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

Higher Burnup Workshop IV

August 31, 2023

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

Opening Remarks

Andrea Kock
Deputy Office Director
NRR

Agenda

Time	Topic	Speaker
12:30 – 12:40	Welcome and Opening Remarks	NRC
12:40 – 12:55	Accident Tolerant Fuel (ATF) “Roadmap to Readiness”	NRC
12:55 – 1:05	Increased Enrichment Rulemaking Update	NRC
1:05 – 1:20	Introduction to the New Fuels ATLAS	NRC
1:20 – 1:40	NEI ATF Industry Update	Industry
1:40 – 1:55	Update on the Collaborative Research on Advanced Fuel Technologies for LWRs (CRAFT)	Industry, DOE
1:55 – 2:10	Discussion	NRC, DOE, Industry
2:10 – 2:20	Break	All
2:20 – 2:30	Non-LOCA Release Fractions for Burnup > 68 GWd/MTU	NRC
2:30 – 2:50	Source Terms with Higher Burnup Using MELCOR	NRC
2:50 - 3:10	Assess the Impact of Prototypic High Burnup Operating Conditions on Fuel Fragmentation Relocation and Dispersal Susceptibility	DOE
3:10 – 3:25	Environmental Evaluation of ATF with Increased Enrichment and Higher Burnup Levels	NRC
3:25 – 3:40	Discussion	NRC, DOE, Industry
3:40 – 3:55	Public Comments	Public
3:55- 4:00	Closing Remarks	NRC

Topic times are estimated based on the participation level and presentation length.

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

Meeting Logistics

- Meeting visuals and audio are through MS Teams.
- Participants are in listen-only mode until the discussion and public feedback period. During which, we will first allow in-person attendees to participate, then allow remote attendees to un-mute.
  - Remote attendees should utilize the hand raised feature in MS Teams, if possible.
- This is an Observation Meeting. Public participation and comments are sought during specific points during the meeting.
  - NRC will consider the input received but will not prepare written responses.
  - No regulatory decisions will be made during this meeting.
- This meeting is being recorded.

Meeting Purpose

- Exchange information between NRC and industry on higher burnup, increased enrichment, and Accident Tolerant Fuel (ATF) activities.
- Provide an opportunity for members of the public to ask questions of the NRC staff.

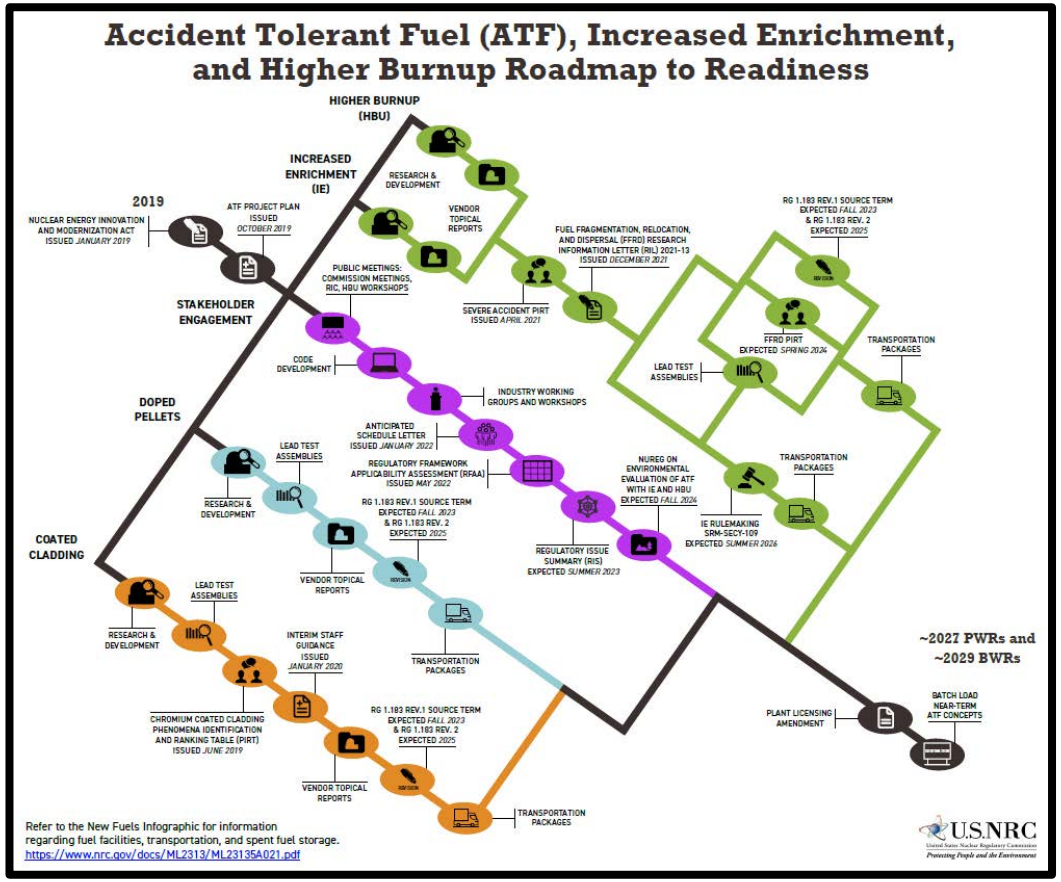
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ATF "Roadmap to Readiness"

Daniel King, NRR/DORL
Carla Roque-Cruz, NRR/DORL

Roadmap Overview

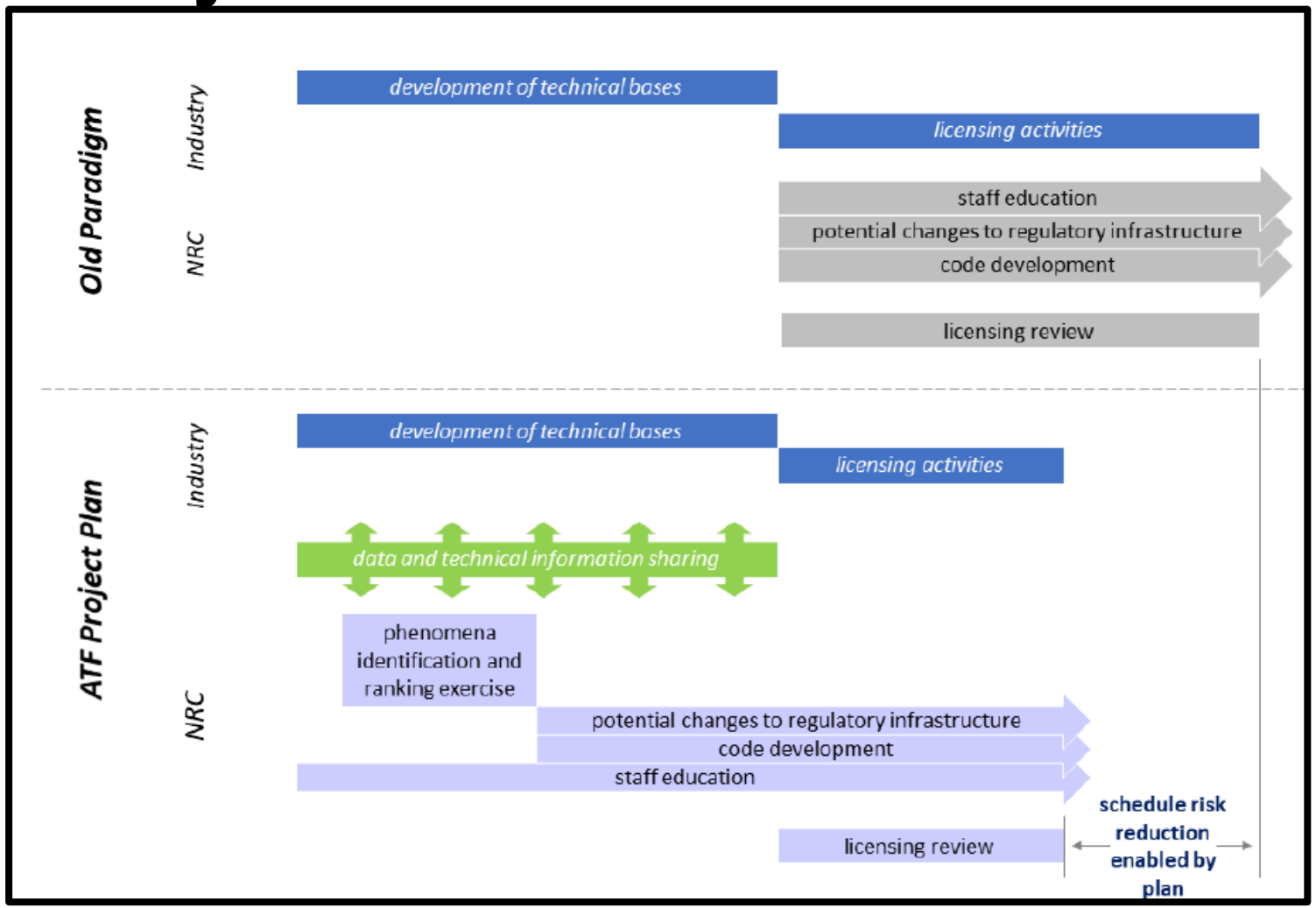
- **Issued:** June 28, 2023 (ML23158A288)
- **Stakeholder Engagement:** May 10, 2023, Public Meeting (ML23138A050)
- **Updates:** Evaluated Biannually
- **Available at:** https://www.nrc.gov/reactors/power/atf.html



The Project Plan

- Version 1.2 of the ATF Project Plan issued September 2021 (ML21243A298).

