U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Fuel Cycle Technologies Material Recovery and Waste Form Development Campaign

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NEUP Webinar
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NE-5 Organization Structure

NE-5
Deputy Assistant Secretary
for Fuel Cycle Technologies:
John W. Herczeg

Associate Deputy Assistant Secretary
for Fuel Cycle Technologies :
Andrew Griffith

Melissa Bates

NE-5 ***NFST***
N*uclear* ***F****uel* ***S****torage and* ***T****ransportation Planning Project*

- ***Integrated Waste Mgmt. System***

Patricia Paviet

NE-51
Systems Engineering And Integration

- ***Material Recovery and Waste Form Development***
- ***System Analysis and Integration***
- ***Fuel Resources***

Dave Henderson

NE-52
Fuel Cycle Research and Development

- ***Advanced Fuels***
- ***Materials Protection, Accounting, and Control Technology***
- ***Uranium Management and Policy***

Bill Boyle

NE-53
Used Nuclear Fuel Disposition Research and Development

- ***Used Fuel Disposal R&D***
- ***Deep Boreholes***
- ***High Burnup Fuel Demonstration***

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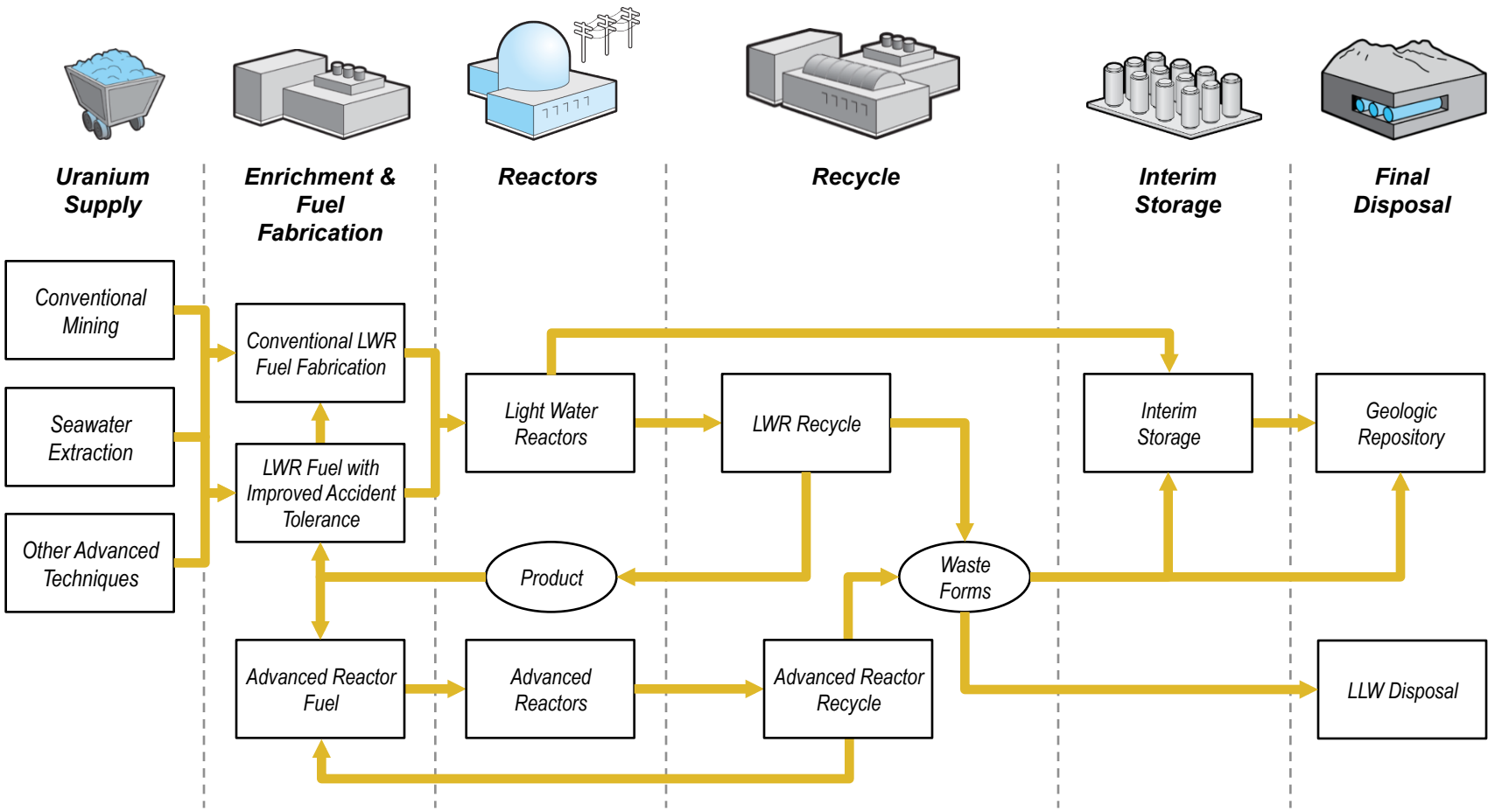
The Nuclear Fuel Cycle as a System Could Incorporate Many Components



