



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

June 30, 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/*  
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Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF THE JUNE 10, 2021, HIGHER BURNUP  
WORKSHOP II

On June 10, 2021, the U.S. Nuclear Regulatory Commission (NRC) staff held the Higher Burnup Workshop II, an observation meeting, with the nuclear industry and other stakeholders. This workshop included presentations by the NRC staff, the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI), Exelon Generation Company, LLC., and the U.S. Department of Energy's Idaho National Labs (INL). The meeting had three purposes: (1) provide all stakeholders with updated information about the current NRC and industry activities for higher burnup (HBU) and increased enrichment (IE) fuel, (2) exchange of information between the NRC staff and industry stakeholders on HBU IE activities, and (3) provide an open question and answer period on HBU and IE for the public. The meeting notice can be found in Agencywide Documents Access and Management System (ADAMS) at Accession No. ML21160A036. The NRC and industry meeting slides can be found at ADAMS Accession Nos. ML21159A070 and ML21159A140, respectively. A recording of the meeting can be found at:

<https://nrc.rev.vbrick.com/#/videos/fbf11224-c780-4528-ba59-603fa645b66d>

Joe Donoghue, Director of the Division of Safety Systems, in the Office of Nuclear Reactor Regulation (NRR) made opening remarks and Ben Holtzman from NEI provided industry's opening remarks. The first presentation given by the NRC staff discussed how the NRC is following the Accident Tolerant Fuel (ATF) Project Plan and the changes being made for the new Version 1.2 of the project plan. The next NRC staff presentation provided an overview of the Regulatory Framework Applicability Analysis that the NRC developed to: (1) identify regulations and guidance that are impacted; (2) review if there is anywhere in the regulations and guidance that do not speak to phenomena unique to ATF/HBU/IE and how those will be addressed or closed; and (3) identify the entity responsible for the data collection. After these two presentations, an NRC/industry discussion was held. The first question from an NEI representative was if the analysis accounts for the industry's previously completed screening analysis. The NRC staff answered that it does not, but the NRC would welcome the information being sent to the staff. The NRC staff also stated that the final analysis tables are going to be incorporated into the new revision of the project plan, but these tables are a living

document and will be updated as necessary in the future. The NEI representative then asked when will the Sandia National Laboratory analysis of the source term for fuel with burnup of 75 gigawatt days per metric ton of uranium (GWd/MTU) be completed. The NRC staff answered that preliminary responses will be received towards the end of this year.

The next NRC presentation provided an overview for the forthcoming licensing pathway. The pathway is a simple depiction of the remaining tasks or informational needs for successful (i.e., timely) approval of topical reports and plant-specific amendments. It shows the ideal plan or path forward given where the subject is today. The next NRC presentation was on the forthcoming research information letter (RIL) on fuel fragmentation, relocation, and dispersal (FFRD). This letter will summarize research findings for FFRD and discuss how information may be used in regulatory decisions. After these presentations, an NRC/industry discussion session was held. The first question during this session was from an NEI representative asking how the NRC is determining the consequences of FFRD. The NRC staff responded that the consequences are not being addressed in the RIL, but said the NRC is dealing with the consequences as they come up because the ability to analyze the consequences are currently being developed. The RIL will provide the initial conditions for the consequence analyses. The next question was from an EPRI representative who asked about the FFRD threshold value and fuel temperature dependence, and whether the RIL will discuss it. The NRC staff stated that the RIL will just look at the burnup level and not temperature dependence. The RIL will simply discuss the science known about FFRD on June 2021 because it is a snapshot in time. A member of the industry asked if the RIL will address the amount of mass dispersed and will use Halden information, or simply provide a bounding scenario. The NRC staff said they are going to take an upper bound position. A second question from an industry member was regarding a peer review on the RIL and asked if the NRC could put out a draft of its views so the industry can have an indication as to the NRC direction. The NRC staff responded that a preview would happen at the proposed Advisory Committee on Reactor Safeguards meeting this fall, but the NRC does not want to release before the peer review of the RIL is completed. Another member of the industry asked if the RIL is going to discuss the interconnections between the five presented elements of FFRD. The NRC staff responded that the RIL will cover interconnections. The RIL will also incorporate all data that the NRC currently has access to, including data below 62 GWd/MTU. A final question was how the NRC will incorporate additional information on FFRD after the RIL is presented to the ACRS. The NRC staff said that the path is currently undecided, but the staff will continue to follow FFRD research.