- The NRC is implementing the strategy laid out in the ATF project plan to enable the safe and efficient use of emerging ATF fuel technologies.



Roadmap Purpose

- Provide graphical representation of the ATF Project Plan
- Enhance efficiency and reliability
- Enhance understanding of the pathways to licensing near-term ATF technology
- Clearly identify direction, challenges, and risks associated in licensing near-term ATF technology
- Depict critical milestones to maintain a mid-to-late 2020s deployment timeline to batch load near-term ATF technology

General Assumptions

- Commercial nuclear industry aims to increase operational cycle time, using a combination ATF technology.
- Increased Enrichment and Higher Burnup are included with ATF technology.
- Industry aims to batch load the suite of near-term ATF technologies in mid-to-late 2020s.

Timeline Assumptions

- Licensing timeline assumptions are from the January 2022, NRC Letter to Industry, regarding scheduling expectations and historical review timelines.

Nominal Schedule for Reviewing Requests to Adopt ATF-Concept, Higher Burnup, and Increased Enrichment Fuels

Task	Duration	Start	Finish	2022 Q1	2022 Q2	2022 Q3	2022 Q4	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4
Vendor Topical Report	16 mos	7/2022	10/2023			NRC staff review	NRC staff review	NRC staff review	ACRS review	NRC staff review					
Site-Specific License Amendment	15 mos	11/2023	12/2024								NRC staff review	NRC staff review	NRC staff review	ACRS review	NRC staff review
Exemption (If Applicable)	15 mos	11/2023	12/2024								NRC staff review	NRC staff review	NRC staff review	NRC staff review	NRC staff review

NRC staff review

ACRS review

Roadmap Description

- **Orientation:** Left-to-Right and Top-to-Bottom.
- **Sequence:** Items are generally displayed in chronological sequence by start date. Of note, the previous item is not always required for the subsequent in the graphic.
- **Dates**: Dates are generally only provided for completed/issued actions.
- **Color-Coding:** Utilized to differentiate near-term technologies only.
- **Hyperlinks:** Text is hyperlinked to associated NRC webpage or to download associated document from ADAMS.

Discussion Questions

- How can the “Roadmap to Readiness” be best utilized to track overall ATF progress and adjust priorities?
- Is the “Roadmap to Readiness” still an accurate representation of the strategy to license ATF?
- Are additional Phenomena Identification and Ranking Table (PIRT) exercises needed for ATF, increased enrichment, and higher burnup?

References

Document Title	ADAMS Accession Number/ FR Citation
Overview of Accident Tolerant Fuels Commission Meeting, January 24, 2023	Transcript: ML23026A288 Meeting SRM: ML23030A013
Accident Tolerant Fuel Project Plan (Version 1.2)	ML21243A298
Scheduling Expectations Regarding the Licensing of Accident Tolerant, Increased Enrichment, and Higher Burnup Fuels	ML22003A168
Regulatory Framework Applicability Assessment and Licensing Pathway Diagram for Licensing ATF-Concept, Higher Burnup, and Increased Enrichment Fuels	ML22014A112
SECY-21-0109, “Rulemaking Plan on use of Increased Enrichment of Conventional and Accident Tolerant Fuel Designs in Light Water Reactors”	ML21232A237
SRM-SECY-21-0109, “Rulemaking Plan on use of Increased Enrichment of Conventional and Accident Tolerant Fuel Designs in Light Water Reactors”	ML22075A103
NRC Regulations Title 10, Code of Federal Regulations	Volume 1 (Parts 1-50) Volume 2 (Parts 51-199)

