Higher Burnup Workshop II Will Begin Shortly…

- Public Meeting Slides:
  - NRC Presentation
    - ML21159A070
  - Industry Presentation
    - ML21159A140
- Please log into Microsoft Teams: Meeting Link.

HIGHER BURNUP WORKSHOP II

July 10, 2021
9:00 am – 3:00 pm

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Workshop Agenda (morning)

Topic	Presenter	Time
Introductions	NRC	9:00 AM
ATF Project Plan	NRC	9:10 AM
Regulatory Framework Applicability Analysis	NRC	9:20 AM
Discussion	NRC/Industry	9:30 AM
Licensing Pathway	NRC	9:40 AM
Research Information Letter	NRC	9:50 AM
Discussion	NRC/Industry	10:00 AM
Break		10:10 AM
Spent Fuel Storage and Transportation	NRC	10:20 AM
Environmental Review of ATF LARs	NRC	10:30 AM
Discussion	NRC/Industry	10:40 AM
Need For Integrated Fleet-Wide Schedule	NRC	10:50 AM
Industry Adoption Plans	Industry	10:55 AM
Discussion	NRC/Indusry	11:00 AM
Public Comments	Everyone	11:05 AM
Break		11:20 AM

Workshop Agenda (afternoon)

Topic	Presenter	Time
CRAFT/ESCP	Industry	12:30 PM
Risk-Informed Method for FFRD	Industry	12:40 PM
Discussion	NRC/Industry	12:50 PM
AST vs. Normal Source Term	Industry	1:00 PM
Discussion	NRC/Industry	1:10 PM
Severe Accident PIRT Impacts	Industry	1:20 PM
Discussion	NRC/Industry	1:30 PM
Break		1:40 PM
Discussion for Any Topic	NRC/Industry	1:50 PM
Public Comments	Everyone	2:30 PM
Adjourn		3:00 PM

Welcome

& Introductions

Welcome

- Joe Donoghue – Director, Division of Safety Systems

Introductions

- Joan Olmstead, NRC Facilitator Corps – Meeting Facilitator
- Mike Orenak, NRR – ATF Lead Project Manager
- Joey Messina, NRR – Technical Reviewer, Nuclear Codes Branch
- Kim Green, NRR – Senior Licensing Project Manager
- James Corson, RES – Reactor System Engineer
- Drew Barto, NMSS – Senior Nuclear Engineer
- Don Palmrose, NMSS – Senior Reactor Engineer
- Paul Clifford, NRR – Senior Advisor for Fuels

Meeting Logistics

- Meeting is held through Microsoft Teams.
- Participants will be on mute until the question-and-answer periods where the NRC will call on those with their hands up to ask their question one at a time.
- Today's meeting is an Observation meeting. Public participation and comments are sought during specific points during the meeting.
- No regulatory decisions will be made at today's meeting.

Purpose of Today's Meeting

1. Provide all stakeholders with updated information about current NRC and industry activities for higher burnup and increased enrichment
2. Exchange of information between NRC and industry on higher burnup and increased enrichment activities.
3. Provide an open question and answer period on higher burnup and increased enrichment for the public.

ATF PROJECT PLAN

HOW WE'RE FOLLOWING THE PLAN AND WHAT CHANGES ARE COMING

Mike Orenak
Lead ATF Project Manager
Office Of Nuclear Reactor Regulation

ATF Project Plan

- Designed to:
  - Increase regulatory stability and certainty
  - Enhance and optimize NRC review

- How to accomplish the above goals?
  - Increased stakeholder engagement
  - Proactive licensing activities
  - Independent confirmatory calculations

Increased Engagement

- Public meetings with vendors
- Conferences
- NRC-led meetings (e.g., this workshop)
- Meetings with DOE

Proactive Activities

Literature Reviews

- Coated cladding
- **Higher burnup fuel performance**
- Coated cladding transportation
- FeCrAl cladding
- FeCrAl cladding transportation
- Coated and FeCrAl cladding spent fuel transportation and storage
- **Severe accidents**

PIRTs

- Coated cladding
- **Severe accidents**

Interim Staff Guidance

- Coated cladding

Proactive Activities (cont'd)

Example: Possible Increased Enrichment Rulemaking

- With industry interested in increased enrichment, NRC staff is exploring rulemaking to update existing regulations.
- Commission approval is needed to pursue rulemaking.

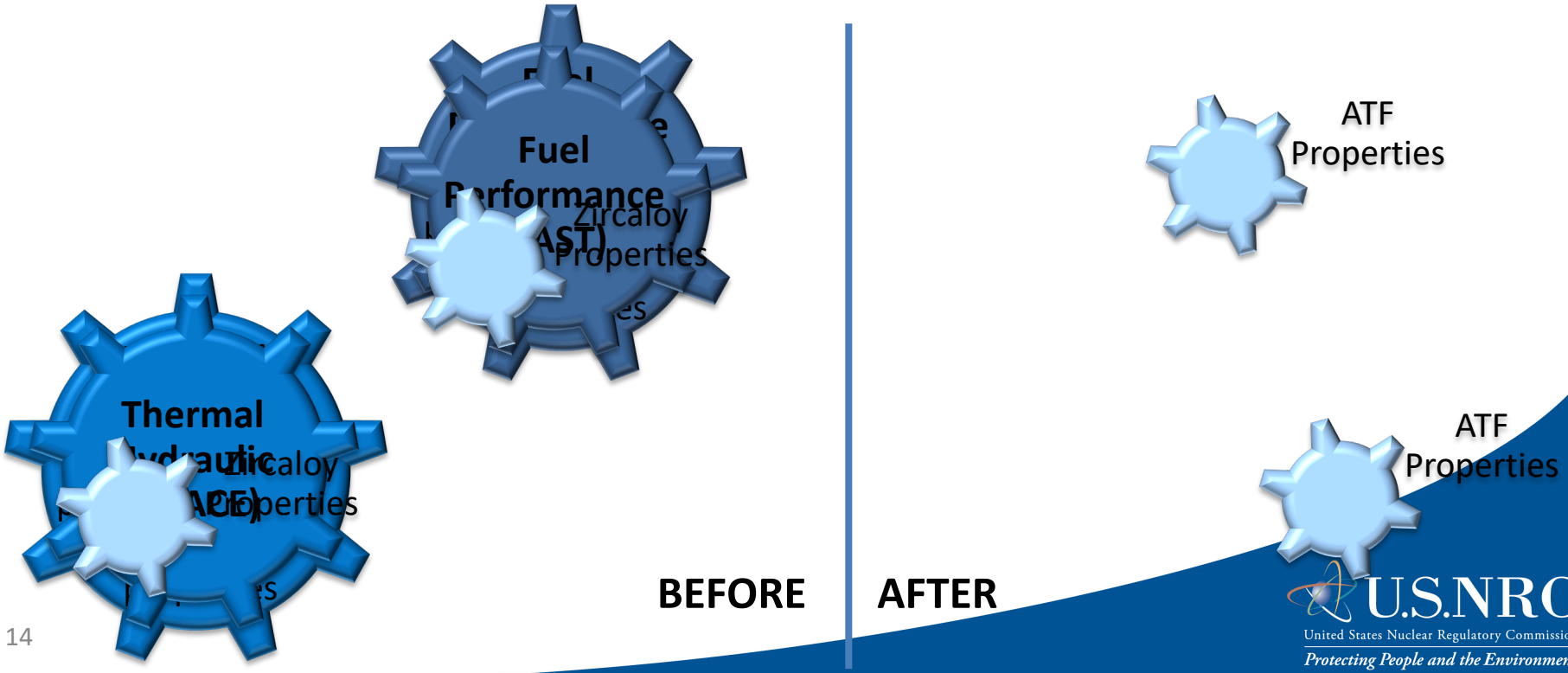
Proactive Activities (cont'd)

Example: Source Term Analysis

- NRC source term memo
  - rolled into the Regulatory Guide 1.183, Rev. 1, update
- MELCOR analysis of 75 GWd/MTU rod average (or equivalent) burnup

Independent Confirmatory Calculations

- Materials property libraries in FAST and TRACE have been separated from the main codes for efficiency in modifying for ATF properties



