The next short presentation was provided by Framatome representatives and it simply reiterated support for the EPRI methodology. No questions were received.

The following presentation was by EPRI representatives on the xLPR analysis of intermediate/large piping ruptures and focused on LOCA frequency estimates and time between leakage and rupture. The NRC staff asked multiple questions during this presentation.

- The NRC staff stated that EPRI has a methodology to predict rare events where a lot of data exists; however, EPRI is trying to predict events when little data exists. The staff asked how EPRI will resolve this challenge. EPRI recognized the concern and stated that xLPR results were being used to validate pipe rupture frequencies in NUREG-1829, "Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process: Man Report" (ADAMS Accession No. ML082250436).
- The NRC staff stated that the LOCA frequencies in NUREG-1829 were not system or line specific, and asked if EPRI can perform enough xLPR analyses to justify the assumed conservative nature of the NUREG LOCA frequencies. The EPRI representatives stated that they were planning on performing enough analyses.
- The NRC staff asked if it is possible to use leak-before-break (LBB) methodology to validate xLPR. The EPRI representatives answered that they used any current data to validate the code but did not have ideal data sets. However, they have been incorporating new data sets into the code when received. The xLPR code was also well validated by the EPRI/NRC development team.
- The NRC staff stated the LB LOCA was understood to be extremely unlikely at the time 10 CFR 50.46 was written, meaning prior to the advent of modern probabilistic methods for assessing rupture frequency; nevertheless, it was established a conservative design-basis event. The staff asked whether the xLPR analysis adds significant new information that would justify reassessment of this situation. The EPRI representatives responded that, beyond reconfirming the rarity of the LB LOCA event, a significant new finding associated with the xLPR analysis is that considerable time would exist between the time at which primary system leakage is detected and the occurrence of rupture.
- The NRC staff asked how failure mechanisms outside the scope of xLPR, such as the additional mechanisms considered in NUREG-1829, would affect the event frequency and operator response time estimates calculated by xLPR. The EPRI representatives responded that they are working on it.

- The NRC staff stated that in NUREG-1829, multiple experts were used for their own judgment and xLPR was developed using lessons learned from that effort and with the current state-of-the-art in probabilistic fracture. EPRI focuses on cases that LBB. NRC asked what about the cases that rupture before leaking? Will this be a separate report? EPRI responded that it will be a separate report.
- The NRC stated that a good explanation of xLPR can be found on YouTube.
- The NRC's final question for this presentation was if EPRI will make the xLPR input data sets available to the NRC. The EPRI representatives responded that they had not thought about it yet, but see no reason why not.

The final presentation was a detailed look at the risk-informed analysis of LOCA-induced FFRD and was provided by MPR Associates, Inc. (MPR) for EPRI. One of the first comments from the presenter during this meeting was that components of the Phase 1 report are outdated and not being considered for the risk-informed method going forward. The MPR representative stated that EPRI intends to submit a TR on this methodology, which will use Regulatory Guides 1.174 and 1.200. The representative also stated that in the methodology, a ΔCDF [change in core damage frequency] for FFRD is determined to be less than 10^{-7}, then calculation for the total CDF is not needed. The NRC staff asked many questions during the presentation:

- The NRC staff questioned a statement by EPRI that the industry initiative would not relax conditions for plant operation. The NRC staff observed that, absent the proposed initiative, stricter operating limits could be required to prevent the fragmentation of high-burnup fuel. In this sense, the proposal could be construed as relaxing conditions for fuel operating at high burnups. The MPR representative responded that MPR does not intend the assessment to justify relaxations that let safety systems out of service. Additionally, more restrictions will not be necessary because it will not take credit for equipment not normally credited.
- The NRC staff asked how MPR comes up with ΔCDF, what types of operator actions and system performance is assumed, and if they are using xLPR to do it. The MPR representative responded that MPR was using xLPR and identified that considering operator actions to shut down and depressurize the plant based upon indications of leakage reduces the LB LOCA event frequency sufficiently to meet a ΔCDF threshold of 10^{-7} / year, without crediting performance of the emergency core cooling system. The EPRI representatives stated that at this ΔCDF threshold, plant-specific probabilistic risk assessment updates would not be necessary.
- The NRC staff asked how MPR/EPRI is going to make future changes in the methodology to incorporate individual power plant design changes. MPR responded that they still need to determine when the methodology is/is not appliable after plant changes. The EPRI representatives followed up stating that the methodology has to be evaluated at each plant change for applicability and modified if needed.
- The NRC staff asked if human reliability analysis (HRA) included in the methodology will be plant specific or generic. The MPR representative responded that EPRI plans to have the HRA be generic and applicable across both Westinghouse-designed and Combustion Engineering-designed plants.
- The NRC staff asked if IB LOCAs can result in FFRD. The EPRI representatives responded that they do not expect them to be an issue, but will back up that assertion with analysis. The EPRI representatives also stated that IBs will also be analyzed using xLPR.