Increase Enrichment Rulemaking Update 8/31/2023

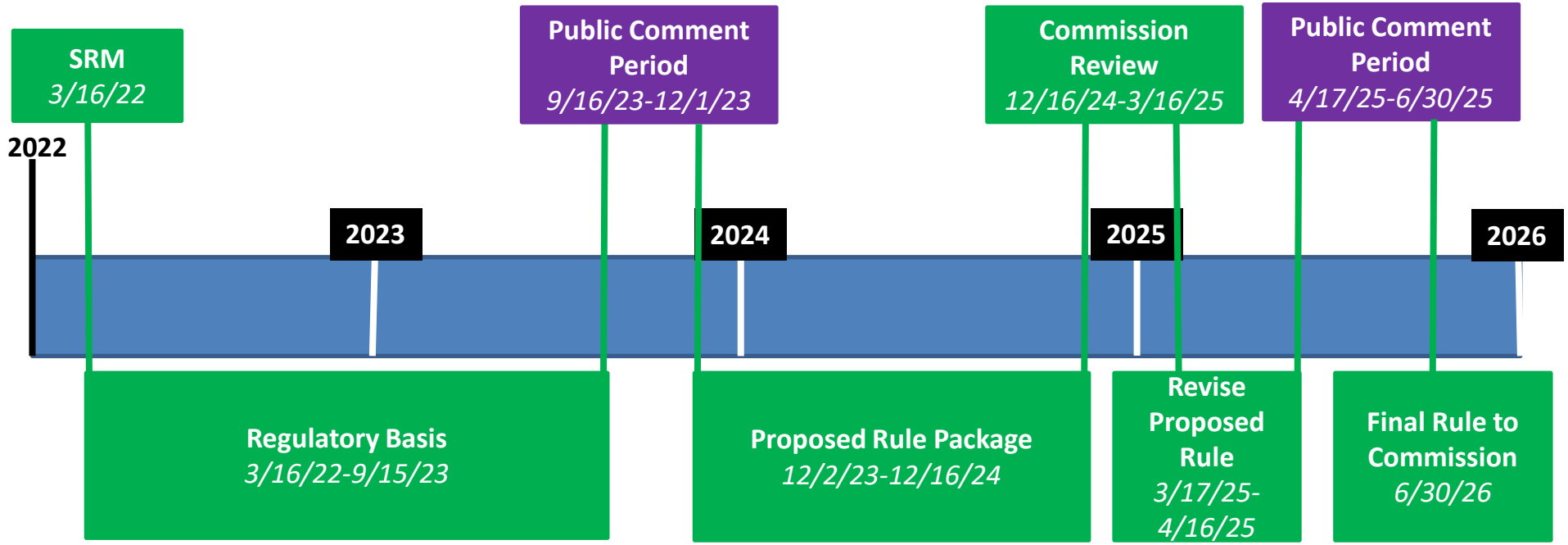
Carla Roque-Cruz, NRR/DORL

Philip Benavides, NMSS/REFS

Status of Rulemaking Activity

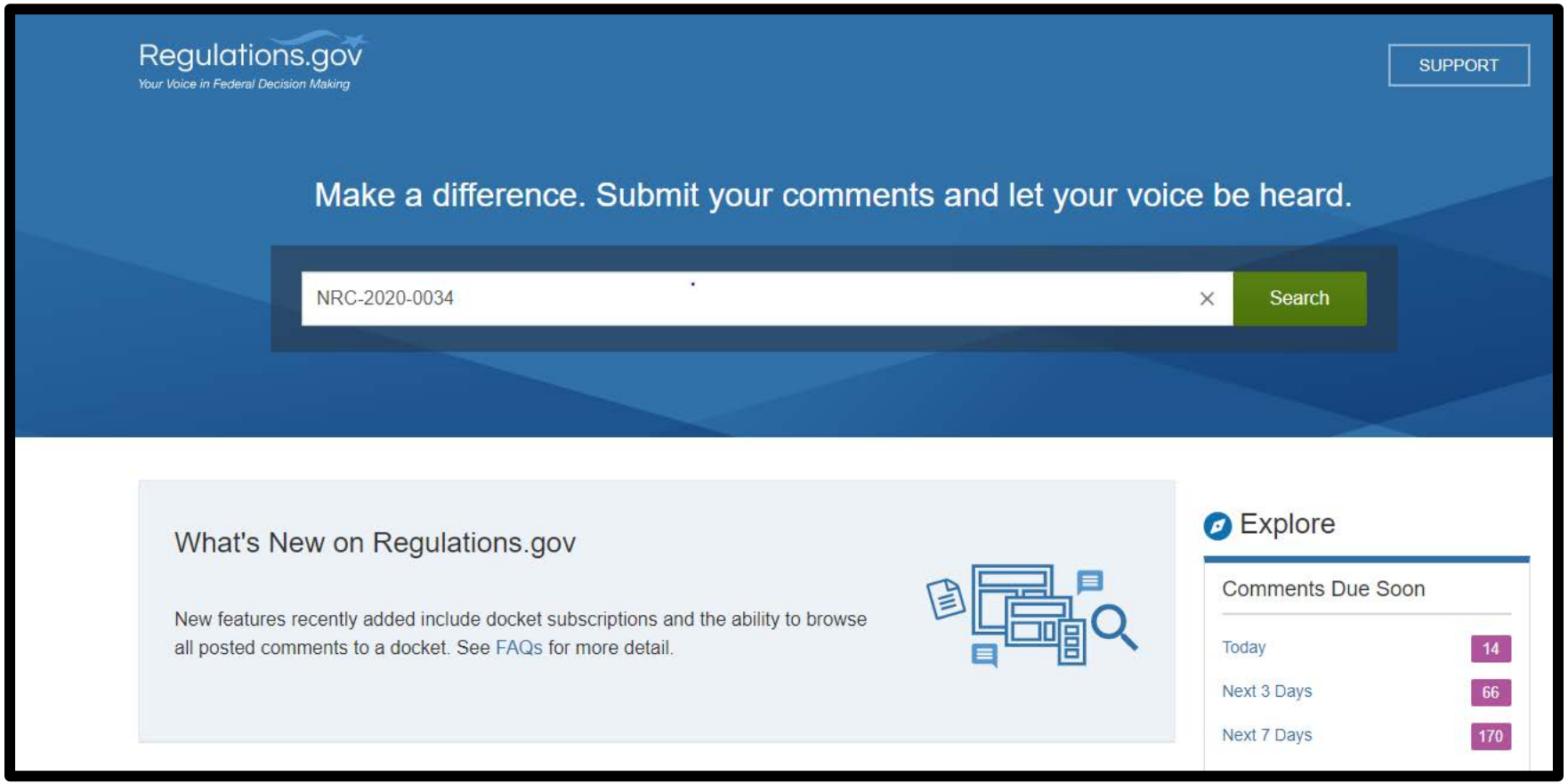
- The NRC staff is preparing the IE rulemaking regulatory basis to support its recommendation on whether it should pursue rulemaking to support industry interest in the use of fuel enriched to greater than 5.0 weight percent U-235.
- The regulatory basis stakeholder comment period will be 75 days.
- NRC will hold a public meeting during the stakeholder comment period.

Next Steps



Note: Dates listed are estimates only, and thus are subject to change.

Stay Updated on IE Rulemaking



Go to https://www.regulations.gov/ and search for docket ID NRC-2020-0034

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

References

Document Title	ADAMS Accession Number/ FR Citation
SECY-21-0109, "Rulemaking Plan on use of Increased Enrichment of Conventional and Accident Tolerant Fuel Designs in Light Water Reactors"	ML21232A237
SRM-SECY-21-0109, "Rulemaking Plan on use of Increased Enrichment of Conventional and Accident Tolerant Fuel Designs in Light Water Reactors"	ML22075A103
NRC Rulemaking Decision Guidance Tool	ML20266G457
NRC Rulemaking Approach Tool	ML20266G456
NRC Regulations Title 10, Code of Federal Regulations	Volume 1 (Parts 1-50) Volume 2 (Parts 51-199)
6/22/2022 Public Meeting	Meeting Summary: ML22208A001 **Meeting Summary contains links to all presentations, transcripts, and the meeting notice.*

Introduction to the New Fuels Atlas

Chris Markley

NMSS/DFM

High Burnup Workshop

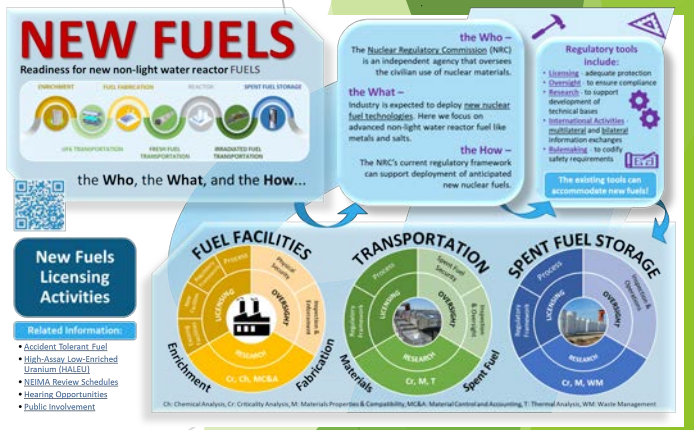
August 31, 2023

New Fuels Environment

- New fuels arena is evolving quickly
- Purpose: Enhance ability to identify and process information
- Outcome: New Fuels Atlas
  - Enhanced communications
    - Infographic
    - New Fuels Website
  - Enhanced organization
    - Regulatory Planner

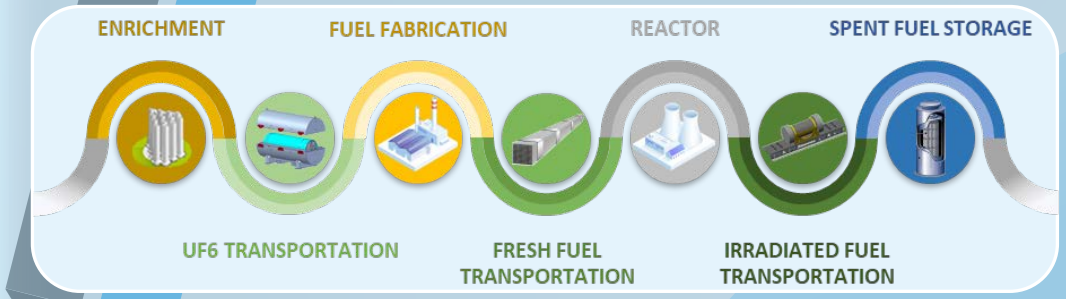
New Fuels Infographic

- Looks at all phases of the front and back end of the fuel cycle
- Provides the who, the what, and the how
- Highlights information for public stakeholders
  - Framework supports current environment
  - NRC has tools available to regulate



NEW FUELS

Readiness for new non-light water reactor FUELS



the **Who**, the **What**, and the **How**...

the Who –

The Nuclear Regulatory Commission (NRC) is an independent agency that oversees the civilian use of nuclear materials.

the What –

Industry is expected to deploy new nuclear fuel technologies. Here we focus on advanced non-light water reactor fuel like metals and salts.

the How –

The NRC's current regulatory framework can support deployment of anticipated new nuclear fuels.

Regulatory tools include:

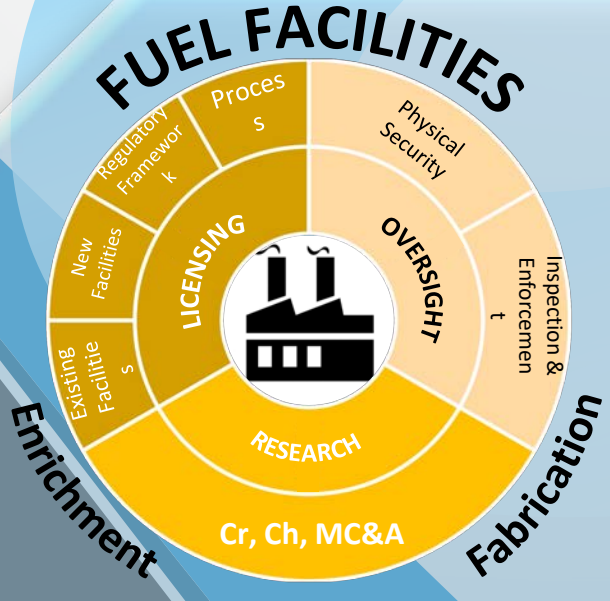
- Licensing - adequate protection
- Oversight - to ensure compliance
- Research - to support development of technical bases
- International Activities - multilateral and bilateral information exchanges
- Rulemaking - to codify safety requirements

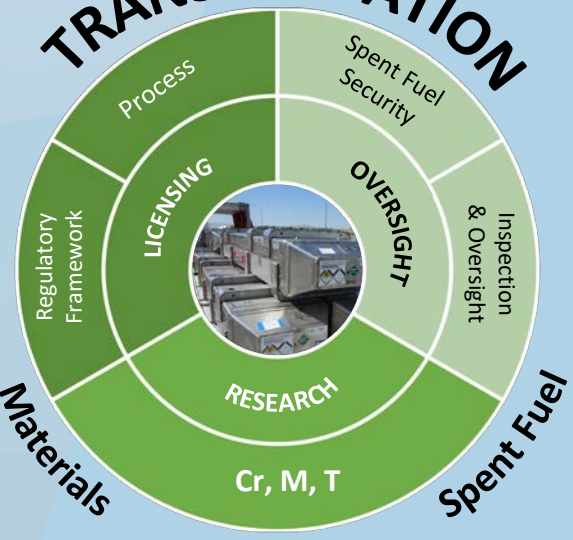
The existing tools can accommodate new fuels!