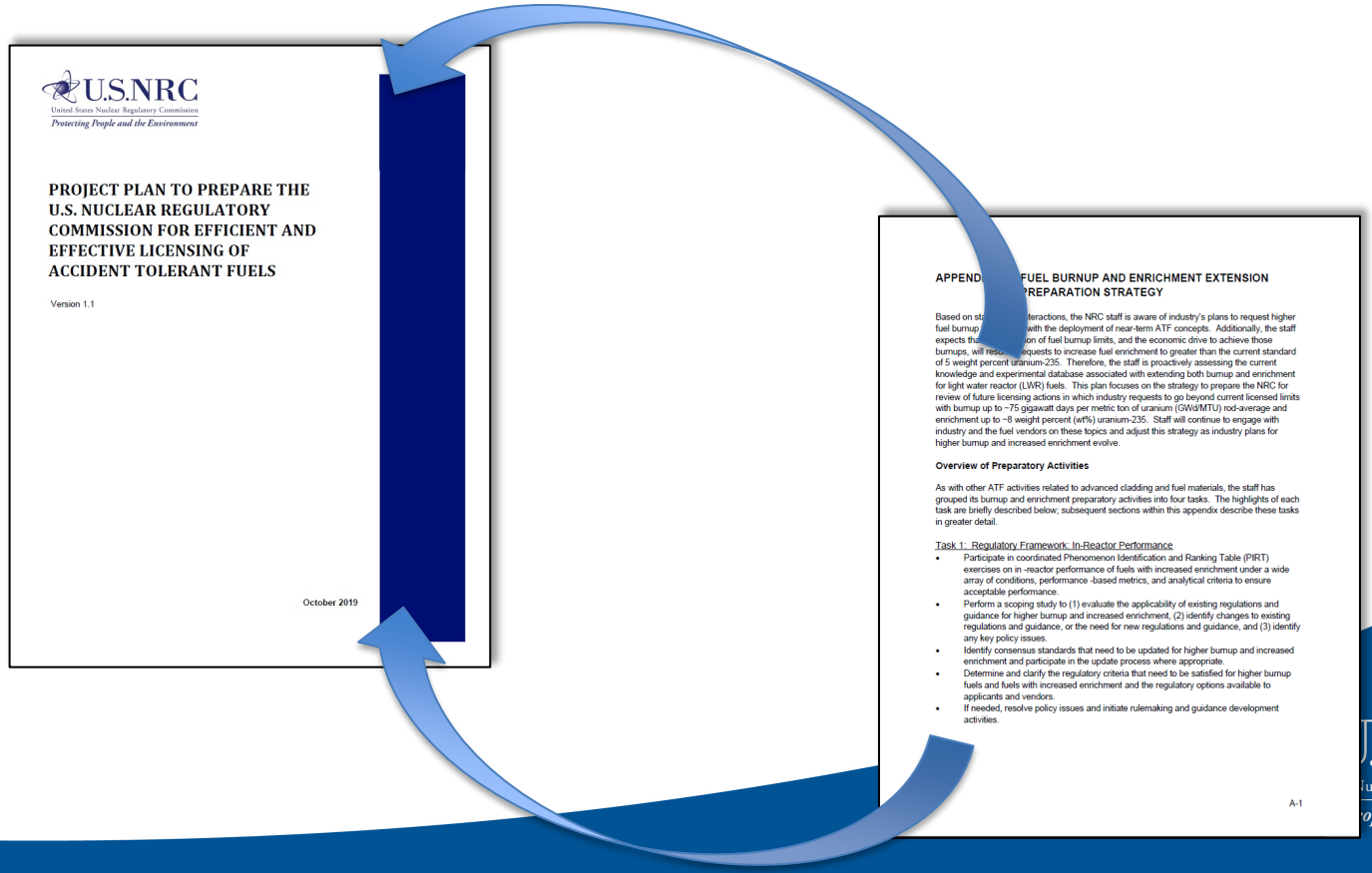
Project Plan Revision 1.2

Revision forthcoming due to:

- Change in industry plans
- NRC accomplishments and activities
- Streamlining to improve useability

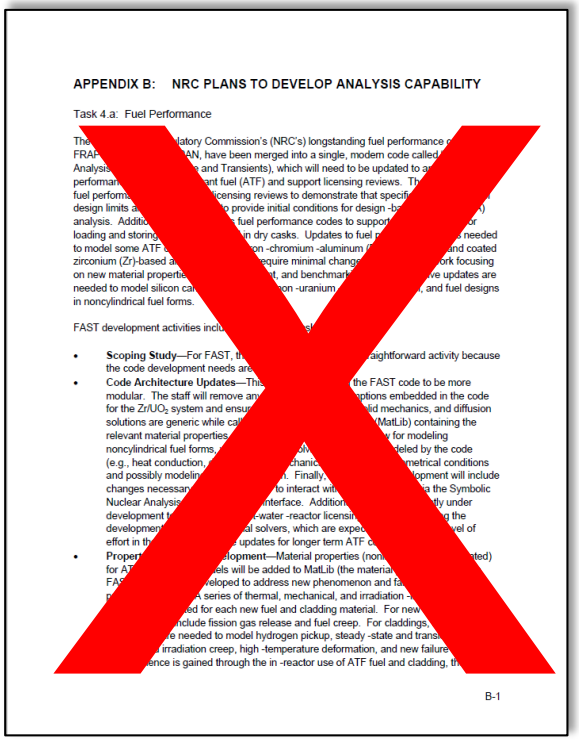
Revision 1.2 Changes

- Incorporation of Appendix A of higher burnup and increased enrichment into main body



Revision 1.2 Changes (cont'd)

- Delete Appendix B due to outdated information



APPENDIX B: NRC PLANS TO DEVELOP ANALYSIS CAPABILITY

Task 4.a: Fuel Performance

B-1

- Removal of exact dates and specific products

~~3.1 Milestone Schedule~~

~~Table 3.1 outlines some of the high-level milestones and associated dates related to implementation of the ATF project plan. These dates are based on the staff's current state of knowledge at the time of publishing.~~

~~**Table 3.1 ATF Milestone Schedule**~~

Milestone/Activity	Schedule
~~Complete ATF project plan V1.0.~~	~~September 2018 [C]~~
~~Issue final LTA guidance.~~	~~June 2019 [C]~~
~~Conduct PIRT for coated claddings.~~	~~July 2019 [C]~~
~~Revise ATF project plan (V1.1) to include the fuel burnup and enrichment extension preparation strategy addendum~~	~~November 2019 [C]~~
~~Complete supplemental guidance regarding the chromium-coated zirconium alloy fuel cladding ATF concept~~	~~Early 2020~~
~~Identify and implement adjustments to the regulatory infrastructure, if necessary, to enable the full potential of ATF (e.g., increase enrichment, increase burnup).~~	~~2019–2025~~
~~Conduct TR reviews for near-term concepts.~~	~~2020–2022~~
~~Conduct LAR reviews for near-term concepts.~~	~~2022–2023~~
~~Conduct TR/LAR reviews for longer-term concepts.~~	~~TBD (in accordance with industry schedules)~~

~~[C] denotes completion of activity.~~

Revision 1.2 Changes (cont'd)

- Addition of Regulatory Framework Applicability Analysis

Applicability of Existing Guidance and Regulatory Requirements

Key: **Green**: data needs for NRC; **Blue**: data need for industry; **Applicable**: indicates that the document can be applied to the concept; **Not fully applicable**: the document or parts of the document may not be applied to the concept, reasons for which are detailed below; **MHA**: maximum hypothetical accident; **LOCA**: loss of coolant accident; **RIA**: reactivity initiated accident; **BU**: burnup; **FGR**: fission gas release; **FFRD**: fuel fragmentation, relocation, and dispersal; **IFBA**: integral fuel burnable absorber; **ID**: inner diameter; **HC PIE**: hot cell post irradiation examination; **RXA**: recrystallized; **ISG**: interim staff guidance

Regulatory Guide or Regulation	Burnup to 68 GWd/MTU	Burnup to 75 GWd/MTU	^{235}U Enrichment beyond 5.0 wt%	Chrome-coated Zirconium Cladding	Doped UO_2 Fuel Pellets
RG 1.183 AST Draft Revision 1 Analytical guidance for predicting dose	• Fully applicable • No data gaps	• Fully applicable • No data gaps	• Fully applicable • No data gaps	• Fully applicable • No data gaps	• Fully applicable • No data gaps
RG 1.183 AST Draft Revision 1 MHA / LOCA source terms	• Not fully applicable • Reason: Fragmentation-induced FGR of high burnup fuel pellets may change MHA/LOCA source term and timing of releases Closure: Informal assistance request (IAR) out to RES to address this Priority: Near-term	• Not fully applicable • Reason: SAND-2011-0128 is not validated to 75 GWd/MTU Closure: Re-analysis of SAND-2011-0128 to higher BU is being conducted by RES and Sandia National Laboratory through 75 GWd/MTU Priority: Medium-term • Reason: Fragmentation-induced FGR of high burnup fuel pellets may change MHA/LOCA source term and timing of releases Closure: Informal assistance request (IAR) out to RES to address this Priority: Near-term	• Fully applicable • No data gaps	• Fully applicable • No data gaps	• Fully applicable • No data gaps
RG 1.183 AST Draft Revision 1	• Not fully applicable • Reason: Fragmentation-induced FGR of high burnup fuel pellets may	• Not fully applicable • Analytical procedure remains applicable	• Analytical procedure remains applicable • Tables 3 remains applicable	• Fully applicable • No data gaps	• Analytical procedure remains applicable • Tables 3 and 4 not applicable