The next NRC presentation was on the transportation and dry storage of spent fuel with HBU and IE. Afterward, the NRC staff presented on the environmental review of ATF license amendment requests. After these two presentations, an NRC/industry discussion was held. An NEI representative first commented that an environmental analysis does not just look at the direct action but reevaluates the entire fuel system and fuel cycle. The reduction of the amount of spent fuel due to IE and HBU has significant positive environmental impact. The NEI believes that fuel with HBU and IE will be able to be categorically excluded from needing an additional NEPA analysis. The NRC staff stated that they do not know what information will be submitted in the amendment requests, so no judgment can be made on whether it can be categorically excluded. A question from an industry member asked if there is coordination between spent fuel pool criticality and transportation criticality analysis work within the NRC. The NRC staff responded that yes, there is coordination, but the two have notably different environments, so the similarities are limited. An industry member also stated that in the past, extrapolation for chemical assays was a function of enrichment, and asked if there will be an issue of extrapolation of data for isotopes for IE in spent fuel pools or casks. The NRC staff stated that there are methods for extrapolation that can be relied on because there won't be

data for a while, but there will need to be a technical justification for the extrapolation, along with increased uncertainties that will need to be applied.

An open public comment discussion period was held. Only one question was received from an industry member who asked if the RIL will discuss any doped fuels, or will it focus on uranium dioxide fuels. The NRC staff responded that the RIL will focus on uranium dioxide fuels. After that question, a lunchbreak was held.

After lunch, EPRI representatives provided two presentations on two of their working groups that support HBU, Collaborative Research on Advanced Fuel Technologies for LWRs [Light Water Reactors] (CRAFT) and Extended Storage Collaboration Program (ESCP). An NRC/industry discussion period then yielded no comments. Next, a member of the industry gave a presentation about one of the technical subgroups in CRAFT, the General Guidance and Analyses Technical Experts Group, and a member of INL gave a presentation on another CRAFT technical subgroup, the Fuel Performance and Testing Technical Experts Group. Then NEI representatives discussed their risk-informed method for FFRD without a dedicated slide presentation. An NRC/industry discussion period followed where the NRC staff commented that industry can propose their own limits and methods for dealing with unknowns about FFRD. The NEI representatives asked if the NRC had any feedback from the June 2<sup>nd</sup> public meeting on the EPRI FFRD approach and the NRC responded that we are looking to continue dialog with this currently under development methodology. The NEI representatives additionally asked the NRC staff for the status of the fee exemption request for EPRI topical report on FFRD, and the NRC staff answered that it was still under internal review. NEI representatives commented that they would like fuel reviews to become more risk-informed, and the NRC responded that fuels reviews are heavily risk-informed already. The NRC staff also commented that industry considers FFRD extremely unlikely to the point of being not credible; however, the regulations state that models should realistically model fuel behavior, of which FFRD is real phenomena. Another NRC staff member commented that the NRC risk analyst staff are following the FFRD approaches closely and that licensees must risk-inform to the requirements in the regulations and not ignore events because the risk is very low.

The NEI representatives provided a short presentation on alternative source term (AST) vs. traditional source term for HBU. The NEI representatives stated that current source term should bound ATF, HBU, and IE and should not need to be recalculated; however, the shift to AST might be necessary for HBU. In response to NEI questions asked during the presentation, the NRC staff stated that the regulations are flexible regarding source term and that guidance contains a section that specifies the attributes of an acceptable AST, and those will continue to be applicable after the Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms For Evaluating Design Basis Accidents at Nuclear Power Reactors," update. The NRC is working to update RG 1.183, Table 1, for HBUs to 68 GWd/MTU. As for going above 68 GWd/MTU for loss-of coolant accidents (LOCA) maximum hypothetical accident (MHA-LOCAs), there is currently ongoing research. The NRC staff commented that industry is not forced to go to AST and follow the guidance but must still meet the regulations. The NEI representatives asked the NRC to elaborate on its plans for source terms for up to 80 GWd/MTU burnups. The NRC staff first discussed non-LOCA source terms and noted that they are dependent on individual rod release fractions, which are very sensitive to operating history and fuel designs; therefore, developing with a bounding approach can possibly be completed, but going up to 80 GWd/MTU needs significantly more development. Also, there is very little data for transient fission gas release over 70 GWd/MTU and extrapolating on data would be difficult. For the MHA-LOCA source term up to 80 GWd/MTU, the NRC is repeating the calculations from a Sandia National Labs report SAND-2011-0128, but those results would not

likely be in the next revision of RG 1.183 currently under development. The NRC staff also commented that the traditional method (e.g., based on U.S. Atomic Energy Commission report "Calculation of Distance Factors for Power and Test Reactor Sites," TID-14844, March 1962) for source term calculations with is based on furnace test experiments performed in the 1950s with burnups around 25 GWd/MTU. It is unclear that this source term is still applicable at HBUs as different radionuclides peak at different burnups as the industry is seeking to go well beyond these experiments. Therefore, industry will need to justify in their applications why the traditional source terms are applicable above 68 GWd/MTU burnups.

