



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

October 26, 2023

MEMORANDUM TO: Gerond A. George, Chief
Licensing Projects Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Daniel G. King, Project Manager */RA/*
Licensing Projects Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF THE AUGUST 31, 2023, HIGHER BURNUP
WORKSHOP IV

On August 31, 2023, the U.S. Nuclear Regulatory Commission (NRC) staff held the Higher Burnup Workshop IV, an observation meeting, with the nuclear industry and other stakeholders. This workshop included presentations by the NRC staff and representatives from the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI), the U.S. Department of Energy's (DOE) Idaho National Labs (INL), and the DOE Oak Ridge National Laboratory (ORNL). The meeting had two purposes: (1) to exchange information between the NRC and industry on higher burnup (HBU), increased enrichment (IE), and accident tolerant fuel (ATF) activities; and (2) to provide an opportunity for members of the public to ask questions of the NRC staff. The meeting notice is available in the Agencywide Documents Access and Management System (ADAMS) at Accession No. ML23242A114. The NRC and industry meeting slides are available at ADAMS Accession Nos. ML23241A011 and ML23262A757, respectively. A recording of the meeting is available at:

<https://www.youtube.com/watch?v=1-wziE84R-A>

Andrea Kock, Deputy Office Director for Engineering in the Office of Nuclear Reactor Regulation (NRR) gave the opening remarks. The first presentation given by the NRC staff provided an overview of the ATF, IE, and HBU "Roadmap to Readiness" (ADAMS Accession No. ML23158A294) graphic, in relation to the ATF Project Plan (ADAMS Accession No. ML21243A298). The NRC staff provided the graphics' assumptions, general descriptors, and purpose as they guided external stakeholders through each ATF technology licensing pathway. The next NRC staff presentation provided an overview and status update on the IE Rulemaking, required by Staff Requirements Memorandum (SRM)-SECY-21-0109 (ADAMS Accession No. ML22075A103). Subsequently, on September 8, 2023, the "Increased Enrichment of Conventional and Accident Tolerant Fuel Designs for Light-Water Reactors Regulatory Basis Document for Public Comment" (ADAMS Accession No. ML23032A504) was issued for a 75-day public comment period on <https://www.regulations.gov/> under docket "NRC-2020-0034." Next, the NRC staff provided a presentation regarding the Office of Nuclear Material Safety and

Safeguards (NMSS) new fuels atlas and infographic (ADAMS Accession No. ML23135A021). The presentation highlighted the fuel cycle, focusing on the regulatory framework that would be contained in the regulatory planner, an organizational tool delineated by fuel type.

Next, NEI presented on the “Drive to Deploy ATF with Increased Enrichment and Higher Burnup,” discussing industry strategic aspirations, key accomplishments, lead test assembly timelines, shipment plants, and recent NEI led ATF surveys and studies. Specifically, NEI discussed industry responses to “The Future of Nuclear Power: 2023 Baseline Survey” (ADAMS Accession No. ML23242A166), which was conducted in anticipation of Regulatory Issue Summary (RIS) 2023-02, “Scheduling Information for the Licensing of Accident Tolerant, Increased Enrichment, and Higher Burnup Fuels” (ADAMS Accession No. ML23123A166). The next presentation was provided jointly by representatives of EPRI, Constellation, DOE INL, and DOE ORNL. It provided an update on the Collaborative Research on Advanced Fuel Technologies for Light-Water Reactors, the Issue Tracking Matrix, and the Consensus LOCA [Loss-of-Coolant Accident] Test Plan.

After these presentations, an NRC/Industry discussion was held. EPRI representatives asked if the alternatives considered in the IE Rulemaking, would encompass a broad range of technologies. The NRC staff noted that the regulatory basis provides a broad range of alternatives, which are currently under consideration. Communication with external stakeholders, like EPRI, on this topic was considered during the development. EPRI commented, for planning, the next HBU Alternative License Strategy pre-submittal meeting is tentatively planned for October 2023. NEI representatives then requested clarification on the intended enrichment of the IE Rulemaking regulatory basis. The NRC staff noted that per SRM-SECY-21-0109, the rulemaking would apply to high-assay low-enriched uranium fuel (HALEU), up to 20.0 weight percent uranium 235. Framatome representatives then asked if the IE Rulemaking replaced or included the “Performance-Based Emergency Core Cooling System Acceptance Criteria,” known as the Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46c rulemaking, as outlined in SECY-10-0033 (ADAMS Accession No. ML15238A947). The NRC staff noted that the referenced rule was provided to the Commission. Thus, there is no intent to replace this rule; however, this was considered during development of the IE Rulemaking regulatory basis. NEI representatives then requested intentions for public engagements, following the IE regulatory basis being issued. The NRC staff noted that a public meeting would occur in October 2023, during the 75-day public comment period. The NRC staff then asked about industry needs for regulatory clarity and predictability moving forward after issuance of Regulatory Guide (RG) 1.183, Revision 1, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors” (ADAMS Accession No. ML23082A305). NEI representatives recommended increased coordination in the development of RG 1.183, Revision 2. Then noted, that the issuance of RG 1.183, Revision 1, is a critical milestone for ATF and power uprates for pressurized water reactors interested in 24-month cycles. The NRC staff then requested if industry has intention on updating responses to RIS 2023-02, regarding future licensing activities, noting the implication on future NRC budget and resource allocations. The NEI representatives responded that much of the information is business sensitive but could be shared during routine project manager interactions with the licensee. Further, NEI representatives committed to discuss with its stakeholders during the October 2023 Industry ATF Working Group meeting, noting that NRC has procedures to accept business sensitive information. After that question, a short break was held.