Regulatory Framework Applicability Analysis

Joseph Messina
Nuclear Methods and Fuels Branch
Office of Nuclear Reactor Regulation

Purpose

- Improve upon the initial scoping study presented in Tables A.1 and A.2 in the ATF Project Plan
- Evaluate the applicability of existing regulations and guidance, as well as identify any updates needed

Initial Scoping Study

- An initial, rough scoping study was presented in Appendix A of the Project Plan

Table A.1 Potentially Affected Regulations

Regulation (10 CFR)	Title	Affected by:	
		Burnup	Enrichment
50.34	Contents of Applications; Technical Information	✓	✓
50.46	Acceptance Criteria for Emergency Core Cooling Systems for Light Water- Nuclear Power Reactors	✓	✓
50.67	Accident Source Term	✓	✓
50.68	Criticality Accident Requirements		✓
50, Appendix I	Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents	✓	✓
50, Appendix K	ECCS Evaluation Models	✓	✓
51	Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions (specifically, Tables S-3 and S-4)	✓	✓
70.24	Criticality Accident Requirements		✓
100	Reactor Site Criteria	✓	✓

Table A.2 Potentially Affected Guidance

Guidance Document	Title	Affected by:	
		Burnup	Enrichment
NUREG-0630	Cladding Swelling and Rupture Models for LOCA Analysis	✓	
NUREG-0800	Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (Section 4.2, "Fuel System Design" in particular for burnup)	✓	✓
NUREG-1465	Accident Source Terms for Light-Water Nuclear Power Plants	✓	✓
NUREG-1555	Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan	✓	✓
NUREG-2121	Fuel Fragmentation, Relocation, and Dispersal During the Loss-of-Coolant Accident	✓	
NUREG/CR-7022 Vol. 1-2	FRAPCON-3.5	✓	✓
NUREG/CR-7023 Vol. 1-2	FRAPTRAN 1.5	✓	✓
NUREG/CR-7024	Material Property Correlations: Comparisons Between FRAPCON-3.5, FRAPTRAN 1.5, and MATPRO	✓	✓
NUREG/CR-7219	Cladding Behavior During Postulated Loss-of-Coolant Accidents	✓	
RG 1.183	Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors	✓	✓
RG 1.195	Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors	✓	✓
RG 1.203	Transient and Accident Analysis Methods	✓	✓
DG 1327	Pressurized Water Reactor Control Rod Ejection and Boiling Water Reactor Control Rod Drop Accidents	✓	✓

Regulatory Framework Applicability Analysis

- NRC staff has been working to more thoroughly assess its regulatory framework and expand Tables A.1 and A.2 in the Project Plan

Example 1: NRC responsibility

Regulatory Guide or Regulation	Burnup to 68 GWd/MTU	Burnup to 75 GWd/MTU	^{235}U Enrichment beyond 5.0 wt%	Chrome-coated Zirconium Cladding	Doped UO_2 Fuel Pellets
RG 1.183 AST Draft Revision 1 Maximum hypothetical accident (MHA) - loss of coolant accident (LOCA) source terms	• Not applicable • Reason: Fragmentation-induced FGR of high burnup fuel pellets may change MHA/LOCA source term and timing of releases Closure: Informal Assistance Request (IAR) out to RES to address this Priority: Near-term	• Not applicable • Reason 1: SAND-2011-0128 is not validated to 75 GWd/MTU Closure: Re-analysis of SAND-2011-0128 to higher BU is being conducted by RES and Sandia National Laboratory through 75 GWd/MTU Priority: Medium-term • Reason 2: Fragmentation-induced FGR of high burnup fuel pellets may change MHA/LOCA source term and timing of releases Closure: Informal Assistance Request (IAR) out to RES to address this Priority: Near-term	• Fully applicable • No data gaps	• Fully applicable • No data gaps	• Fully applicable • No data gaps

Note: Green text indicates the NRC is responsible for closure. Blue text indicates that the industry is responsible for closure.

Example 2: Industry responsibility

Regulatory Guide or Regulation	Burnup to 68 GWd/MTU	Burnup to 75 GWd/MTU	^{235}U Enrichment beyond 5.0 wt%	Chrome-coated Zirconium Cladding	Doped UO_2 Fuel Pellets
RG 1.236 PWR Control Rod Ejection (CRE) and BWR Control Rod Drop (CRD) Accidents	• Fully applicable • No data gaps	• Not applicable • Empirical database limited beyond 68 GWd/MTU. • Reason 1: FFRD as a result of HBU and possible loss of coolable geometry during RIA has not been well quantified or understood Closure: RIA testing on high and increased burnup fuel rod segments with deposited energy beyond predicted cladding damage needed to investigate FFRD and loss of coolable geometry. These tests should also measure transient FGR. • Reason 2: HBU effects on RIA not well quantified. HBU cladding failure thresholds should be defined. Closure: RIA testing on high and increased burnup fuel rod segments, especially RXA cladding, with low corrosion needed to better understand burnup-effects and define cladding failure thresholds.	• Not applicable • Extent of ^{235}U enrichment in RIA empirical database unknown. • Increased enrichment will promote higher rod worth and peaking factors.	• Not applicable • Thin coating will not significantly alter fuel rod response. • Cladding failure thresholds and damaged core coolability limits remain applicable. • No data gaps	• Not applicable • Reason 1: doped fuel RIA performance has not been well quantified. Closure: Testing on irradiated, doped UO2 fuel pellets and IFBA fuel pellets needed to better understand impact of additive agents (e.g., larger grain size, retained fission gas, grain boundary hold-up, thermal conductivity) on cladding failure thresholds, FFRD, transient FGR, and coolable geometry.

Note: Blue text indicates that industry is responsible for closure.

Next Steps

- Update the Regulatory Framework Applicability table and develop and pursue expanding range of applicability, if necessary
- The Regulatory Framework Applicability table will replace Tables A.1 and A.2 in the updated ATF Project Plan Revision 1.2