The next set of presentations were on schedules; NRC presentation on integrated fleet wide scheduling and why it will support efficient NRC review, and an NEI presentation on the industry's forthcoming plans for ATF, HBU, and IE. In the proceeding NRC/industry discussion period, the NRC first asked about industry's batch reload schedule for burnup up to 75 GWd/MTU. The NEI representatives stated that will happen in the mid-2020s, but no firm dates at this time. A member of the industry asked NEI what is the estimated year for the shipment of greater than 5 weight percent and fuel fabrication. The NEI representatives repeated that it will happen mid-2020s but gave no specific dates. The next NRC comment stated that staff resources in multiple review areas, including environmental review, are limited, therefore, knowledge of industry plans is very important to ensure that resources are available when needed. The final NRC comment was to remind industry that the spent fuel pool and new fuel storage must be approved for fuel with IE before that fuel can be received at the power reactor site.

The final presentation by NEI representatives was on impacts from the report on the severe accident phenomena identification and ranking table exercise. The NRC staff commented after the presentation that the impacts are still be evaluated and they will be incorporated into RG 1.183, if necessary.

In the final NRC/industry comment period, a member of the industry commented that there should be a rule change to allow above 5 weight percent enrichment and asked the NRC what is that timeline. The NRC staff responded that the appointed members of the Commission need to give permission for the staff to move forward and the standard timeline is around 4 years for a rule change. In fall/winter 2021, the NRC staff will be submitting a paper to the Commission to ask for permission to proceed. The NRC staff had a final question for INL on the credibility of FFRD for a large-break LOCA. INL representatives stated that the experiments regarding FFRD were performed outside of reactor vessels but do show that fuel is fragmenting. The consequences of FFRD are still being evaluated. The final two comments provided by the NRC staff were that the agency is open to different approaches to FFRD and will be ready to review submittals. Also, NRC management is mainly concerned about the resource levels needed to review submittals and not the NRC's technical ability to review them, therefore, the more schedule information provided by the industry, the better.

There was one public comment received during the second public comment period. The member of the public asked the NRC about safety in storage and transportation of spent fuel because the data doesn't exist. Data cannot be obtained from welded shut canisters; therefore, how is the industry and government going to obtain that data. The NRC staff answered that there is a plan. The long-term test cask at North Anna Power Station will be shipped to a hot cell and opened for inspection after 10 years to obtain the necessary data.

No regulatory decisions were made in the meeting.

Enclosure:

List of Attendees

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Higher Burnup Workshop II  
June 10, 2021

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
Drew	Barto	NRC
Kim	Green	NRC
Don	Palmrose	NRC
Joseph	Messina	NRC
Joshua	Whitman	NRC
Hossein	Esmaili	NRC
Ngola	Otto	NRC
James	Corson	NRC
Elijah	Dickson	NRC
David	Wrona	NRC
Nicholas	Hansing	NRC
Ben	Holtzman	Nuclear Energy Institute (NEI)
Robert	Daum	Electric Power Research Institute (EPRI)
Hatice	Akkurt	EPRI
Bill	Gassmann	Exelon Generation Company, LLC.
Dan	Wachs	Idaho National Labs
Nima	Ashkeboussi	NEI
Dale	Lancaster	NuclearConsultants.com
Lisa	Gerken	Framatome, Inc.
Jana	Bergman	Curtiss-Wright
Stephen	Hess	Jensen Hughes
Thomas	Kindred	Southern Nuclear Operating Company
Susan	Hoxie-Key	<i>Public</i>
Rebecca	Steinman	Exelon
Kristopher	Cummings	Nuscale

Enclosure

SUBJECT: SUMMARY OF THE JUNE 10, 2021, HIGHER BURNUP WORKSHOP  
DATED JUNE 30, 2021

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**ADAMS Accession Nos.:**

**ML21176A040 (Package)**

**ML21176A028 (Summary)**

**ML21160A036 (Meeting Notice)**

**ML21159A070 (NRC Meeting Slides)**

**ML21159A140 (Industry Meeting Slides)**

**\*via e-mail**

OFFICE	NRR/DORL/LLPB/PM	NRR/DORL/LLPB/LA	NRR/DORL/LLPB/BC	NRR/DSS/SFNB/BC
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DATE	06/29/2021	06/29/2021	06/29/2021	06/29/2021
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NAME	JMarcano-Lozada (ZLi for)	KErwin	HEsmaili	MOrenak
DATE	06/30/2021	06/30/2021	06/29/2021	06/30/2021

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