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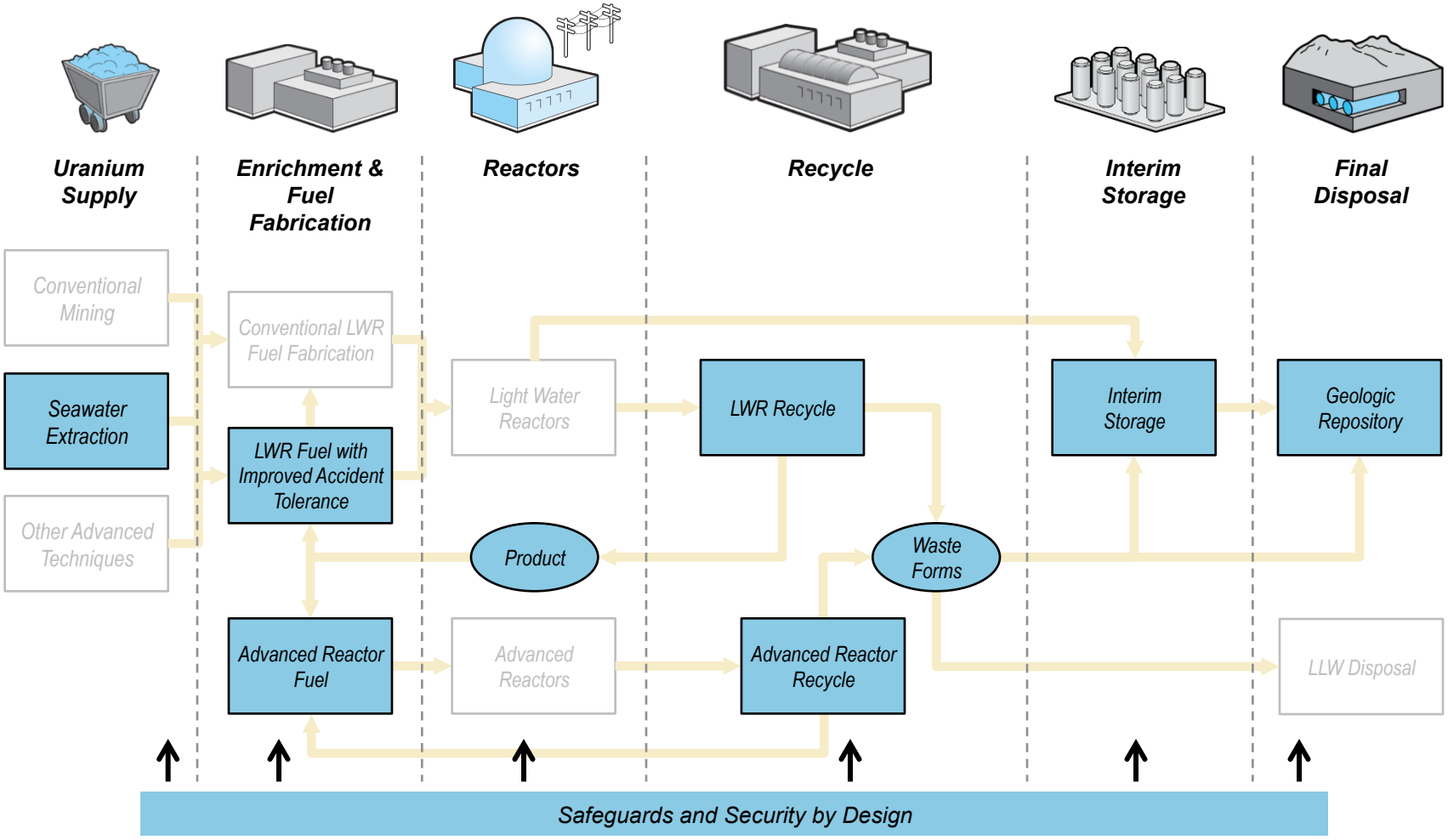
Focus Areas of DOE Fuel Cycle Technologies