NRC/Industry Discussion

LICENSING PATHWAY

Kim Green
Senior Project Manager
Office Of Nuclear Reactor Regulation

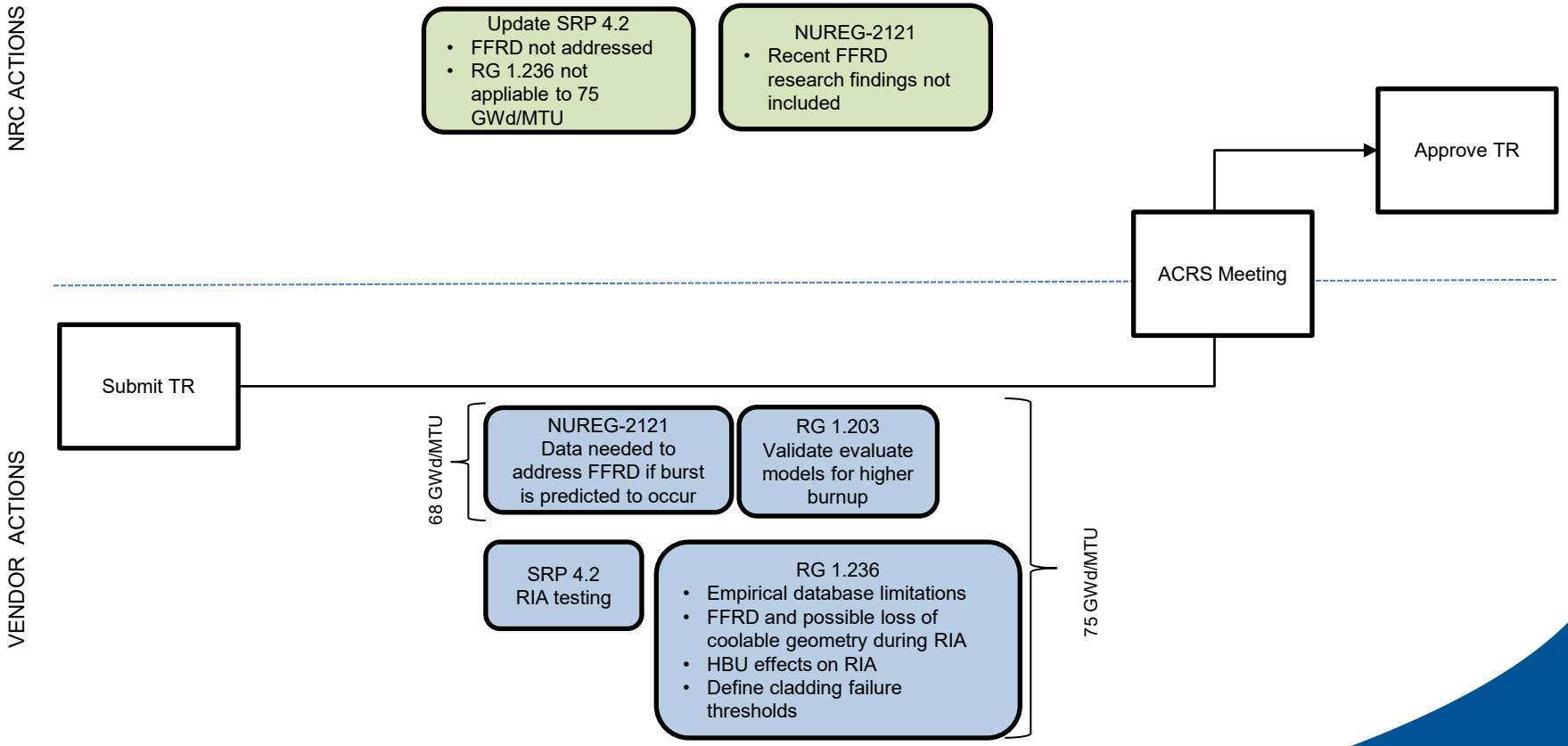
Licensing Pathway

- What the Licensing Pathway is NOT:
  - All-inclusive
  - A Timeline
  - A Checklist

- What the Licensing Pathway is:
  - Ideal depiction of remaining tasks
  - Draft

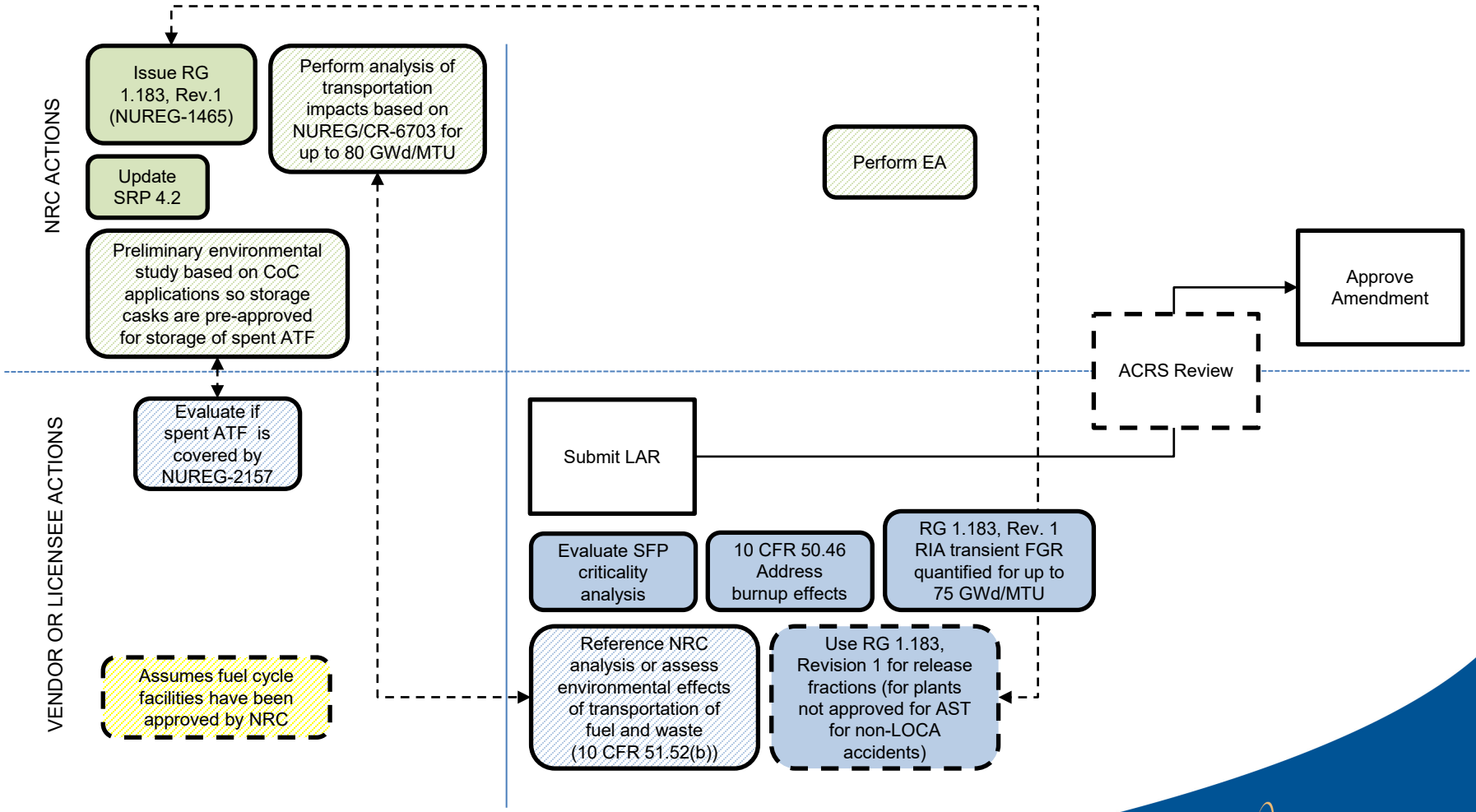
Licensing Pathway (cont'd.)

Higher Burnup Topical Report Reviews



Licensing Pathway (cont'd.)

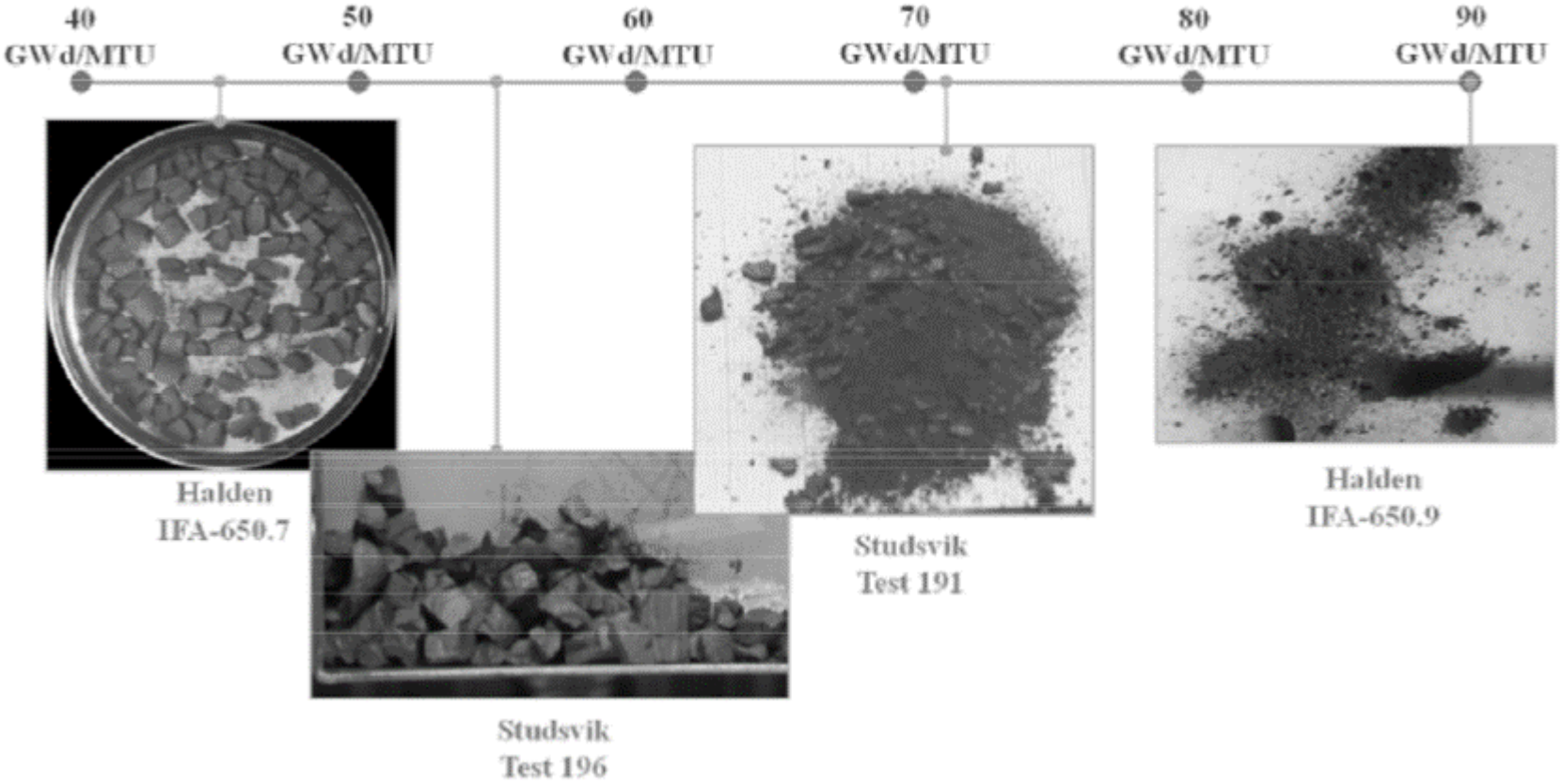
Higher Burnup Plant-Specific LAR Reviews



