



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

September 16, 2022

MEMORANDUM TO: Richard Chang, Chief
Licensing Projects Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Stephanie Devlin-Gill, ATF Lead Project Manager */RA/*
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF THE AUGUST 30, 2022, PRE-SUBMITTAL,
PARTIALLY CLOSED MEETING WITH THE ELECTRIC POWER
RESEARCH INSTITUTE REGARDING THE USE OF THE
ALTERNATE LICENSING STRATEGY TO ADDRESS LOSS-OF-
COOLANT ACCIDENT INDUCED FUEL FRAGMENTATION,
RELOCATION, AND DISPERSAL (EPID L-2022-TOP-0044)

On August 30, 2022, the U.S. Nuclear Regulatory Commission (NRC) staff held a partially closed (open and closed sessions) meeting with representatives from the Electric Power Research Institute (EPRI). The purpose of the meeting was for EPRI and the NRC staff to discuss the submittal schedule and technical aspects of EPRI's Alternative Licensing Strategy (ALS) which was developed to address LOCA-induced fuel fragmentation, relocation, and dispersal (FFRD).

The meeting was noticed on August 18, 2022, and the meeting notice is available at the Agencywide Documents Access and Management System (ADAMS) Accession No. ML22242A121. The publicly available presentation materials can be found at the following ADAMS Accession Nos.: ML22241A133 (open session) and ML22236A562 (closed session).

The meeting was conducted as a hybrid meeting with attendees joining either in-person in an NRC conference room, or online via Microsoft Teams. EPRI attended the meeting in-person and online along with representatives from Framatome, MPR, Nuclear Energy Institute, and Westinghouse Electric Company (WEC). There were members of the public in attendance online during the open session of the meeting, but they made no comments nor asked questions during the meeting. A list of meeting attendees is enclosed.

CONTACT: Stephanie Devlin-Gill,
NRR/DORL 301-415-5301

During the open session of the meeting, EPRI representatives gave the NRC staff an overview of the ALS objective, approach, and scope planned for the topical report (TR), and an overview of ALS supporting analyses from WEC and Framatome for LOCA and from MPR for leak-before-break (LBB).

EPRI stated that the objective of the ALS TR will be to address LOCA-induced FFRD in pressurized water reactors (PWRs) using a generically applicable method. EPRI plans to submit the TR in the fourth quarter of calendar year 2023 and the TR would be supported by proprietary, vendor reports from Framatome, MPR, and WEC. EPRI's ALS approach would address FFRD in PWR fuel that has a higher burnup (HBU), approximately 75 gigawatt-days per metric ton of uranium (GWd/MTU) rod-average, while the current burnup limit in approved vendor methods is 62 GWd/MTU. EPRI representatives stated that the plan is to address FFRD by performing small break and intermediate break LOCA analysis to demonstrate that no fuel cladding rupture occurs and that any fuel relocation that occurs is within an acceptable amount. EPRI also plans to apply a treatment of large break LOCAs based on the analyses that are performed by using the extremely low probability of rupture (xLPR) probabilistic fracture mechanics (PFM) code. Specifically, EPRI plans to evaluate the event propagation considering plant shutdown requirements for LBB-qualified piping described in the Technical Specifications. EPRI's rationale is that:

LBB has been used to exclude various local phenomena external to [the reactor pressure vessel (RPVs)] (jet impingement, asymmetric vessel loading, failure of [emergency core cooling system (ECCS)] cross-connect valve) and internal to RPV (control rod scram, fuel mechanical loads). Similarly, LBB would be used to exclude FFRD caused by large break LOCA.

EPRI would apply the xLPR code analysis to LBB-qualified piping for determining if the time available to detect leakage and shut down is sufficient to justify excluding LOCA-induced FFRD from large break LOCA analysis. EPRI representatives stated that non-LBB qualified piping would be analyzed with design basis LOCA analysis methods.