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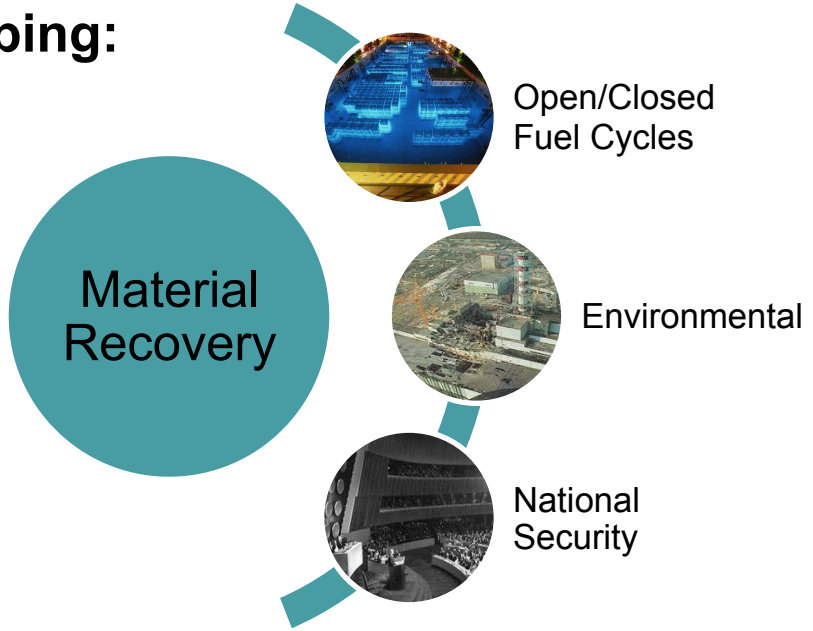
Material Recovery and Waste Form Development Campaign Objectives

- **Develop advanced fuel cycle material recovery and waste management technologies that improve current fuel cycle performance and enable a sustainable fuel cycle, with minimal processing, waste generation, and potential for material diversion to provide options for future fuel cycle policy decisions**

- **Campaign strategy is based on developing:**
  - **Technologies** for economical deployment
    - *Concept through engineering-scale demonstration*
  - **Capabilities** for long-term science-based, engineering driven R&D, technology development and demonstration
  - **People** to provide the next generation of researchers, instructors, regulators and operators