Research Information Letter on Fuel Fragmentation, Relocation, and Dispersal

James Corson, Ph.D.
Reactor Systems Engineer
Office of Nuclear Regulatory Research

Experiments Have Shown That Fuel Can Fragment during a Loss of Coolant Accident



NRC Has Studied FFRD and Published Findings

- NUREG-2121 (March 2012) discussed history of fuel fragmentation
- NUREG-2160 (Aug. 2013) provided results of NRC-sponsored tests
- SECY-15-0148 (Nov. 2015) concluded that rulemaking was not needed to address FFRD *at that time*
  - Conclusion based on existing burnup limits, existing fuel management practices

NRC Continues to Participate in FFRD Research

- Significant advancements in understanding of FFRD since 2015
  - Third phase of the Studsvik Cladding Integrity Project completed in 2019
  - Fourth phase of SCIP (2019-2024) is ongoing
  - Oak Ridge National Laboratory recently performed hot cell LOCA tests

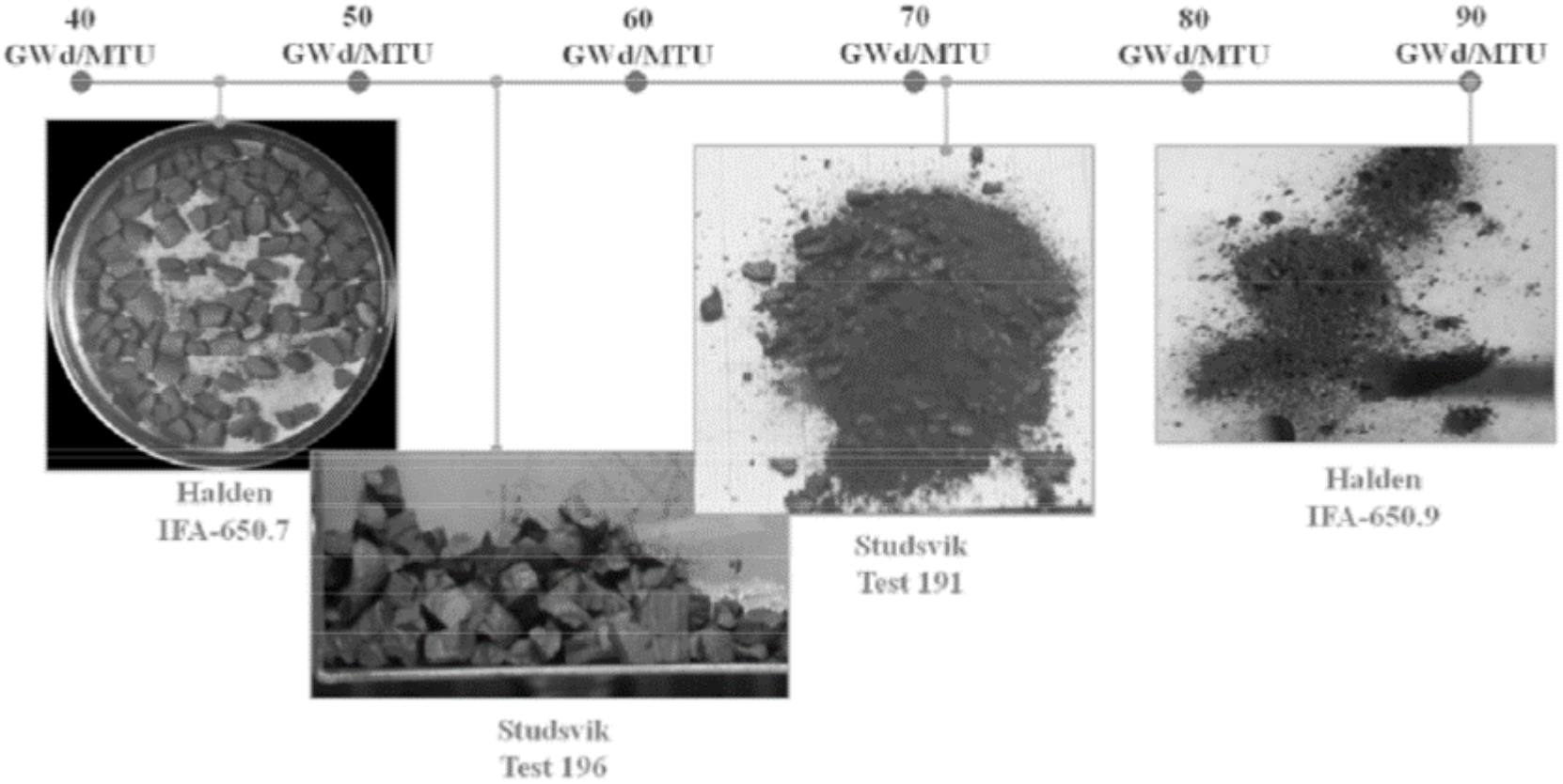
RES Staff Intend to Communicate Recent FFRD Findings in a RIL

- Research Information Letters summarize research findings and discuss how information may be used in regulatory decisions
- RILs are meant for internal use, but they can be made publicly available
  - Intent is to make FFRD RIL public
  - Some information in the FFRD RIL will need approval from SCIP and Halden management boards to publish
- Goal of RIL is to synthesize recent FFRD research

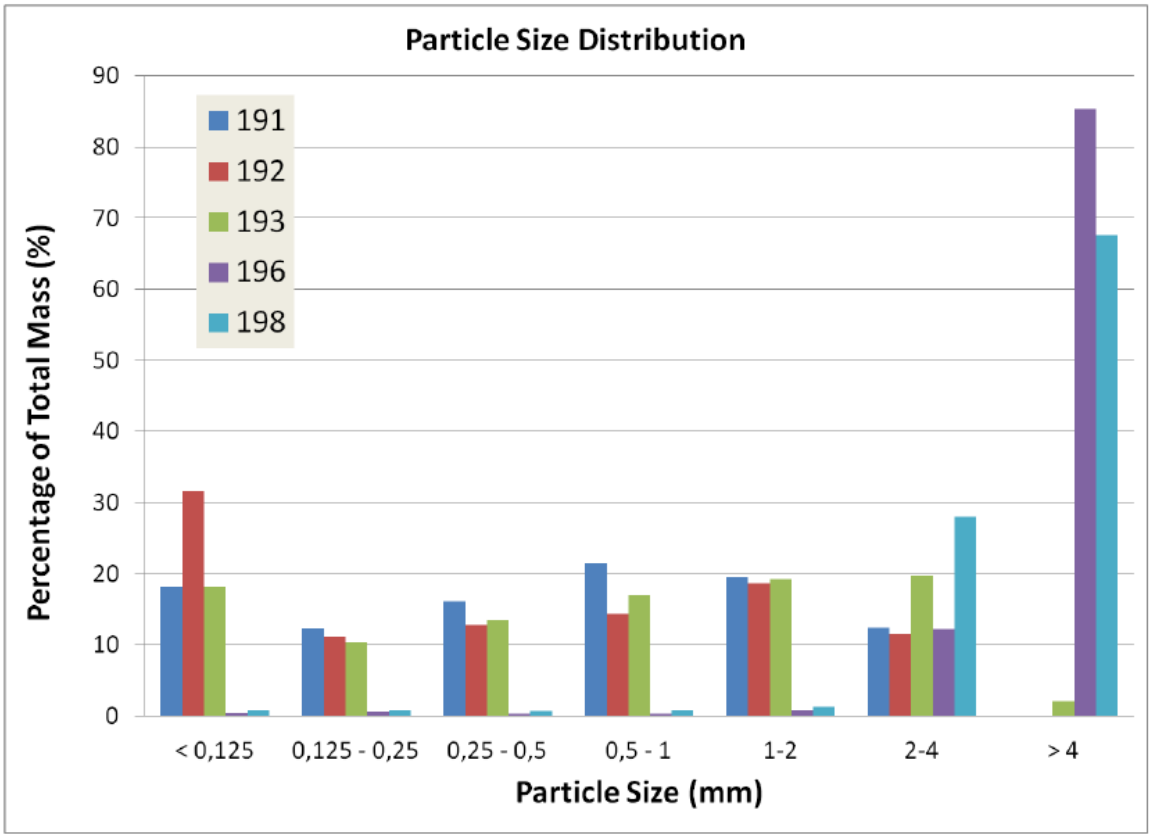
The RIL Will Address Five Elements of NRC's Interpretation of FFRD Research

- Fine fragmentation burnup threshold
- Dispersible mass fraction
- Strain threshold for fragmentation
- Transient fission gas release
- Fuel packing fraction

At What Burnup Is Fuel Susceptible to Fine Fragmentation?