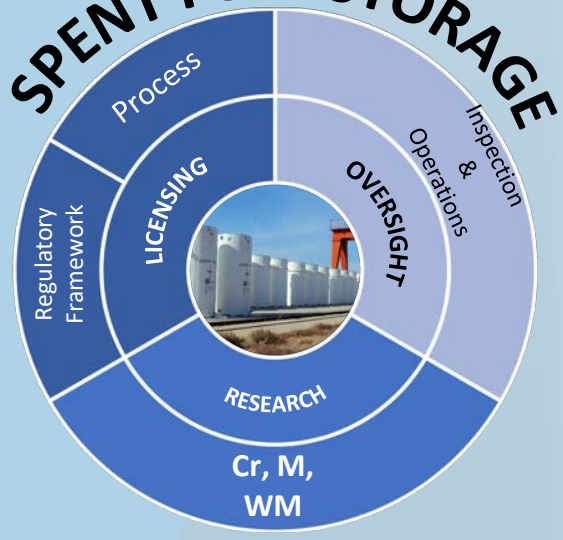
New Fuels Licensing Activities

Related Information:

- Accident Tolerant Fuel
- High-Assay Low-Enriched Uranium (HALEU)
- NEIMA Review Schedules
- Hearing Opportunities
- Public Involvement



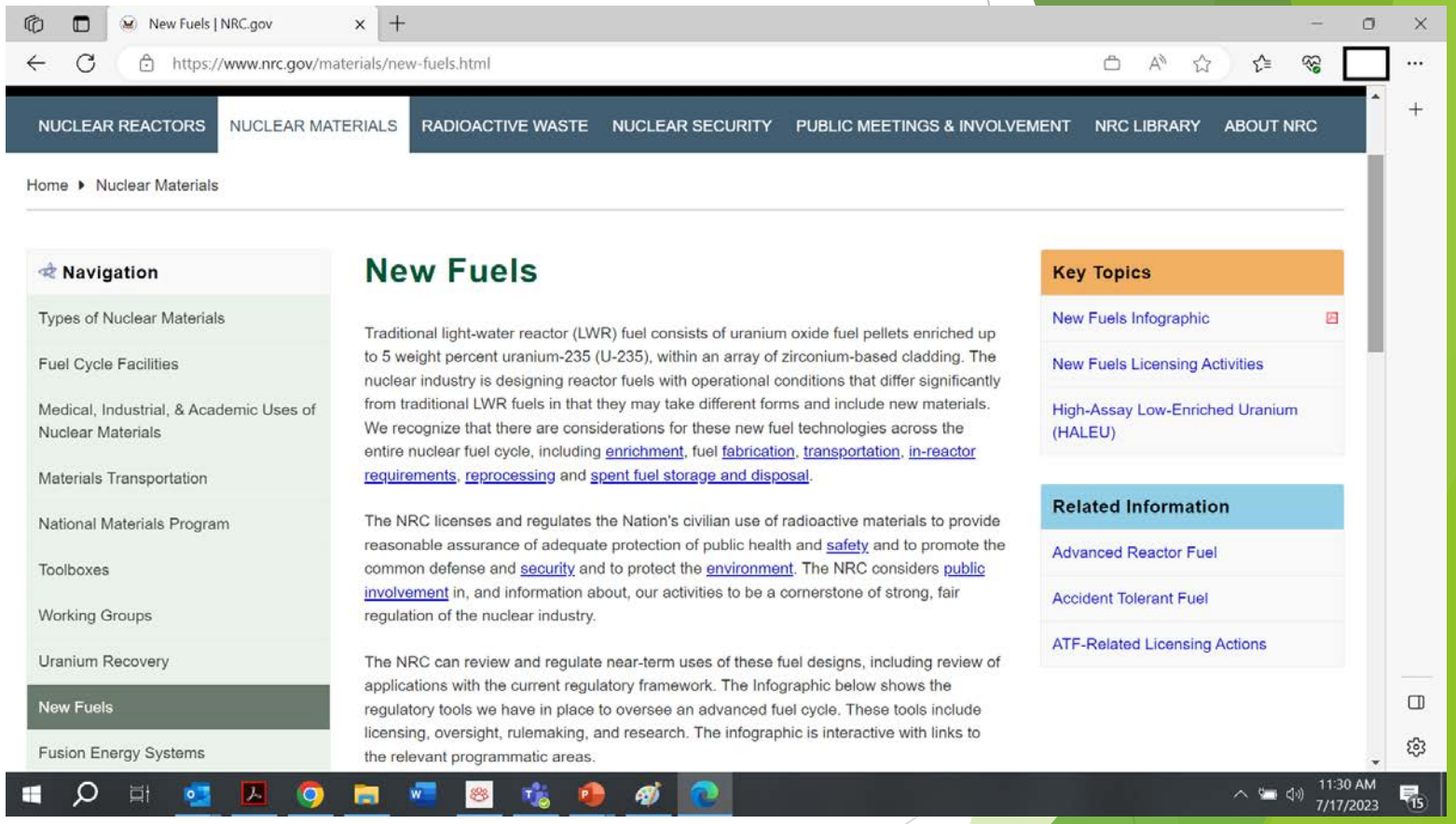




Ch: Chemical Analysis, Cr: Criticality Analysis, M: Materials Properties & Compatibility, MC&A: Material Control and Accounting, T: Thermal Analysis, WM: Waste Management

New Fuels Website

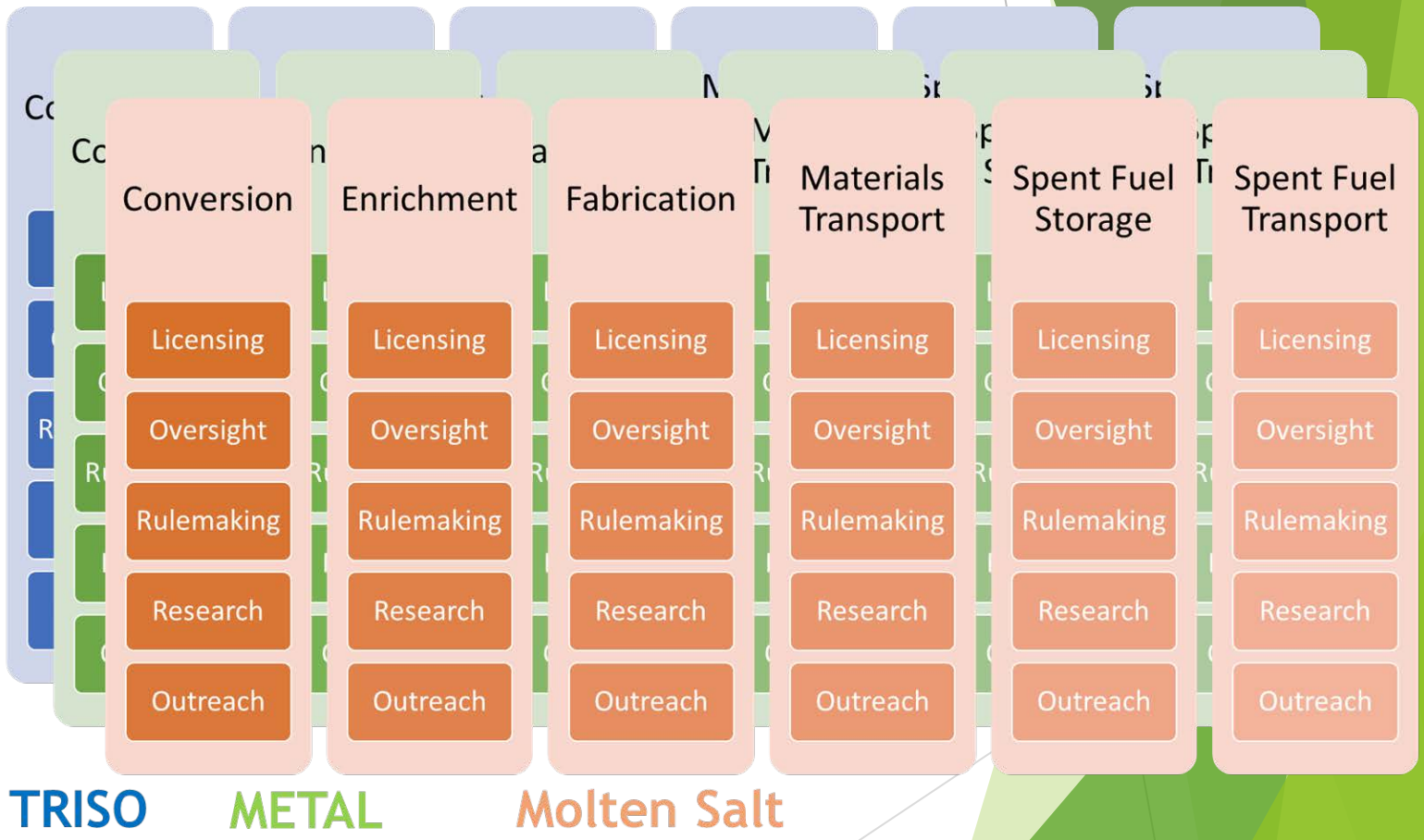
- Enrichment
- Fabrication
- Transportation
- Utilization
- Safety
- Environmental Protection
- Security and Safeguards
- Stakeholder Engagement



https://www.nrc.gov/materials/new-fuels.html

The Regulatory Planner

- Organizational tool
- For each technology
  - Fuel cycle phase
  - Programmatic area