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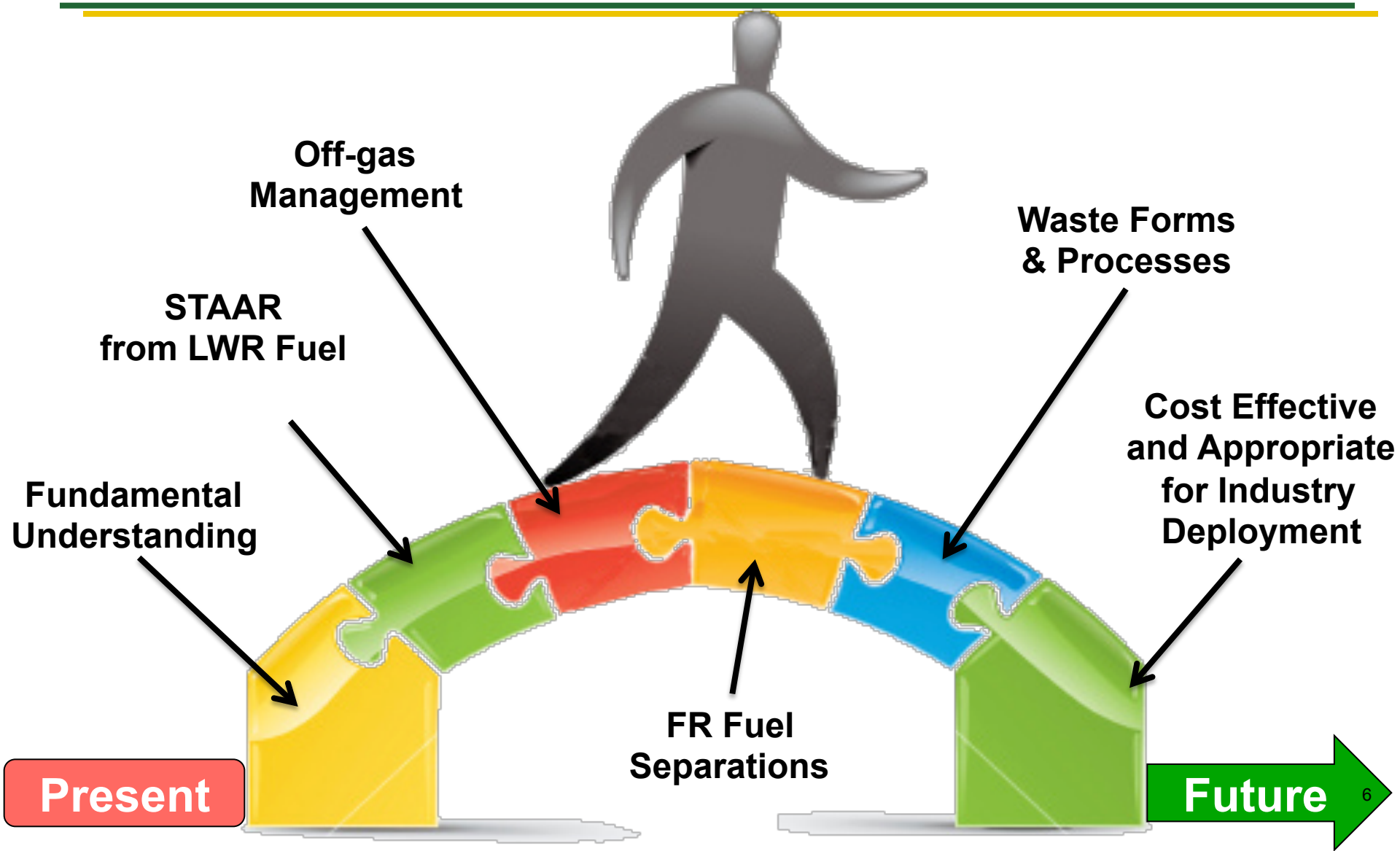
Full Recycle Technology Gaps



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Objectives of Some Major R&D Areas

Reference Technologies and Alternatives	• ***Develop and demonstrate technologies applicable over a broad range of aqueous separation methods***
Sigma Team for Advanced Actinide Recovery (STAAR)	• ***Enabling technology for TRU recycle options from LWR fuel*** • ***Develop cost effective technology ready for deployment***
Off-gas Sigma Team	• ***Enabling technology for any recycle option*** • ***Develop cost effective technology ready for deployment***
Fundamental Separation Data/Methods	• ***Develop advanced methods for fundamental understanding of separations processes.*** • ***Develop predictive models based on fundamental data***
Advanced Waste Forms and Characterization	• ***Enable broader range of disposal options with higher performance waste forms*** • ***Develop cost effective technology ready for deployment***
Electrochemical Processing	• ***Develop and demonstrate deployable and sustainable technology for fast reactor fuel recycling***

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FC-1.1: ELECTROCHEMICAL SEPARATIONS (Federal POC – Stephen Kung & Technical POC – Mark Williamson)

- **Topic 1: *Metal* – Salt Separation: Actinides recovered during the electrorefining process contain residual molten salt adhering to the surface and within the structure of the metallic product. The residual salt must be separated from the metal before the metal can be used in fuel fabrication. Proposals are requested for innovative methods of separating the residual salt from the metal that limit actinide loss and provide highly effective separation. (Methods that use hydrogenous solvents or materials will not be considered.)**

- **Topic 2: *Off-gas Sequestration*: Off-gas released from used fuel during electrochemical processing needs to be treated so that long-lived radionuclides can be sequestered for storage. Specifically, novel methods are sought to separate krypton and tritium from xenon and argon (i.e., inert gas from hot-cell) present in the off-gas stream produced during electrochemical processing.**

- **Topic 3: *Actinide / Fission Product Separations:* Proposals are requested for advanced electrochemical separations technologies that improve upon the efficiency (decontamination factor, waste management, etc.) of current technologies while providing the desired product quality. The proposals should address the expected improvements resulting from the advanced technology and integration of the technology into existing flowsheets.**

