U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Nuclear Technology Research and Development

Material Recovery and Waste Form Development Campaign

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NEUP Webinar

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NE-4 Organization Structure

NE-4
Deputy Assistant Secretary
for Nuclear Technology Research and Development
John W. Herczeg

Associate Deputy Assistant Secretary
for Nuclear Technology Research and Development :
Sal Golub

Alice Caponity

NE-41
Office of Advanced Reactor Technologies

- ***Fast Reactor***
- ***Gas Reactor***
- ***Molten Salt Reactor***
- ***Energy Conversion R&D***
- ***Special Purpose Applications***

Bill McCaughey

NE-42
Office of Advanced Fuel Technologies

- ***Advanced Fuels***
- ***System Analysis and Integration***

Patricia Paviet

NE-43
Office of Materials and Chemical Technologies

- ***Material Recovery and Waste Form Development***
- ***Materials Protection, Accounting, and Control Technology***

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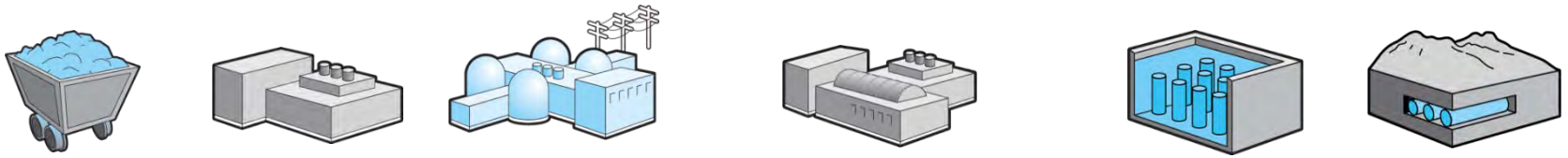

Uranium Supply | ***Enrichment & Advanced Fuel Fabrication*** | ***Reactors*** | ***Recycling*** | ***Storage*** | ***Disposal***

Conventional Mining
Seawater Extraction
Other Advanced Techniques
Conventional LWR Fuel Fabrication
LWR Fuel with Improved Accident Tolerance
Light Water Reactors
Material Recovery
Interim Storage
Geologic Repository
Product
Transmutation Fuel
Advanced Reactors
Fast Reactor Recycle
Waste Form

←----------Safeguards and Security By Design----------→

Optimize through Systems Analysis, Engineering, and Integration

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Material Recovery and Waste Form Development Campaign Objectives

- **Develop advanced fuel cycle separation 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**
  - A key objective is to establish collaborative research programs that ***maintain US fuel cycle expertise*** and ***provide the next generation of scientists*** for nuclear science and research that are critical to implementing long term nuclear energy and waste management strategies
  - The expertise and capabilities fostered under the MRWDF campaign have been ***recognized throughout the US and internationally for their excellence and leadership***

Maintaining Recycling Technology Expertise

Keeping the options open

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Objectives of Major R&D Areas

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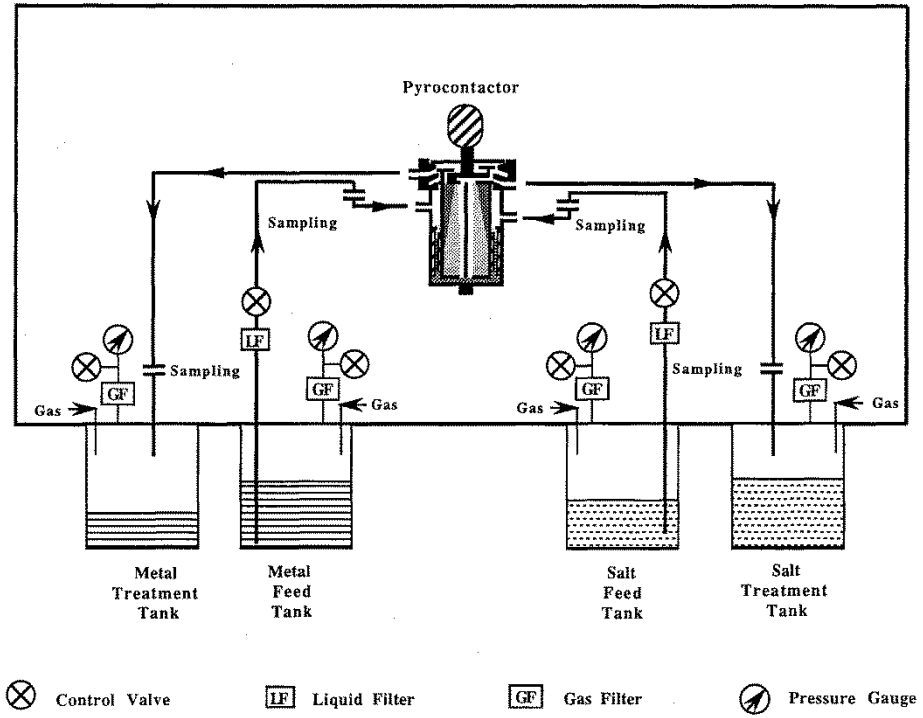
FC-1.1: ELECTROCHEMICAL SEPARATIONS (Federal POC – Stephen Kung & Technical POC – Mark Williamson)