The Regulatory Planner: Research

Fuel Cycle Phase →

Standard Review Plan Subtopic ↓

	Enrichment*	Fabrication	Fresh Fuel Transportation	Spent Fuel Storage	Spent Fuel Transportation	Spent Fuel Disposal
Criticality Safety	1) Criticality benchmark data and validation of criticality codes and methods for UF6 (5-20% enrichment); 2) SCALE Assessment (Volume 5)	Criticality benchmark data and validation of criticality codes and methods for TRISO fabrication stages (5-20% enrichment)	1) Criticality benchmark data and validation of criticality codes and methods for fresh TRISO fuel (5-20% enrichment); 2) HTGR SCALE Assessment for Transportation of Fresh Fuel Pebbles	1) Criticality benchmark data and validation of criticality codes and methods for spent TRISO fuel (5-20% enrichment); 2) Burnup credit and depletion analyses for storage container designs and fuel burnup loading curve evaluation; 3) HTGR SCALE Assessment - Inventory Generation of Spent Fuel Pebbles	1) Criticality benchmark data and validation of criticality codes and methods for spent TRISO fuel (5-20% enrichment); 2) Burnup credit and depletion analyses for storage container designs and fuel burnup loading curve evaluation	TBD
Shielding & Radiation Protection	None Expected	None Expected	Source term specification (including gamma and neutron sources and their energy) and shielding design for packaging fuels	Source term specification (including gamma and neutron sources and their energy) and shielding design for packaging spent TRISO fuel	Source term specification (including gamma and neutron sources and their energy) and shielding design for packaging spent TRISO fuel	TBD
Thermal Performance	N/A	N/A	None expected	Higher decay heat with FHR fuel compared to Fort St Vrain needs to be evaluated, perform thermal analysis using content decay heat and properties to compare with allowable temperatures of storage system	None expected; perform thermal analysis using content decay heat and properties to compare with allowable temperatures of transportation system	TBD
Structural Analysis	None Expected	None Expected	None expected	None expected	None expected	TBD
Materials Performance	N/A	N/A	Applicability of codes and standards for package design and fabrication with new materials	1) Evaluation of material performance of FHR fuel with residual salt material; 2) Evaluation of performance of TRISO coating layers under storage environments 3) Review of material properties and fuel performance considerations under storage and transportation conditions on TRISO fuel.	1) Applicability of codes and standards; 2) Material performance of FHR fuel with residual salt material evaluation; 3) Performance of TRISO coating layers under transportation environments 4) Review of material properties and fuel performance considerations under storage and transportation conditions on TRISO fuel.	TBD
Confinement & Containment	N/A	N/A	None expected	None expected; evaluate release calc (including release fractions) if required	None expected; evaluate release calc (including release fractions) if required	TBD
Fire Safety	None Expected	Fire hazards are process and facility specific, not fuel specific (e.g., combustible gas could be generated during processing)	N/A	None Expected (TRISO fuel can withstand extreme high temperatures and can not self-melt during storage)	None Expected (TRISO fuel can withstand extreme high temperatures and can not self-melt during transportation)	N/A
Chemical Process Safety	HTGR MELCOR Assessment - UF6 Rupture *Assumes Centrifuge Enrichment, not Laser or Diffusion	None Expected	N/A	N/A	N/A	N/A
References (as available)			ML21021A326	ML20022A217	ML20237F393	ML20237F397

TRISO | Metallic | Molten Salt

Any Questions?

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

Industry Presentation:

NEI ATF Industry Update

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

Industry Presentation:

Update on the Collaborative Research on Advanced Fuel Technologies for LWRs (CRAFT)

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

Discussion Period

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

Break

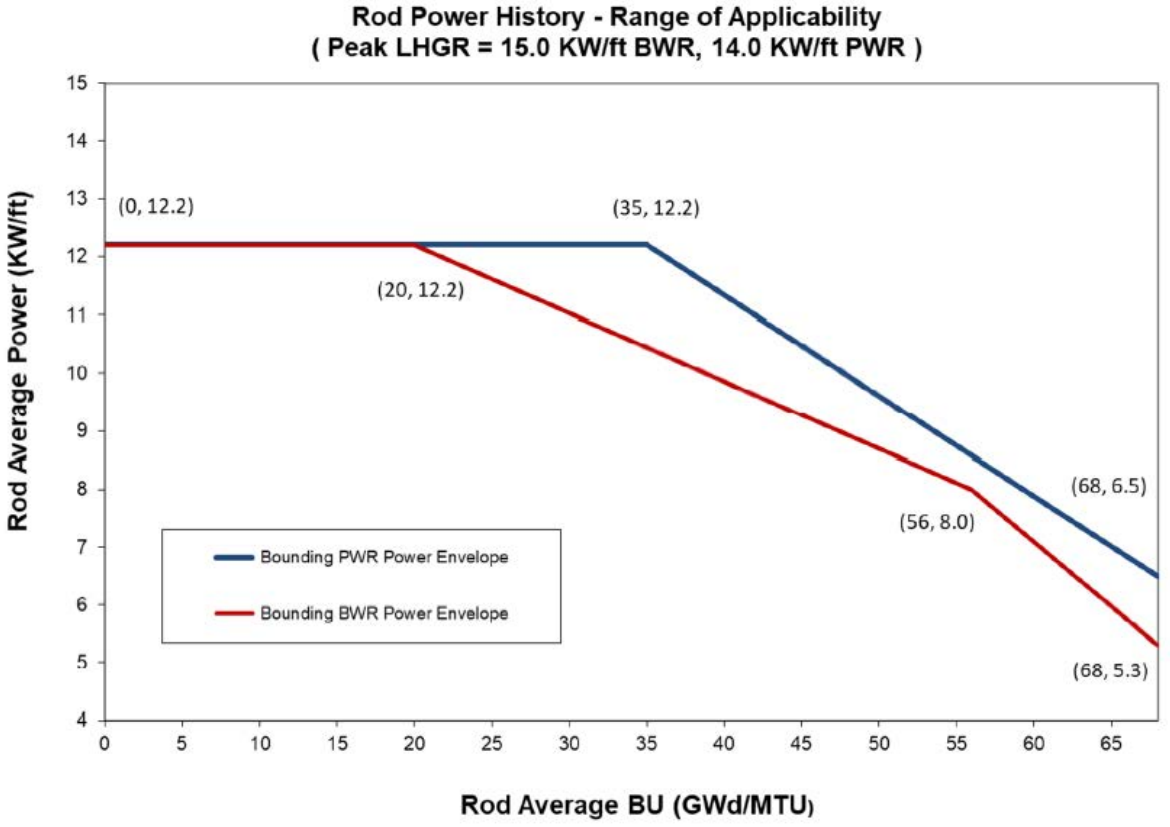
Non-LOCA Release Fractions for Burnup > 68 GWd/MTU

NRC HBU Workshop IV – August 31

Joseph Messina, James Corson

Background

- The Non-LOCA release fractions in RG 1.183 Rev. 1 are applicable if operation remains below the power history provided in the RG.
  - The power history curve extends to 68 GWd/MTU (rod-average)
- An appendix provides an analytical procedure to calculate release fractions for other power histories, fuel designs, etc.



DG-1389 Figure 1

Challenges for Non-LOCAs Above 68 GWd/MTU

- Generating non-LOCA gap fractions > 68 GWd/MTU poses a challenge:
  - ANS-5.4 (2011) Standard is not applicable for BUs > 70 GWd/MTU
  - Limited data exists at moderate rod powers for rods at high burnup
    - NRC does not plan to be responsible for necessary experiments to generate data to update regulatory guidance to support industry's higher burnups targets
  - The NRC does not have representative power histories up to 75 GWd/MTU, therefore any gap fractions the NRC calculates may not be useful

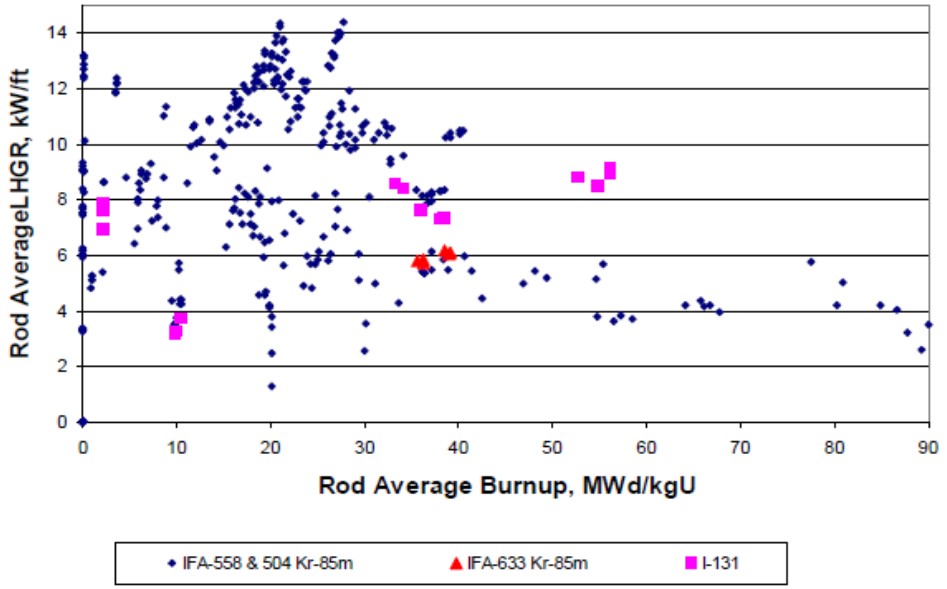


Figure 1 from NUREG/CR-7003, "Background and Derivation of ANS-5.4 Standard Fission Product Release Model"

Possible Paths Forward

The NRC staff is considering several actions for non-LOCA gap fraction guidance for BUs > 68 GWd/MTU:

- Reconvene the inactive ANS-5.4 Working Group to discuss expanding applicability
- Provide a rod power limit at HBUs for ANS-5.4 application given the available data
- Provide an analytical procedure to calculate non-LOCA gap fractions using an approved fuel performance code instead of a table of non-LOCA gap fractions to address issue of having non-representative power histories and gap fractions

Questions/Feedback?