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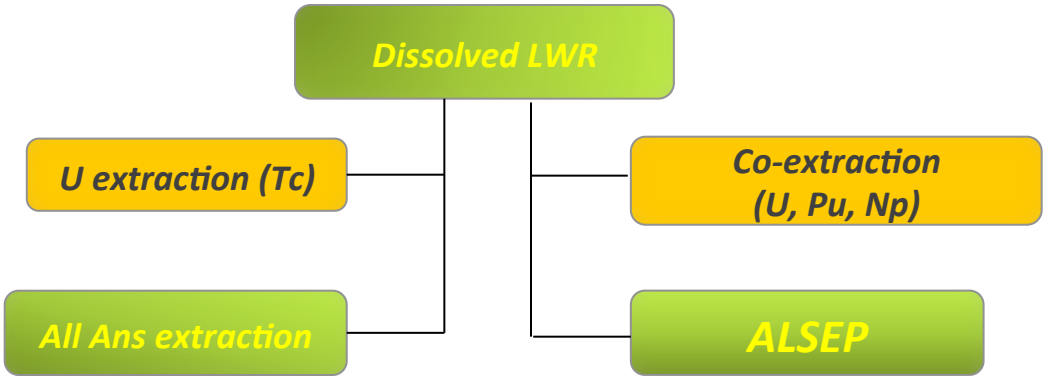
FC-1.2: MATERIALS RECOVERY (Federal POC – Jim Bresee & Technical POC – Terry Todd)

- **Topic 2: Liquid kinetics of trivalent minor actinide stripping in ALSEP or other advanced extraction processes (such as diglycolamide based extractants), or in related solvent extraction systems relying on the use of an aqueous complexant for selectivity for trivalent minor actinides. (Preliminary work can be performed with surrogates, but any proposal must include verification testing with trivalent minor actinides).**



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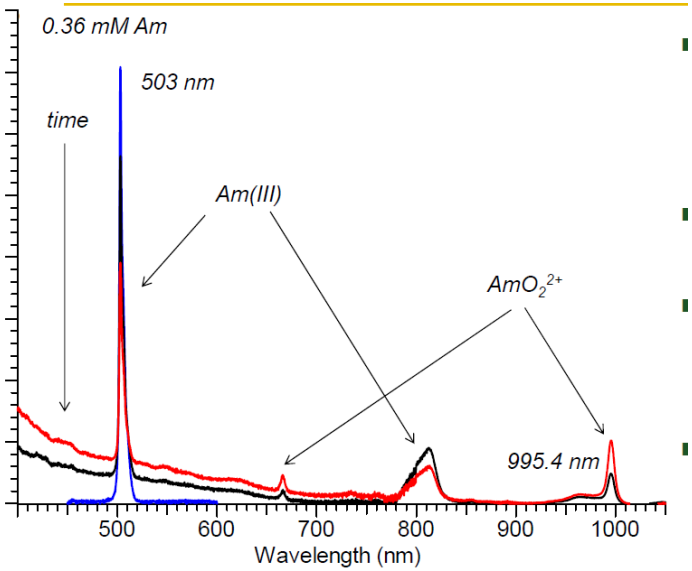
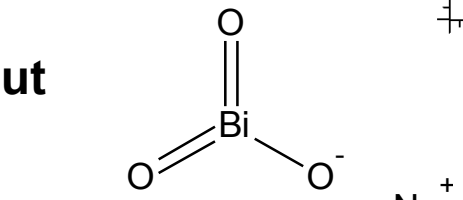
FC-1.2: MATERIALS RECOVERY (Federal POC – Jim Bresee & Technical POC – Terry Todd)

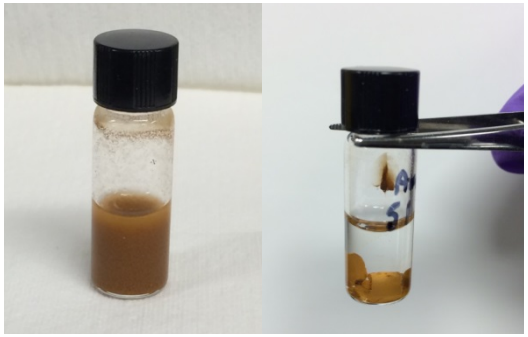
- **Topic 1: Oxidation and stabilization of Am(III) to Am(V) or (VI) in nitric acid, by chemical or electrochemical means.**
  Techniques should focus on kinetics, and mechanisms with the goal of developing a workable process for minor actinide separation applications. (Preliminary work can be performed with surrogates, but any proposal must include verification testing with americium).