- **Develop innovative fission product recovery technologies to enable salt recycle thus minimizing high-level waste production and potentially reducing fuel cycle costs**
  - Proposal should address the chemical basis for the recovery process, fission product elements targeted by the process, expected recovery efficiencies, final form of fission product elements for encapsulation in waste forms, and waste generation estimates



Pyrocontactor system for fission product recovery

Processes could employ electrochemical, reductive extraction or other techniques to recover fission product elements, present as chlorides in the electrolyte salt, in a form suitable for encapsulation in robust waste forms.

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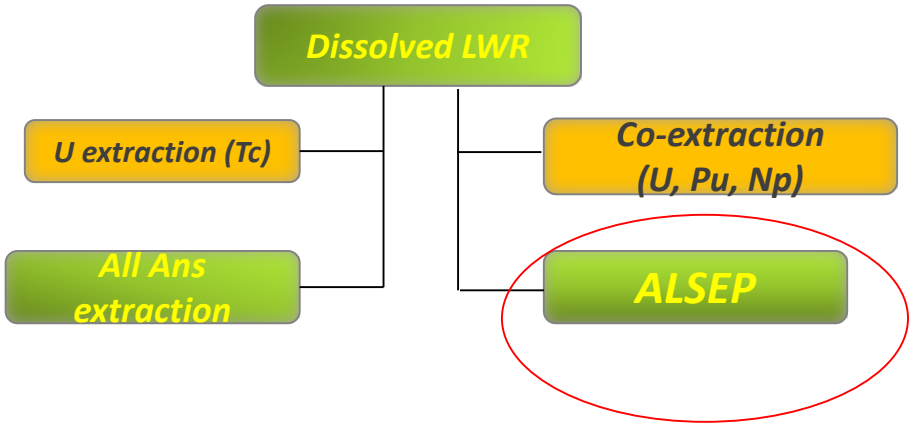
FC-1.2: MATERIALS RECOVERY (Federal POC – Jim Bresee & Technical POC – Terry Todd)

- **Solvent Extraction Chemistry and Radiation Chemistry**

Investigation of the stability of the Actinides/Lanthanides Separation Process (ALSEP) and other actinide solvent extraction systems to chemical and radiolytic degradation.

Information is needed on degradation pathways and product species.

Concepts for solvent cleanup should be developed based on the resulting insights.