Regarding the scope of ALS, EPRI representatives stated that: ALS does not modify ECCS system design or analysis for non-FFRD LOCA evaluations; ALS applies credit only for LBB to piping systems already qualified for LBB applications; fuel cladding rupture is expected to be precluded but should it occur the associated dispersal is a result of the dynamic effects (temperature and pressure) of the piping system rupture; and fuel cladding rupture and dispersal is a local phenomenon similar to the LBB based evaluation of loads on individual fuel pins during blowdown.

EPRI representatives expressed interest in a follow-up meeting to the public meeting that occurred on June 14, 2022, between the NRC, EPRI, and stakeholders to discuss the use of xLPR code for LOCA frequency estimates (ADAMS Accession No. ML22173A222).

During the open session of the meeting, the NRC staff asked questions about EPRI's assumptions regarding LBB as they apply to the following regulations and guidance:

- Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants" (GDC) Criterion 4, "Environmental and dynamic effects design bases" (GDC 4),
- Title 10 of the CFR Part 50, Appendix A, GDC Criterion 35, "Emergency core cooling" (GDC 35),

- Title 10 of the CFR 50.46, “Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,” and
- NUREG-1829, “Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process” (ADAMS Accession No. ML082250436).

The NRC staff heard from EPRI representatives that it would apply LBB assumptions to GDC 35 and 10 CFR 50.46, insofar as LBB would be credited to relieve analytic requirements associated with calculating the effects of the most severe postulated LOCAs. The NRC staff stated that EPRI’s interpretation that fuel cladding rupture during the LOCA heatup transient is a local dynamic effect may not be consistent with past regulatory precedents. The NRC staff stated that existing regulations do not appear to allow application of LBB to ECCS performance analysis as GDC 4 does for dynamic effects such as the effects of pipe whipping and discharging fluids. The NRC staff stated that EPRI’s assumptions could reduce the NRC staff’s assurance that 10 CFR 50.46(b)(4), “Coolable geometry,” and/or GDC 35 are met. The NRC staff also questioned whether ECCS evaluations that neglect FFRD could meet the requirements in 10 CFR 50.46(a)(1)(i), meaning that they provide assurance that the effects of the most severe postulated LOCAs are calculated.

During the open session presentations for WEC and Framatome, the NRC staff asked whether the vendors would be reliant on EPRI’s ALS as the sole path forward for addressing FFRD for HBU fuels. Both WEC and Framatome stated that EPRI’s ALS is the preferred path forward for the licensing of HBU fuels, but that it is not their only path.

The NRC staff asked questions regarding how the fuel vendors’ analysis methodologies for addressing FFRD for non-LBB qualified piping would fit into the EPRI planned TR. EPRI representatives stated that the TR would refer to proprietary reports from WEC and Framatome that describe their methodologies. EPRI representatives stated that after approval of the ALS TR, operating reactor licensees would use the applicability criteria described in the TR and submit license amendment requests to modify the licensing basis to use HBU fuel. In response, the NRC staff stated that it needed to understand the detailed schedule for submittals and connections between reports to plan the review resources.

During the MPR’s open session presentation, the NRC staff asked whether MPR’s LBB analysis would involve an analysis consistent with NRC Regulatory Guide (RG) 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decision on Plant-Specific Changes to the Licensing Basis” (ADAMS Accession No. ML17317A256). MPR representatives stated that its LBB analysis is not intended to quantify risk, but that MPR plans to make the case that leakage is detectable years before rupture, consistent with the LBB application, and the risk is low enough to demonstrate the acceptability of not including FFRD in the large break LOCA analysis. MPR also stated that it would demonstrate that non-piping failures are either bounded by the piping LOCA analyses, precluded by timely leak detection, or otherwise not credible. After MPR’s statement, the NRC staff recommended that EPRI and MPR include a discussion of degradation mechanisms in its documentation and justification for the evaluation of non-piping failures.

During the closed session of the meeting, WEC representatives presented an overview of the WEC approach for performing the fuel cladding rupture calculations to support of EPRI’s ALS topical report. WEC representatives highlighted similarities and differences from other WEC methods which have previously been submitted to the NRC, and WEC representatives solicited feedback on the proposed approach.