Source Terms with Higher Burnup Using MELCOR

2023 Containment Source Term and Peer Review

NRC HBU Workshop IV – August 31

Michael Salay

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

Source Term Regulatory Basis

- **Footnote to 10 CFR 100.11(a) (Siting: Exclusion Area, Low population zone, …)**

"The fission product release assumed for these calculations should be based upon a major accident hypothesized for purposes of site analysis or postulated from consideration of possible accidental events, that would result in potential hazards not exceeded by those from any accident considered credible. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release of appreciable quantities of fission products."

History of Containment Source Term (1/2)

- TID-14844 (1962)
  - Based on furnace heating of irradiated fuel chips
  - Instantly available in the containment at the start of an accident
- NUREG-1465 (1995) (& RG1.183 rev 0)
  - Result of post-Three Mile Island Accident severe-accident research effort
  - Development Source Term Code Package (STCP) used in NUREG-1150 risk analysis
  - Representative set of unmitigated accident sequences
  - Timing and release fractions for accident phases
  - Based on analyses of plants with fuel used to burnups < 40 GWd/t (regulatory limit is 62 GWd/t)

History of Containment Source Term(2/2)

- Impact of High Burnup and MOX fuel (2011)
  - Burnups up to 62 GWd/t
  - SAND2011-0128 Accident Source Terms for Light-Water Nuclear Power Plants Using High-Burnup or MOX Fuel
  - Representative accident sequence similar to those selected for NUREG-1465 with insights from the Individual Plant Examinations NUREG–1560
  - Peer review found methodology appropriate for containment source terms
  - Technical basis for RG 1.183 Rev. 1
- Impact of Higher Burnup and Enrichment (2023)
  - Burnups up to 80 GWd/t
  - Near-term ATF analyses ongoing

Containment Source Term Development

PIRT process identified FP release behavior as major unkown for MOX and HBU fuel

Experimental Basis

MELCOR

Clad burst timing

Melt Progression Behavior

Fission Product Release

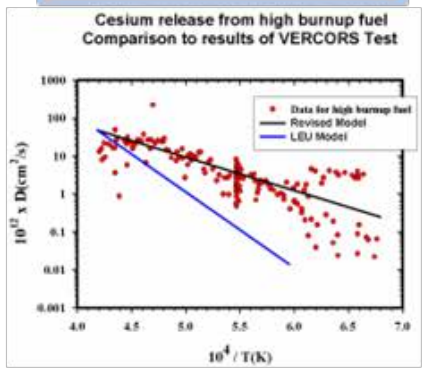
Gas Generation Rate

Fission Product Transport

Etc…

Oxidation Rate

Models

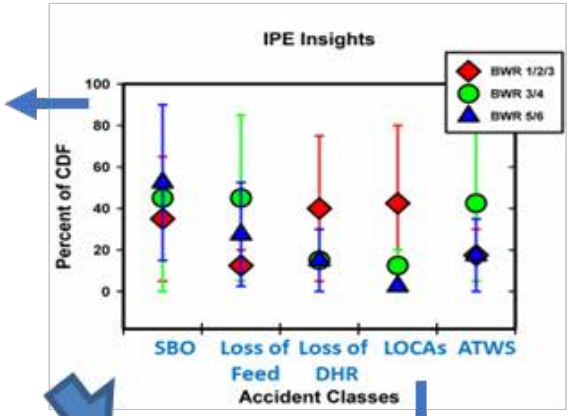


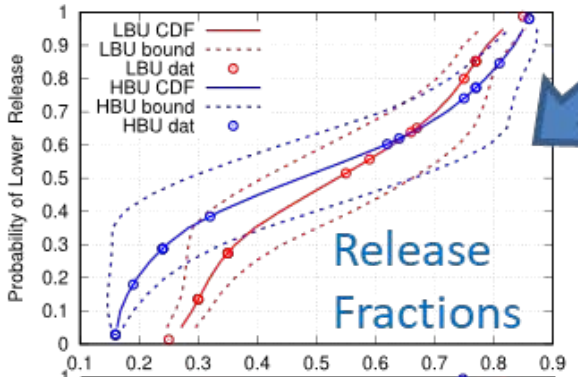
Accident Analysis for Range of Accident Scenarios

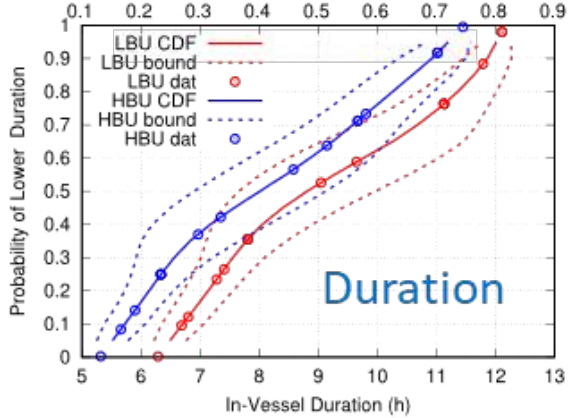
Scenario #1 | Scenario #4

Scenario #2 | Scenario #5

Scenario #3 | Scenario #6







Synthesize sequence-specific timings and release fractions to representative table

Design Basis Source Term

Fission Product class	Gap 0.5 hr	In-vessel 1.3 hr	Ex-vessel 2 hr	Late 10 hr
Noble Gases	5%	95%	~0	~0
Iodine, bromine	5%	35%	25%	1%
Cesium	5%	25%	35%	1%
Tellurium	~0	5%	25%	0.5%
Ba, Sr	~0	2%	10%	~0
Ru, Mo, Pd, etc.	~0	0.25%	0.25%	~0
Lanthanides	~0	0.02%	0.5%	~0
Cerium group	~0	0.05%	0.5%	~0

2023 Source Term: Higher Burnup/Enrichment

- Extend Source Terms to 80 GWd/MTU and 10 w/o enrichment

  "High Burnup Fuel Source Term Accident Sequence Analysis", SAND2023-01313, Sandia national Laboratories, ML23097A087, April 2023

- Similar objectives and approach to the NUREG-1465 and SAND2011-0128 source terms
- Incorporation of insights from SOARCA, post-Fukushima studies, and international experimental programs
  - Evolution of severe accident modeling best-practices
- Peer review found methodology appropriate for containment source terms

  ''Peer Review of the In-Containment Source Term Study for High-Burnup and High-Assay Low Enriched Uranium Fuels", ERI/NRC 23-201, Energy Research Inc., ML23097A086, April 2023

Key Severe Accident Knowledge Evolution Since NUREG-1465

- Evolution of severe accident state-of-knowledge
  - Improved understanding of fission product chemistry affecting I, Cs, Te release and transport (e.g., Phébus FP Program, VERCORS, VERDON)
  - Insights from SOARCA and post-Fukushima studies
- MELCOR modeling enhancements
  - Refined modeling of core damage progression leads to extended core degradation and delayed lower head failure
  - Induced failure of reactor systems following core damage leads to lower pressure
    - BWR simulations consistently predict thermal SRV seizure
    - PWR simulations consistently predict hot leg creep rupture

Key Findings

PWR	Gap Release			Early In-vessel		
Study	2023	2011	NUREG-1465	2023	2011	NUREG-1465
Phase Duration	1.3	0.22	0.50	4.0	4.5	1.3
Halogens	0.007	0.004	0.050	0.58	0.37	0.35
Alkali Metals	0.003	0.003	0.050	0.50	0.23	0.25
Te Group	0.006	0.004	0.0	0.55	0.30	0.050

BWR	Gap Release			Early In-vessel		
Study	2023	2011	NUREG-1465	2023	2011	NUREG-1465
Phase Duration	0.70	0.16	0.50	6.7	8.0	1.5
Halogens	0.005	0.002	0.050	0.71	0.47	0.25
Alkali Metals	0.005	0.002	0.050	0.32	0.13	0.20
Te Group	0.003	0.002	0.0	0.56	0.39	0.050

- Moving to higher burnup does not significantly change the source term to containment
- Increase in halogen releases from NUREG-1465 due to
  - enhanced knowledge of FP release and transport
  - higher proportion of low-pressure scenarios
- Suppression pool can impact BWR containment source terms

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

DOE Presentation:

Assess the Impact of Prototypic High Burnup Operating Conditions on Fuel Fragmentation Relocation and Dispersal Susceptibility

Environmental Evaluation of ATF with Increased Enrichment and Higher Burnup Levels

Donald Palmrose, Ph.D.