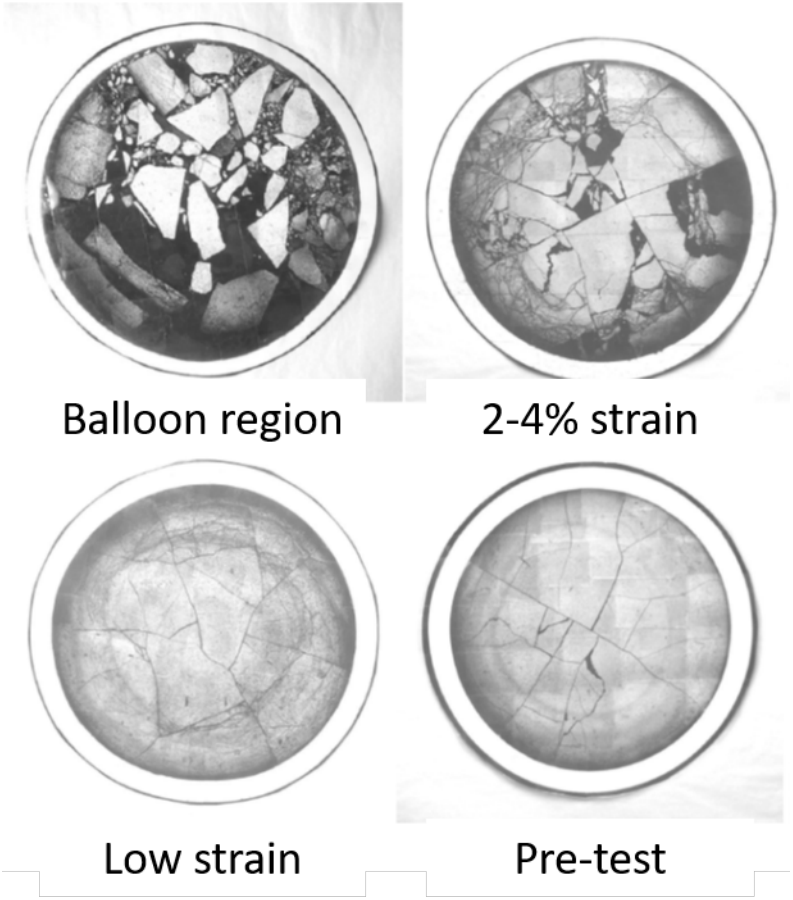


How Much Mass Can Be Dispersed?



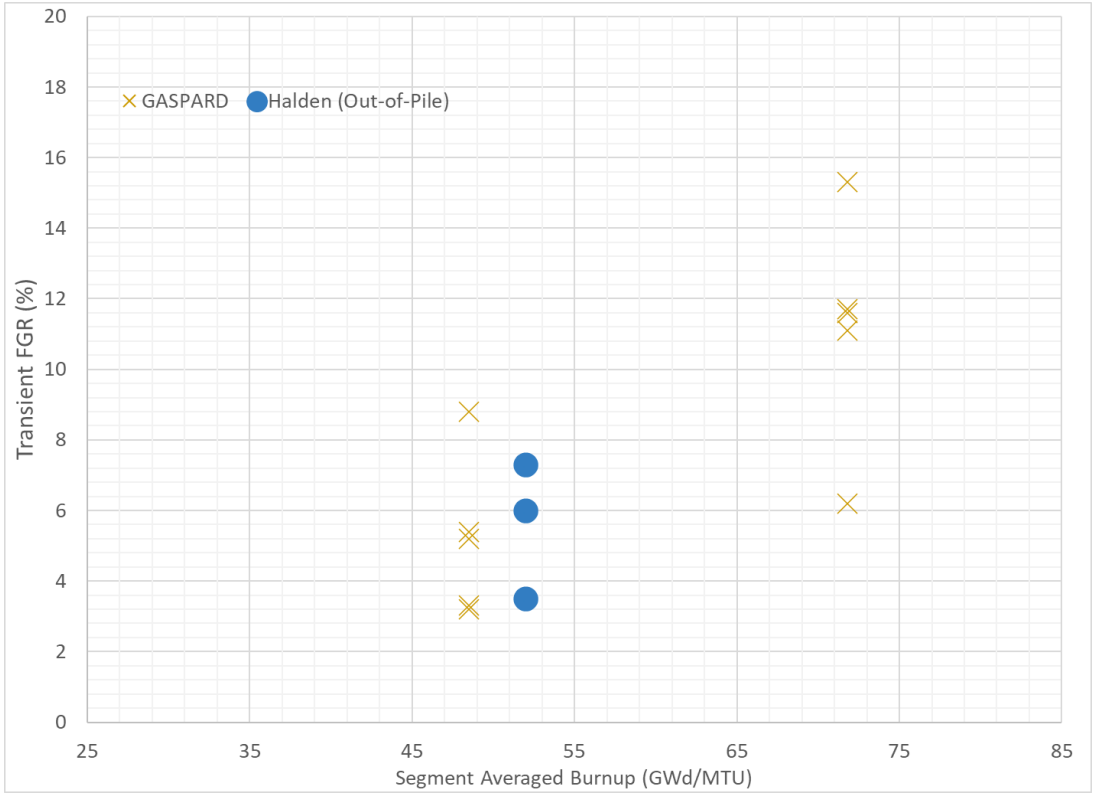
Particle size distribution from NRC-sponsored LOCA tests conducted at Studsvik (Fig. 4-40 in NUREG-2121)

How Much Cladding Strain Is Needed for Fragmentation and Relocation?



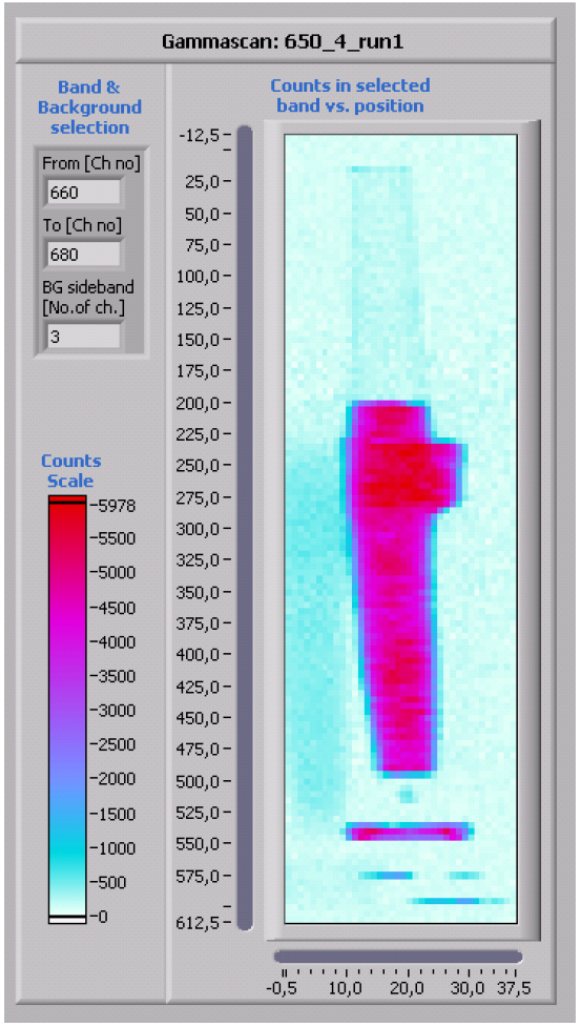
Results from Argonne National Laboratory hot cell LOCA tests performed on BWR rods (56 GWd/MTU) (Fig. 4-25 in NUREG-2121)

How Does Fragmentation Influence Transient Fission Gas Release?



- GASPARD data from Pontillon et al., Proceedings of the 2004 International Meeting on LWR Fuel Performance, Paper 1025 (Article)
- Halden data from Bianco et al., Journal of Nuclear Materials 465 (2015) 260-267 (Article)

What Is the Packing Fraction of Fuel in the Balloon Region?