No regulatory decisions were made because of this meeting.

Please direct any inquiries to me at 301-415-5301, or via e-mail at Stephanie.Devlin-Gill@nrc.gov.

Docket No. 99902021

Enclosure: As stated

PRE-SUBMITTAL MEETING LIST OF ATTENDEES

August 30, 2022

U.S. Nuclear Regulatory Commission

Bucholtz, Kristy
Collins, Jay
Davis, Robert
Devlin-Gill, Stephanie
Dijamco, David
Donoghue, Joseph
Gilbertson, Anders
Heller, Kevin
Hiser, Allen
Homiack, Matthew
Humberstone, Matthew
Iyengar, Raj
James, Lois
Kalikian, Varoujan
King, Daniel
Krsek, Robert
Lehning, John
Lenning, Ekaterina
McKirgan, John
Messina, Joseph
Min, Seung
Parks, Benjamin
Pham, Bo
Sallaberry, Cedric
Tsao, John
Whitman, Josh

Breakthrough Institute

Lloveras, Leigh

Constellation Energy

Sarikaya, Baris

Dominion Engineering

Burkardt, Markus
Mount, Brian L.

Electric Power Research Institute

Barber, Kevin J.
Kucuk, Aylin
Muftuoglu, Kurshad
Smith, Fred

Framatome

Gerken, Lisa
Hottle, Nathan
Strumpell, John

Idaho National Laboratory

Jensen, Colby B.

Members of the Public

Bergman, Jana
Dolley, Steven
Hoxie-Key, Susan
Markivich, Alex J.

MPR

Dame, Cecile
Kauffman, Storm

Nuclear Energy Institute

Csontos, Aladar

State Government of New Jersey

Fakory, Jacob
Gubbi, Veena
Humphreys, Jerry

Southern Nuclear Operating Company

Kindred, Tomas

Westinghouse Electric Company

Christian, Rachel
Connor, Landon
Harper, Zachary S.
Husser Jr, Eric P.
Karoutas, Zeses
Kobelak, Jeffrey R.
Laird, James N
Mackereth, Nathaniel J.
Margherio, Ethan
Smith, James D.
Taylor, Tina

Enclosure

SUBJECT: SUMMARY OF THE AUGUST 30, 2022, PRE-SUBMITTAL, PARTIALLY CLOSED MEETING WITH THE ELECTRIC POWER RESEARCH INSTITUTE REGARDING THE USE OF THE ALTERNATE LICENSING STRATEGY TO ADDRESS LOSS-OF-COOLANT ACCIDENT INDUCED FUEL FRAGMENTATION, RELOCATION, AND DISPERSAL (EPID L-2022-TOP-0044) DATED SEPTEMBER 16, 2022

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DKing, NRR	SMin, NRR	DPalmrose, NMSS
LJames, NRR	VKalikian, NRR	EDickson, NRR
ELenning, NRR	JTsao, NRR	JCorson, RES
CRoque-Cruz, NRR	DDijamco, NRR	LKyriazidis, RES
JDonoghue, NRR	KBucholtz, NRR	DRoth, OGC
SKrepel, NRR	Rlyengar, RES	RWeisman, OGC
	JMcKirgan, RES	

ADAMS Accession Nos.:
ML22244A074 (Package)
ML22242A121 (Meeting Notice)
ML22241A133 and ML22236A562 (Meeting Slides)
ML22249A002 (Meeting Summary)

OFFICE	NRR/DORL/LPLII-1/PM	NRR/DORL/LLPB/LA	NRR/DORL/LLPB/BC	NRR/DSS/SFNB/BC
NAME	SDevin-Gill	DHarrison	RChang	SKrepel
DATE	09/07/2022	09/09/2022	09/12/2022	09/09/2022
OFFICE	NRR/DNRL/NPHP/BC	NRR/DNRL/FO	NRR/DORL/LPLII-1/PM	
NAME	MMitchell	JWise	SDevin-Gill	
DATE	09/11/2022	09/12/2022	9/16/2022	

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