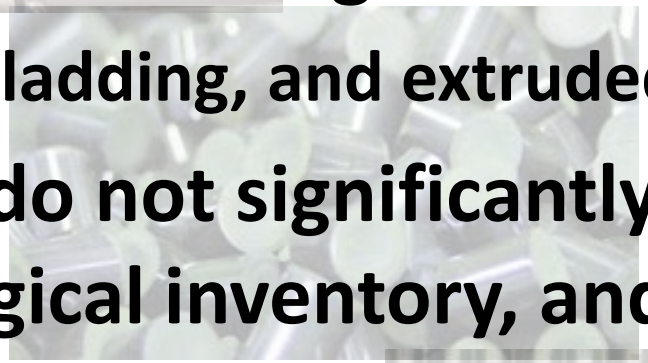
Senior Reactor Engineer

Office of Nuclear Material Safety and Safeguards (NMSS)

Key Points

- Evaluate environmental impacts of deployment and use of near-term ATF with increased enrichment (IE) and higher burnup (HBU) levels to support future licensing reviews
- Current NEPA coverage for 5 wt % U-235 and 62 GWd/MTU
- Evaluation of impact in the uranium fuel cycle (UFC), transportation of fuel and waste, and decommissioning
- Table S-3, Table S-4, and Decommissioning GEIS still bounding for deployment and use of ATF with up to 8 wt % U-235 and 80 GWd/MTU
- Continued Storage (CS) GEIS still applies
- Address release fraction uncertainty at HBU levels

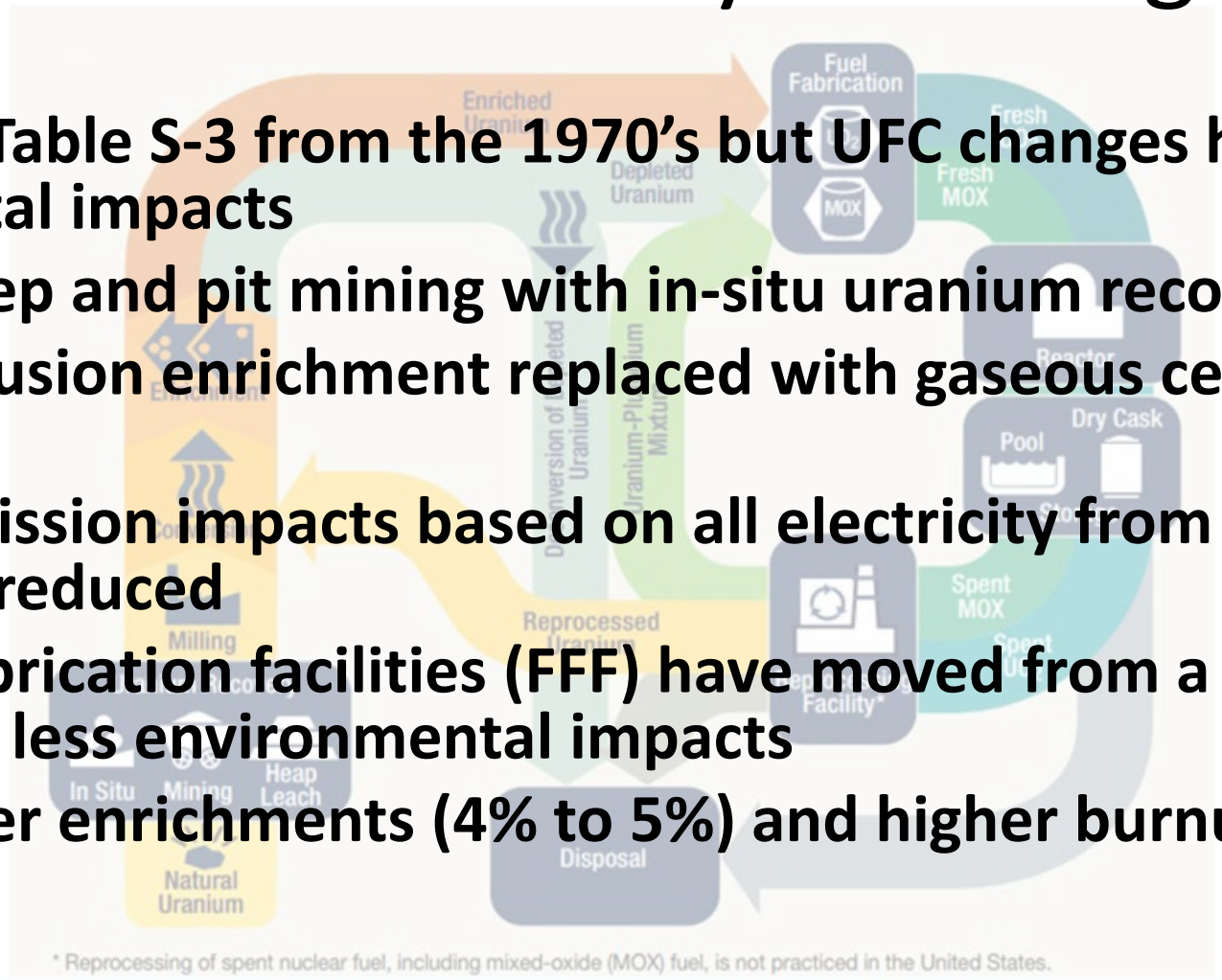
Impacts of ATF Technologies



- **Focus is on near-term ATF technologies**
  - **Coated cladding, doping, FeCrAl cladding**
- **Longer-term ATF technologies not covered**
  - **UN pellets, SiC cladding, and extruded metallic fuel**
- **Near-term ATFs do not significantly change fuel fabrication impacts, radiological inventory, and releases fractions**
- **IE and HBU being part of the deployment and use of ATF are the key factors for impacts**

Uranium Fuel Cycle Changes

- **Analysis for Table S-3 from the 1970's but UFC changes have reduced environmental impacts**
- **Replaced deep and pit mining with in-situ uranium recovery technology**
- **Gaseous diffusion enrichment replaced with gaseous centrifuge enrichment**
- **Table S-3 emission impacts based on all electricity from coal but now significantly reduced**
- **Most fuel fabrication facilities (FFF) have moved from a wet to a dry process with less environmental impacts**
- **Slightly higher enrichments (4% to 5%) and higher burnup levels (33 to 62 GWd/MTU)**