Post-test gamma scan of Halden IFA-650.4 fuel rod (92 GWd/MTU) (Fig. 4-28 in NUREG-2121)

The Goal Is to Publish the RIL by the End of 2021

- Current status: draft RIL under internal review
- Future steps
  - June-July 2021: internal review
  - End of July 2021: seek approval from SCIP management board to publish data
  - August 2021: peer review
  - Fall 2021: ACRS review

NRC/Industry Discussion

10 minute Break

High Burnup and Increased Enrichment Spent Fuel in Transportation and Dry Storage

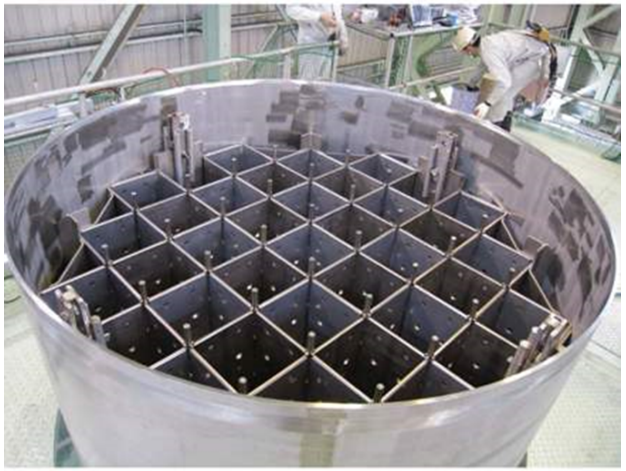
Andrew Barto
Division of Fuel Management
Office of Nuclear Material Safety and Safeguards

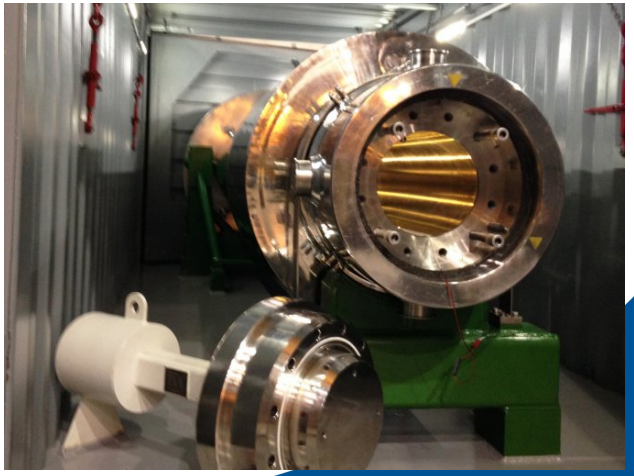
Overview

- Background on HBU Spent Fuel Storage and Transportation
- Research on Neutronics Codes Capabilities for Higher Burnup and Increased Enrichment
- Validation of Neutronics Codes at Higher Burnup and Increased Enrichment

Background

- All commercial SNF storage and transportation limited to 5% initial enrichment
- Large SNF storage or rail transportation casks limited to 60 GWd/MTU burnup for most fuel, but can go as high as 70 GWd/MTU
- Smaller transportation packages can ship higher burnups for single assemblies or groups of removed rods
- Burnup credit criticality limited to 60 GWd/MTU for code validation considerations

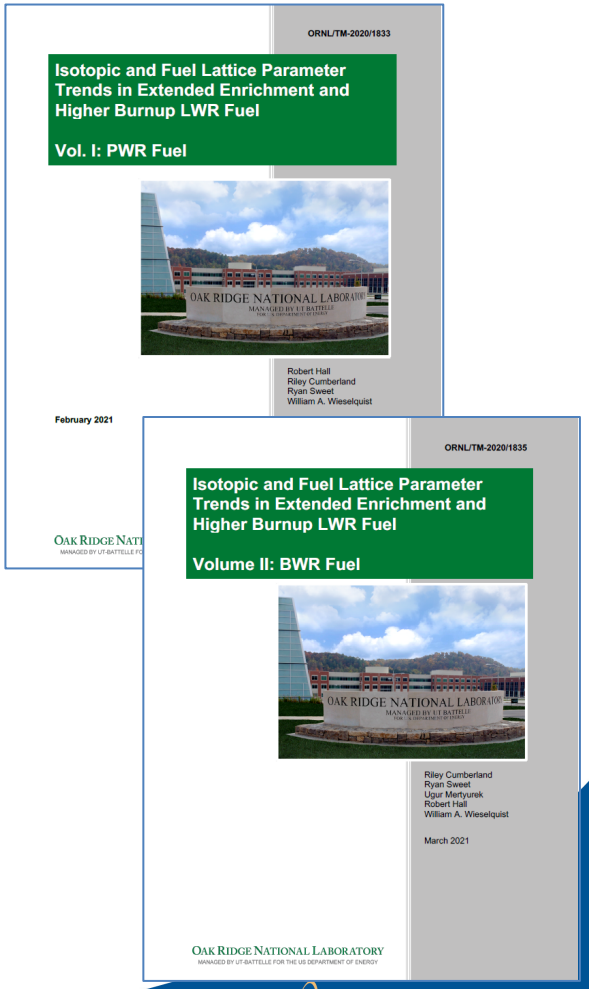




Higher Burnup/ Increased Enrichment Neutronics Code Research

Isotopic and Fuel Lattice Parameter Trends in Extended Enrichment and Higher Burnup LWR Fuel (ORNL)

- Volume I: PWR Fuel (ML21088A336)
- Volume II: BWR Fuel (ML21088A354)
- Research goals:
  - Identify important effects on reactivity, lattice physics, and isotopic effects
  - Provide code-to-code comparisons with higher order cross section libraries and/or codes
  - Identify anomalous trends in the results for further investigation



Higher Burnup/ Increased Enrichment Neutronics Code Research (cont'd)

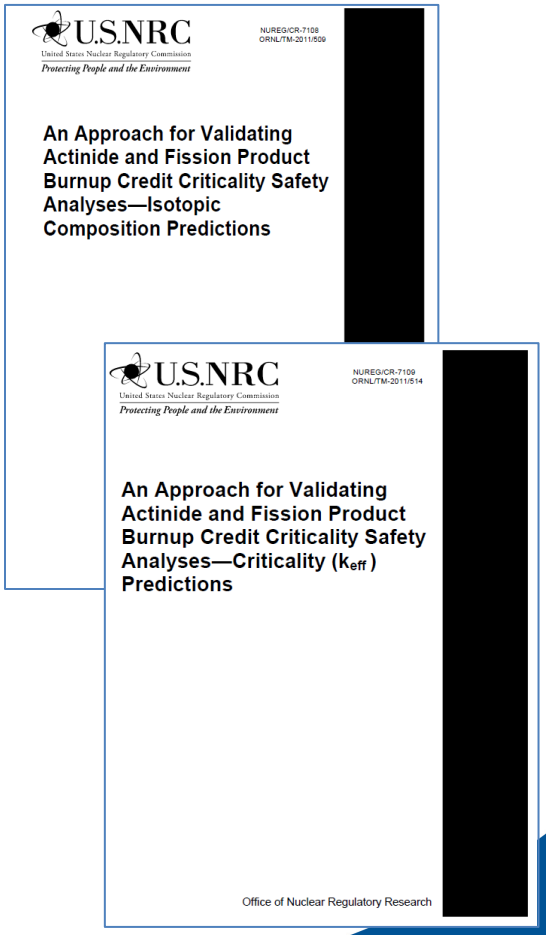
- Calculations performed using SCALE/Polaris, TSUNAMI, and ORIGEN
- Evaluated changes from base case to higher burnup / increased enrichment case:

  5% / 60 GWd/MTU → 8% / 80 GWd/MTU

- Key conclusions for storage and transportation:
  - No unexpected trends found with use of the Polaris code for depletion, lattice physics, and isotopic content calculations
  - TSUNAMI calculations show that 5% / 60 GWd/MTU case is similar to 8% / 80 GWd/MTU case in rack cell ($c_k > 0.98$)

Neutronics Code Validation

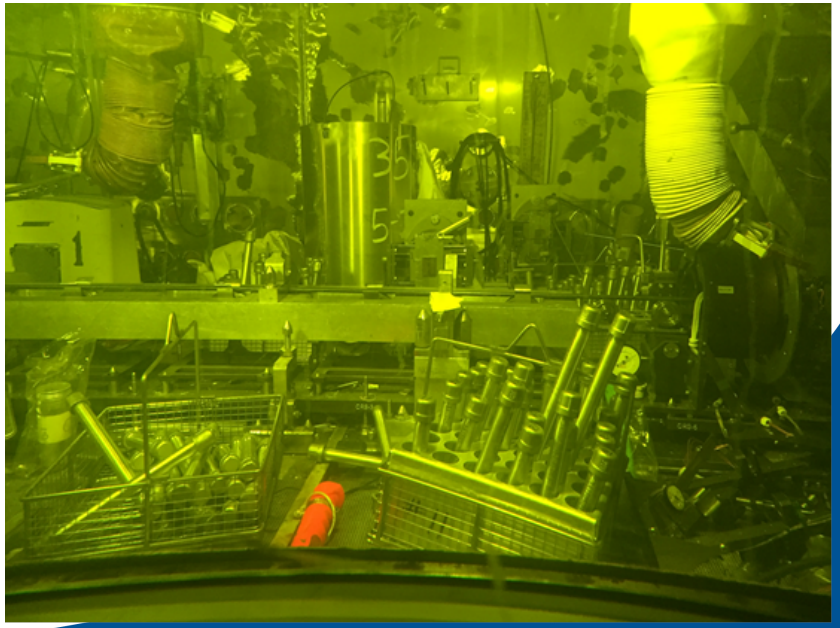
- Burnup credit in storage and transportation recommended to be limited to 5% / 60 GWd/MTU based on:
  - Available radiochemical assay data for validation of depletion codes
  - Available critical experiments similar to SNF in storage and transportation configuration
- SRPs for storage and transportation endorse approaches for validating actinide and fission product burnup credit criticality safety analyses for:
  - Isotopic composition predictions in NUREG/CR-7108
  - Criticality predictions in NUREG/CR-7109