After the break, the NRC staff provided a presentation on non-LOCA release fractions at HBU. Next, an NRC staff member from the Office of Research (RES) provided a presentation on source terms at HBU utilizing MELCOR code. The NRC staff demonstrated containment source

term development from the associated phenomena identification and ranking table process, experimental basis, modeling with MELCOR, accident analysis scenarios, to conclusions and analysis. The next presentation on assessing the impact of HBU conditions on fuel fragmentation, relocation, and dispersal (FFRD) was provided jointly by DOE INL and DOE ORNL. Utilizing VERA and BISON code, DOE characterized the ranges of operating conditions experienced by HBU rods and quantified FFRD susceptibility. The NRC staff then provided a presentation on performing transportation evaluations of ATF with IE and HBU. The National Environmental Policy Act evaluations, aligned with 10 CFR Part 51.52, Environmental Effects of Transportation of Fuel and Waste - Table S-4 were discussed, for IE and HBU. The NRC staff noted that on August 28, 2023, NUREG-2266, "Environmental Evaluation of Accident Tolerant Fuels with Increased Enrichment and Higher Burnup Levels – Draft Report for Comment" (ADAMS Accession No. ML23240A756) was issued.

After these presentations, an NRC/Industry discussion was held. The NRC staff requested clarification from DOE INL and DOE ORNL representatives on sensitivity assumptions for power peak calculations, noting the difference in local and average burnup. DOE ORNL representatives indicated that axial power was determined with VERA, without this sensitivity assumption. Though unlikely to change results, specifics were outside the scope of the study. EPRI provided a comment on NRCs "Non-LOCA Release Fractions for HBU" presentation, noting testing data and physics codes could likely be provided from industry to assist in mitigating the challenges identified. A Dominion Energy representative then commented that Draft Regulatory Guide (DG)-1389, Proposed Revision 1 to Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Reactors" (ADAMS Accession No. ML21204A065) provides useful operational tools, but industry is interested in more generic gap fractions. Specifically, expansion of generic values for a 17-by-17 fuel array. The NRC staff acknowledged all comments, then held a public comment period.

There were two public comments received during the public comment period. First a member of the public asked the NRC staff about the consequences of specific cladding material, leading to development of hydrogen. Next a member of the public, asked a similar question regarding Zircaloy cladding impacts on hydrogen, the impact of the subsequent reaction on the fuel rods, and the availability of such information. The NRC staff noted that we frequently interact with international and government groups to maintain awareness of research and potential issues. Additional information on NRC interactions on ATF, IE, and HBU can be found at: <https://www.nrc.gov/reactors/power/atf/interactions.html>. Staff from RES then noted that the NRC maintains awareness of hydrogen absorption and embrittlement, ensuring that operations remain safe.

Joseph Donoghue, Director of the Division of Safety Systems in NRR made closing remarks.

No regulatory decisions were made in the meeting.

Enclosure:
List of Attendees

List of Attendees

Higher Burnup Workshop IV
August 31, 2023

U.S. Nuclear Regulatory Commission (NRC)	
First Name	Last Name
Zena	Abdullahi
Reed	Anzalone
Philip	Benavides
Andrew	Bielen
Kristy	Bucholtz
Christopher	Brown
Jesse	Carlson
Alice	Chung
Alex	Collier
James	Corson
Elijah	Dickson
Joseph	Donoghue
Kenneth	Erwin
Hossein	Esmaili
Mike	Franovich
Richard	Fu
Gerond	George
James	Hammelman
Kevin	Heller
Shana	Helton
Kevin	Hsueh
Lois	James
Meena	Khanna
Daniel	King
Andrea	Kock
Scott	Krepel
John	Lehning
Chris	Markely
Damaris	Marcano
Joseph	Messina
Steven	Muller
Tony	Nakanishi
Ngola	Otto
Donald	Palmrose
Bo	Pham
Jason	Piotter
Kevin	Roach