Uranium Fuel Cycle

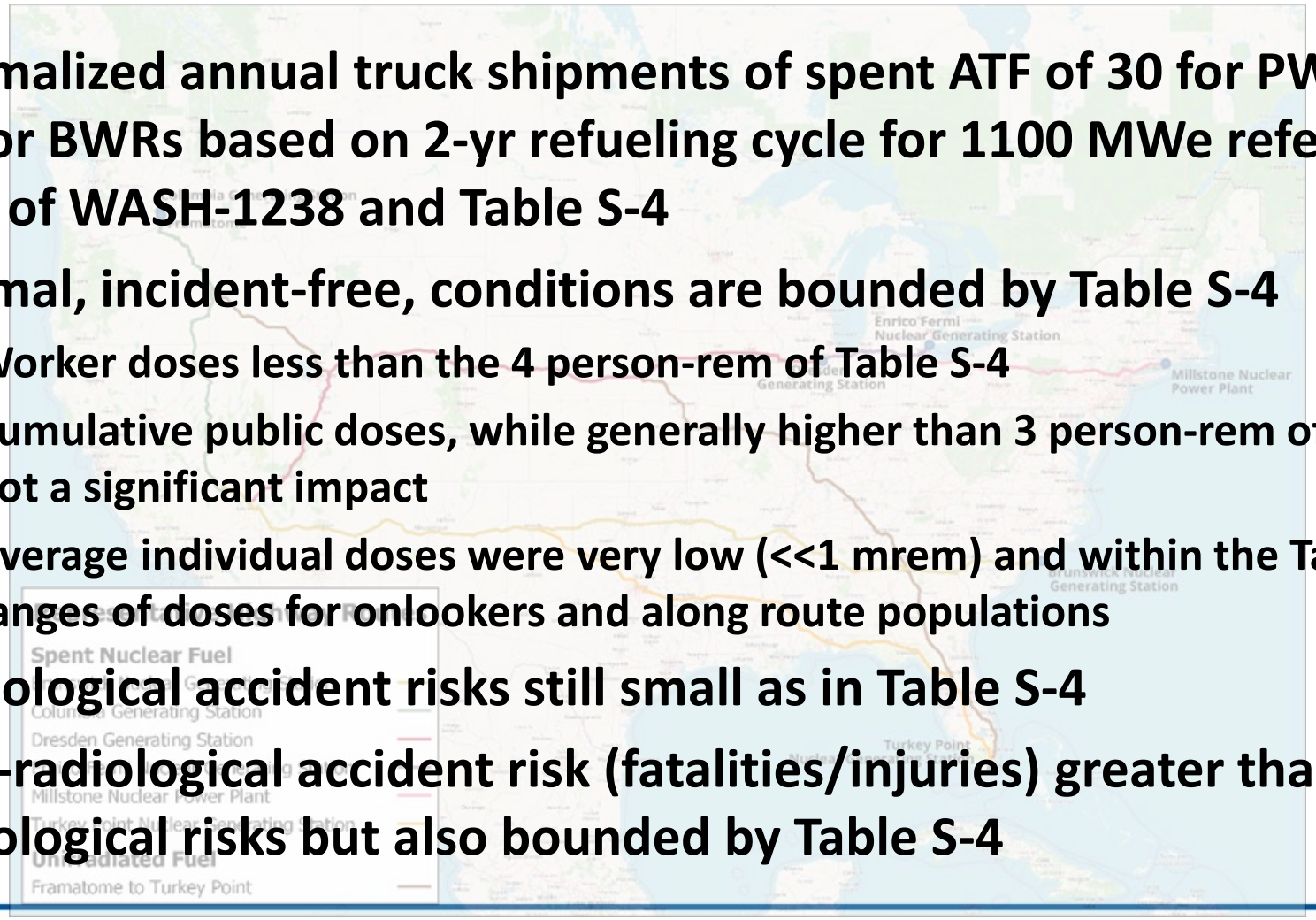
- **UFC impacts for deployment and use of ATF is from IE and HBU**
  - **The greater amount of yellowcake to support IE would not cause a significant change in related Table S-3 impacts**
  - **Gaseous centrifuges use less electricity for 10 wt % U-235 than gaseous diffusion did for 4 wt % U-235**
  - **Longer refueling cycles would reduce the rate of spent nuclear (used) fuel generation**
  - **Spent ATF management would still be similar to Continued Storage (CS) GEIS (NUREG-2157)**
- **Table S-3 and CS GEIS would bound or still apply to deployment and use of ATF with IE & HBU levels**

Transportation

- **Use of DOE & NRC guidance & the code NRC-RADTRAN (radiological transportation risk) with WebTRAGIS (routing)**
- **Six sites selected by regions**
- **ATF assembly radionuclide inventory from ORNL ATF studies**
- **Parameter values for fuel shipments from prior analyses and new sources for incident-free and accident risk impacts**
  - **Some are *very conservative*, for example, vehicle accident rates based on commercial shipping and least capacity in a transport package**
- **Sensitivity cases for rail shipments and release fraction uncertainty at HBU levels**

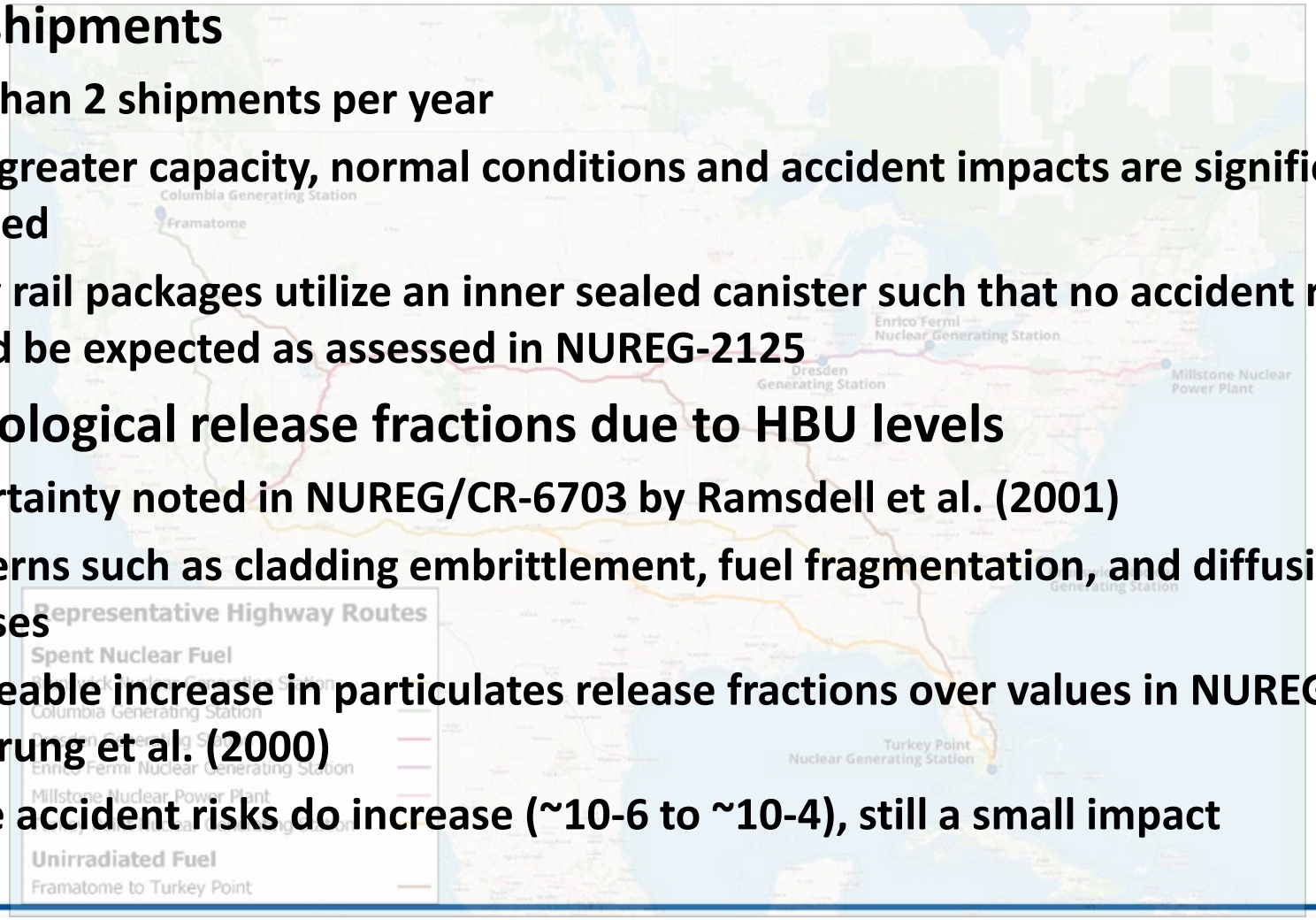
Transportation (cont.)

- **Normalized annual truck shipments of spent ATF of 30 for PWRs and 52 for BWRs based on 2-yr refueling cycle for 1100 MWe reference NPP of WASH-1238 and Table S-4**
- **Normal, incident-free, conditions are bounded by Table S-4**
  - **Worker doses less than the 4 person-rem of Table S-4**
  - **Cumulative public doses, while generally higher than 3 person-rem of Table S-4, not a significant impact**
  - **Average individual doses were very low (<<1 mrem) and within the Table S-4 ranges of doses for onlookers and along route populations**
- **Radiological accident risks still small as in Table S-4**
- **Non-radiological accident risk (fatalities/injuries) greater than radiological risks but also bounded by Table S-4**



Transportation Sensitivity Cases

- **Rail shipments**
  - **Less than 2 shipments per year**
  - **With greater capacity, normal conditions and accident impacts are significantly reduced**
  - **Many rail packages utilize an inner sealed canister such that no accident releases would be expected as assessed in NUREG-2125**
- **Radiological release fractions due to HBU levels**
  - **Uncertainty noted in NUREG/CR-6703 by Ramsdell et al. (2001)**
  - **Concerns such as cladding embrittlement, fuel fragmentation, and diffusional releases**
  - **Noticeable increase in particulates release fractions over values in NUREG/CR-6672 by Sprung et al. (2000)**
  - **While accident risks do increase (~10-6 to ~10-4), still a small impact**



Decommissioning

- **Decommissioning GEIS is NUREG-0586 Supplement 1**
  - **Extensively discussed in 2013 License Renewal GEIS (NUREG-1437 Rev 1) and in past new reactor EISs**
- **ATF deployment, use, and subsequent termination of operations would only affect human health and waste management**
  - **All other resource areas would be the same or slightly less**
- **ATF deployment effects on decommissioning:**
  - **Effluent releases would still be lower after cessation of ops**
  - **Worker doses still controlled per 10 CFR Part 20**
  - **Would not alter the practices employed to manage the wastes**
  - **Would need less ISFSI capacity than staying with current fuels**
- **Decommissioning GEIS would bound deployment and use of ATF with IE and HBU levels**

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

Discussion Period

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

Public Comment Period

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

Adjourn

How did we do?

https://feedback.nrc.gov/pmfs/

Meeting Code: 20230872