- The NRC asked if the forthcoming TR will consider the impact of other regulations, such as 10 CFR 50.67. The EPRI representatives responded that they have not looked at it yet, but will take that comment back and do so.
- The NRC staff stated that the French regulatory agency recently adopted a transition break size approach for analyzing LOCAs. Different criteria and evaluation models were utilized for LB LOCA which is considered an extremely low probability event. The NRC staff asked how future changes in plant operation or fuel design would be assessed with respect to FFRD under LB LOCA conditions. The EPRI representatives responded that they would look at assumptions and validate the changes.
- The NRC staff pointed out that existing regulations require an analytical technique that either follows Appendix K to 10 CFR Part 50 or realistically describes the behavior of the reactor during a LOCA and satisfies the acceptance criteria in 10 CFR 50.46(b), including maintaining a coolable core geometry. The NRC staff questioned how, without an explicit analysis of the LB LOCA that includes FFRD, it would be possible to assess whether existing regulations are satisfied. The EPRI representatives responded that crediting xLPR means that there is time to shut down the plant and that the event involving the existence of FFRD is not credible.
- The NRC staff commented that the approach appears to single out one particularly challenging phenomenon (i.e., FFRD), and eliminate it from the LB LOCA analysis on a risk-informed basis. The staff stated that the logic used in the EPRI proposal could presumably support a similar argument for the elimination of other potentially challenging LB LOCA phenomena, such as critical heat flux exceedance during blowdown, thermal conductivity degradation, or cladding swelling and rupture. The NRC staff questioned the logic of selectively eliminating certain problematic phenomena, and stated that such selective elimination of one or more phenomena could undermine confidence in the realism of the calculated results. The EPRI representatives responded that the proposal pertains only to FFRD and not other phenomena.
- The NRC staff questioned whether the proposal by EPRI could be implemented via a simple licensing basis change, in light of explicit requirements imposed by existing regulations. The NRC staff further noted that a broader effort had been made to implement a transition break size approach in the 50.46a rulemaking, which was discontinued in 2016 following significant effort by the NRC staff.

The EPRI representatives then finished up with a short presentation on the schedule for the submittal of the TR. EPRI planned on submitting it in the fourth quarter of 2022. The NRC staff had one final comment that this is a first-of-a-kind methodology and will require a lot of NRC staff to review. To ensure NRC staff resources are available, the NRC will need an accurate schedule from EPRI.

There were no public questions received during the meeting.

No regulatory decisions were made in the meeting.

Enclosure:
List of Attendees

List of Attendees

June 2, 2021, Meeting on the Electric Power Research Institute
Risk-Informed Method for Licensing of Higher Burnup Fuels

First Name	Last Name	Organization
Michael	Orenak	Nuclear Regulatory Commission (NRC)
Joe	Donoghue	NRC
Paul	Clifford	NRC
Kevin	Heller	NRC
Mark	Blumberg	NRC
Kent	Wood	NRC
Josh	Kaizer	NRC
John	Lehning	NRC
Bob	Lukes	NRC
Kristy	Bucholtz	NRC
Todd	Hilsmeier	NRC
David	Rudland	NRC
Robert	Krsek	NRC
Jesse	Seymour	NRC
Joseph	Messina	NRC
Joshua	Whitman	NRC
Hossein	Esmaili	NRC
Rebecca	Patton	NRC
Ben	Holtzman	Nuclear Energy Institute (NEI)
Fred	Smith	Electric Power Research Institute (EPRI)
Jeffrey	Kobelak	Westinghouse Electric Company
John	Strumpell	Framatome Inc. (Framatome)
Storm	Kauffman	MPR Associates, Inc.
Lisa	Gerken	Framatome
Baris	Sarikaya	Exelon
Jana	Bergman	Curtis-Wright
Susan	Hoxie-Key	*Public*
Robert	Daum	EPRI
Markus	Burkardt	Dominion Engineering
Steven	Dolley	S&P Global
Kurshad	Muftuoglu	GE Hitachi
Matt	Nudi	EPRI
Will	Maxson	Framatome
Matthieu	Aumand	Framatome
Erik	Mader	EPRI
Nathan	Glunt	EPRI

Enclosure

SUBJECT: SUMMARY OF THE JUNE 2, 2021, PUBLIC MEETING WITH NEI AND EPRI ON THE EPRI APPROACH TO LICENSING HIGHER BURNUP FUEL (EPID L-2021-TOP-0012) DATED JUNE 23, 2021

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PClifford
KHeller
MBlumberg
KWood
JKaizer
JLehning
RLukes
KBucholtz
THilsmeier
DRudland
RKersk
JSeymour
JMessina

ADAMS Accession Nos.:
ML21167A243 (Summary)
ML21152A063 (Meeting Notice)
ML21139A328 (Meeting Slides) ***via e-mail**

OFFICE	NRR/DORL/LLPB/PM	NRR/DORL/LLPB/LA*	NRR/DORL/LLPB/BC*	NRR/DSS/SFNB/BC*
NAME	MOrenak	DHarrison	DMorey	RLukes
DATE	6/16/2021	6/21/2021	6/23/2021	6/23/2021
OFFICE	NRR/DORL/LLPB/PM			
NAME	MOrenak			
DATE	6/23/2021			

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