U.S. Nuclear Regulatory Commission (NRC)		
First Name	Last Name	
Carla	Roque-Cruz	
MaryJane	Ross-Lee	
Michael	Salay	
Ashley	Smith	
Jeffery	Smith	
Nicholas	Smith	
Rao	Tammara	
Chris	Van Wert	
Gokul	Vasudevamurthy	
Kimberly	Webber	
Josh	Whitman	
Kent	Wood	
Non-NRC		
First Name	Last Name	Organization (if provided)
Don	Algama	Department of Energy (DOE)
John	Alvis	DOE Idaho National Labs (INL)
Robert	Armstrong	INL
Nima	Ashkebiussi	Nuclear Energy Institute (NEI)
Uriel	Bachrach	Westinghouse Electric Company (Westinghouse)
Kevin	Barber	Westinghouse
Philippe	Bellanger	Framatome Inc. (Framatome)
Jan	Bergman	Curtis Wright Corporation
Michael	Boone	Westinghouse
Jan	Boudart	Nuclear Energy Information Service (NEIS)
Fabiola	Cappia	INL
Nathan	Capps	DOE Oak Ridge National Laboratory (ORNL)
Johnathan	Chavers	Southern Nuclear Company (SNC)
Paul	Clifford	Framatome
Aladar	Csontos	NEI
Kris	Cummings	
Cecile	Dame	MPR Associates
Madeline	Feltus	DOE
Nathaniel	Hall	South Texas Project Electric Generating Station (STPEGS)
Jason	Harp	ORNL
Matt	Hendrickson	Oregon Department of Energy (ODOE)
Neil	Herman	BWXT Technologies Inc.
Jerald	Holm	Framatome
Susan	Hoxie Key	
William	Gassmann	Constellation Nuclear
Lisa	Gerken	Framatome
Donna	Gilmore	
Frank	Goldner	DOE
Andrea	Jennetta	S&P Global
Colby	Jensen	INL
Zeses	Karoutas	Westinghouse

Non-NRC		
First Name	Last Name	Organization (if provided)
Thomas	Kindred	SNC
Jeffrey	Kobelak	Westinghouse
Aylin	Kucuk	
David	Kraft	NEIS
Dave	Kropaczek	DOE ORNL
David	Luxat	Sandia National Laboratories
Steven	Maheras	DOE Pacific Northwest National Laboratory (PNNL)
Alex	Marchivich	Dominion Energy
Kacey	Mcgee	PNNL
Brian	Mount	Dominion Energy
Brenden	Mervin	Electric Power Research Institute (EPRI)
Kurshad	Muftuoglu	EPRI
Carole	Naugle	Framatome
Stephen	Novascone	INL
Stephen	O'Hearn	Dominion Energy
Kevin	Quick	Framatome
Deann	Raleigh	Curtis Wright Corporation
Jeff	Reef	Framatome
Jason	Schulthess	INL
John	Strumprell	Framatome
Charlyne	Smith	Breakthrough Institute (BTI)
Fred	Smith	EPRI
Ava	Traverso	
Daniel	Wachs	INL
Kalene	Walker	
Gordo	Wissinger	Framatome

SUBJECT: SUMMARY OF THE AUGUST 31, 2023, HIGHER BURNUP WORKSHOP IV
DATED OCTOBER 26, 2023

DISTRIBUTION:

PUBLIC	JCorson, RES	KHeller, NRR
RidsOpaMail	EDickson, NRR	SHelton, NMSS
RidsNrrDorl	JDonoghue, NRR	KHsueh, NRR
RidsNrrDorlLLpb	KErwin, NMSS	LJames, NRR
RidsNrrDnrI	ASmith, NRR	MKhanna, NRR
RidsNrrDss	NSmith, NRR	DKing, NRR
RidsNrrDssSfnb	JSmith, NRR	AKock, NRR
BPham, NRR	RTammara, NMSS	SKrepel, NRR
RAnzalone, NRR	CVanWert, NRR	CMarkely, NMSS
PBenavides NMSS	GVasudevamurthy, NRR	DMarcano, NMSS
ABielen, RES	KWebber, RES	JMessina, NRR
DHarrison, NRR	JWhitman, NRR	SMuller, RES
KBucholtz, NRR	KWood, NRR	NOtto, NRR
JPiotter, NMSS	HEsmaili, RES	DPalmrose, NMSS
JCarlson, NMSS	RFu, NRR	MRoss-Lee, NRR
AChung, RES	GGeorge, NRR	KRoach, NRR
	JHammelman, NMSS	MSalay, RES

ADAMS Accession No.:

ML23291A052 (Meeting Summary)

NRR-106

OFFICE	NRR/DORL/LLPB PM	NRR/DORL/LLPB LA	NRR/DORL/LLPB BC	NRR/DORL/LLPB PM
NAME	DKing	DHarrison	GGeorge	DKing
DATE	10/17/2023	10/23/2023	10/25/2023	10/26/2023

OFFICIAL RECORD COPY