Neutronics Code Validation (cont'd)

Applicants need to provide additional technical basis to extend SNF burnup credit criticality isotopic depletion analyses to 8% / 80 GWd/MTU:

- Ongoing research for high fidelity radiochemical assay measurements of DOE HBU storage demo sister rods for depletion code validation
  - Several samples over 65 GWd/MTU
  - 16 samples total with very low measurement uncertainties
  - No samples over 5% initial enrichment
- Update to NUREG/CR-7108 for depletion code validation



Neutronics Code Validation (cont'd)

Applicants need to provide additional technical basis to extend SNF burnup credit criticality analyses to 8% / 80 GWd/MTU:

- Are mixed oxide experiments applicable at increased enrichment and burnup?
- Can methodology for estimating k_{eff} bias based on cross section uncertainty be applied at increased enrichment and burnup?
- Update to NUREG/CR-7109 on criticality code validation

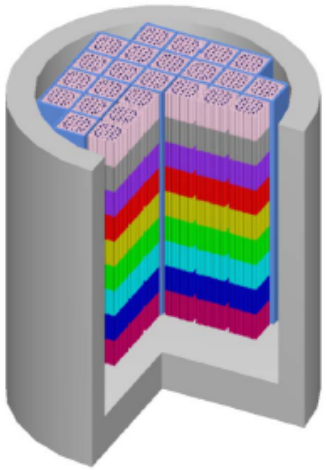


Figure 4.3 Cutaway view of the GBC-32 cask showing the cask bottom half with a quarter of the model removed.

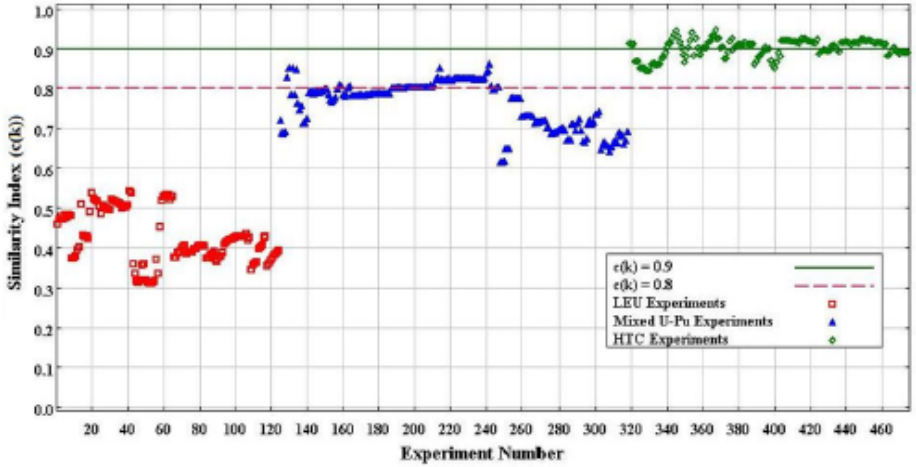


Figure 6.2 Similarity of 40 GWd/MTU PWR SFP model and each critical experiment.

Summary

- Lattice physics codes can model higher burnup and increased enrichment in transportation and storage systems, and there are no surprises regarding predicted SNF characteristics
- Applicants need to ensure that depletion and criticality codes can be properly validated at higher burnup and increased enrichment.
- NRC is sponsoring research which will assist staff in reviewing applications for higher burnup and increased enrichment

Environmental Review of ATF License Amendment Requests

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Office of Nuclear Material Safety and Safeguards

Problem Statement

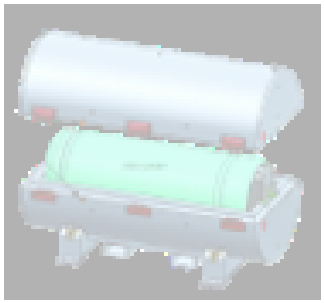
- New site-specific impacts
- Modified fuel cycle facilities
- Table S-4 criteria will be exceeded:
  - 5 wt % U-235
  - Burnup up to 62 GWD/MTU
- NEPA assessment could be affected by differences in ATF designs

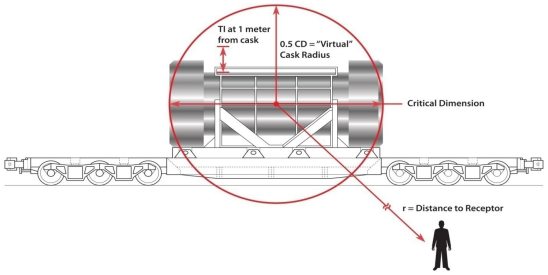
Affected Environmental Resources

- Some environmental impacts are principally driven by radionuclide inventory (i.e., source term)
- Environmental resource areas of specific interest:
  - Radiological health (site-specific)
  - Postulated accidents (site-specific)
  - Fuel cycle (offsite)
  - Transportation of unirradiated and spent ATF fuel assemblies (offsite)

Factors to be Considered in the Environmental Evaluation

- Updated FSAR for site-specific impacts
- Evaluation of off-site impacts:
  - Prior fuel cycle facility NEPA assessment(s)
  - Characteristics of transportation packages
  - Bounding assumptions
  - Information and analytical methodologies from prior studies and NEPA assessments





Planned Path Forward

- NRC is assessing the following:
  - Environmental Assessment (EA) vs Categorical Exclusion (CATX)
    - Impacts from higher enrichment and burnup could require an EA for the first LAR of an ATF design with the potential of a CATX for subsequent LARs.
  - Performance of an environmental transportation analysis
  - Expected license changes for fuel cycle facilities
  - Information and data needs

Summary

- NRC is evaluating the most appropriate path forward for its NEPA assessment of ATF LARs
- Goal of early resolution of environmental issues to the extent practicable
- Leverage prior NEPA assessments and technical studies
- Must identify and resolve information and data needs

NRC/Industry Discussion

Integrated Fleet-Wide Schedule

Paul Clifford
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HBU/IE Licensing Actions

- Integrated, fleet-wide schedule for HBU/IE licensing actions would be beneficial to prioritize and balance work-load
  - Both industry and staff resources are limited
  - Multiple strategies for implementing HBU/IE complicate work-load management
  - Coincident deployment of multiple ATF design concepts further complicate work-load management
- Fuel vendors have provided detailed schedules for HBU/IE and ATF topical reports

Unknown scope and schedule of future licensing actions (e.g., LARs, exemptions) = **RISK**

50.46c Implementation Plan

- Exceptional level of communication and coordination to develop implementation plan
  - 4 separate, focused public workshops held in 2015
- Industry developed a comprehensive, integrated GANTT chart illustrating the parallel and in-series work activities which needed to be completed in order to implement the new requirements of 50.46c.
  - Up to 24 vendor topical reports
  - Up to 65 LARs
    - 29 Level 1 LARs; maintain EMs, no new LOCA simulations
    - 5 Level 2 LARs; maintain EMs, partial re-analysis
    - 31 Level 3 LARs; new EMs, complete break spectrum
- 50.46c implementation plan should **reduce** scheduling risk and burden, while improving flexibility and efficiency

Industry Goals

- Timely HBU/IE implementation
- Prioritize and balance work-load among fuel vendor and licensee staff to complete plant-specific licensing actions
- Flexibility to accommodate outage schedules, plant modifications, vendor contracts, ATF deployment, etc…
- Assurance that NRC reviews do not delay implementation

NRC Goals

- Effective and efficient HBU/IE reviews
- Prioritize and balance work-load
- Manage staff resources and contractors (as needed)

Industry Adoption Plans Presentation

NRC/Industry Discussion

Public Comments

Lunchtime!

Final Closing Remarks

Joe Donoghue
Director
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Thank you for Participating in Today's Workshop!

For further information, please email accident_tolerant_fuel@nrc.gov or visit https://www.nrc.gov/reactors/atf.html