Oxidation of Am(III) in 1 M HNO3 with 10 mM Ag and Ozone (Goff et al., LANL)



Sodium bismuthate



Oxidized Am(VI) sample (0.001 M ^{243}Am in 1M HNO_3 with ~2 mg $NaBiO_3$ excess solid on the bottom after centrifugation) (Mincher et al. INL)

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FC-1.3: ADVANCED WASTE FORMS (Federal POC – Kimberly Gray & Technical POC – John Vienna)

- **Topic 1: Fuel Processing Off-gas Management- Mechanistic Understanding of Silver Sorbent Aging Processes**

Develop a fundamental understanding of the silver aging processes on selected sorbents aged in off-gas streams containing air, NOx, and iodine. Determine the cause for observed differences in adsorption capacity of different silver sorbents exposed to moist air and NOx. In particular, why do silver functionalized aerogels age and load differently than silver mordenite?

Ag^0Z (left) and Ag^0-aerogel (right)

Test Matrix			I_2 Capacity or Retention	
Aging environment	Ag^0Z	Ag^0-Aerogel	Ag^0Z	Ag^0-Aerogel
Dry air	✓	✓	- 40%	-22%
Moist air	✓	✓	-60%	-22%
2% NO_2[a]	✓	✓	-30%	-15%
1% NO	✓	□	-78%	—

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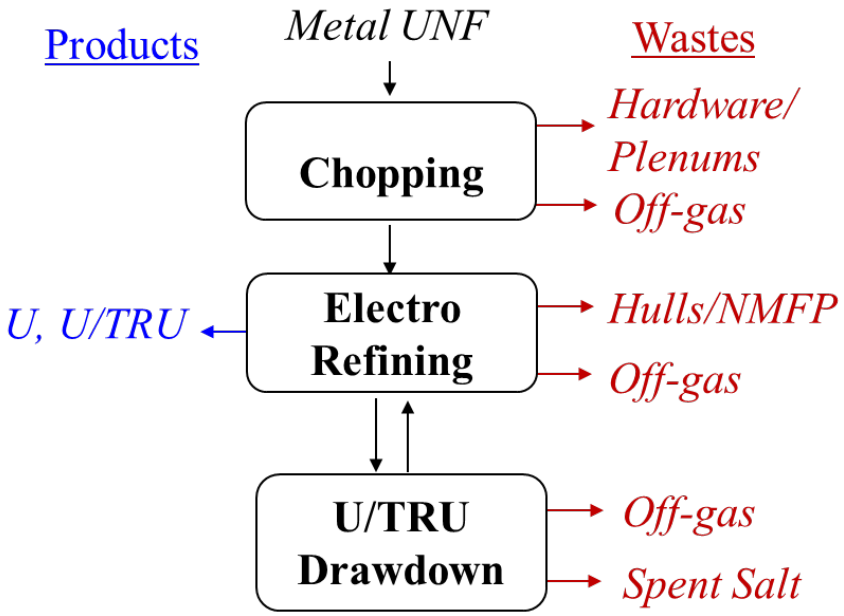
FC-1.3: ADVANCED WASTE FORMS (Federal POC – Kimberly Gray & Technical POC – John Vienna)

- **Topic 2: Waste Forms Development- High-Level Waste Salt Immobilization**

Develop a waste form and process to efficiently immobilize [Li,K]Cl based waste stream containing fission products. Current immobilization technology for electrochemical salt waste is constrained by the solubility and control of chlorine in glass bonded sodalite waste form. Processes that can convert the chloride salts into a high-loaded waste form with good chemical durability with significantly lower cost that the baseline technology are desired. Special attention to controlling the fate of chlorine is essential to success.



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Summary

- The FCT Material Recovery and Waste Form Development Program is looking forward to partnering with universities to enhance their R&D portfolio and research capabilities
- This call is tailored to research topics that are well suited for university research
- The MRWFD program seeks university researchers who want to actively participate in the program and enhance interactions with national laboratory research staff
- The FCT Material Recovery and Waste Form Development management team considers NEUP Principal Investigators to be an integral part of our research program!
  - We encourage and, actively seek close engagement with the MRWFD campaign

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