Development of advanced recycling technologies

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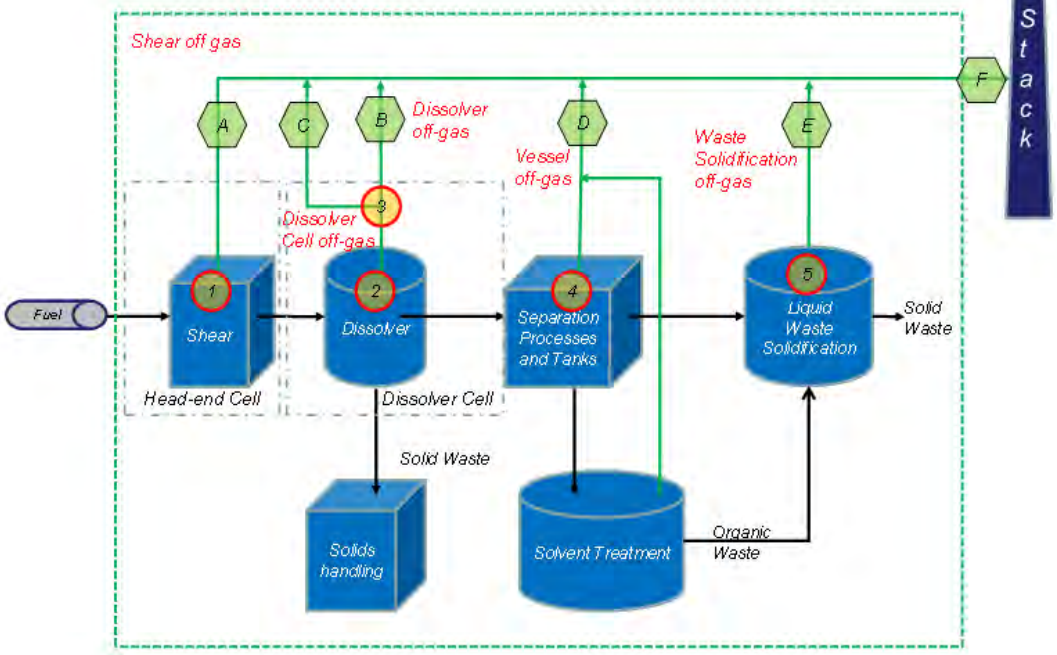
FC-1.3: ADVANCED WASTE FORMS (Federal POC – Kimberly Gray & Technical POC – John Vienna)

Iodine Capture from Vessel Off-Gas Streams

The capture of iodine from vessel off-gas streams (VOG) is a high priority research area. It is estimated that only 1 to 6 % of the total iodine is found in this stream. However, capture of 99.9+% of this iodine is required to achieve the overall plant iodine abatement requirements. This capture is complicated by three factors: 1) The iodine concentration is 100 to 1000 times more dilute than in the dissolver off-gas steam (DOG), resulting in VOG iodine concentrations between 5 and 100 ppb. 2) The VOG gas stream is ~10 times the volume of the DOG resulting in the need for larger equipment. 3) The primary form of the iodine in the VOG is a mixture of organic iodine species



Off-gas pathways in recycling facility

Proposals are sought to determine the reaction pathways and kinetics for the adsorption of iodine on a silver-containing sorbent over the range of anticipated organic iodide compounds (C1 [methyl-iodide] to C12 [iodo-dodecane]).

The effects of temperature and associated VOG constituents on the reaction pathways and rates should also be determined.

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

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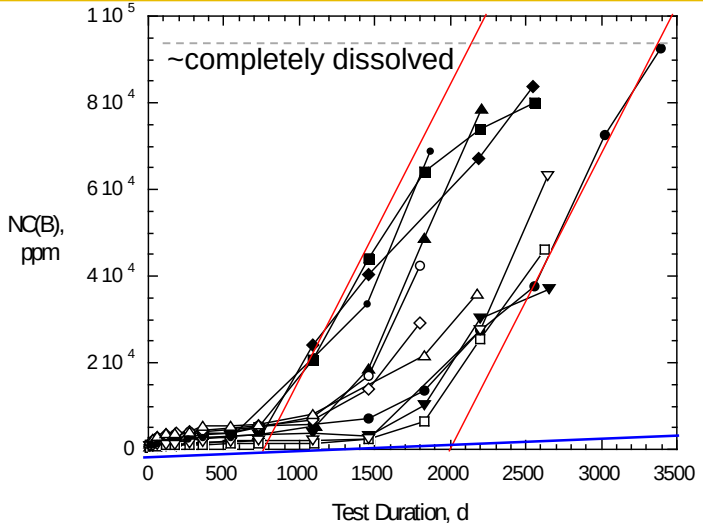
- **Zeolite Formation Thermodynamics and Kinetics**

The nucleation and growth of zeolite secondary phases during borosilicate waste glass degradation is believed to couple with the dissolution kinetics of the glass and increase the dissolution rate under certain conditions.

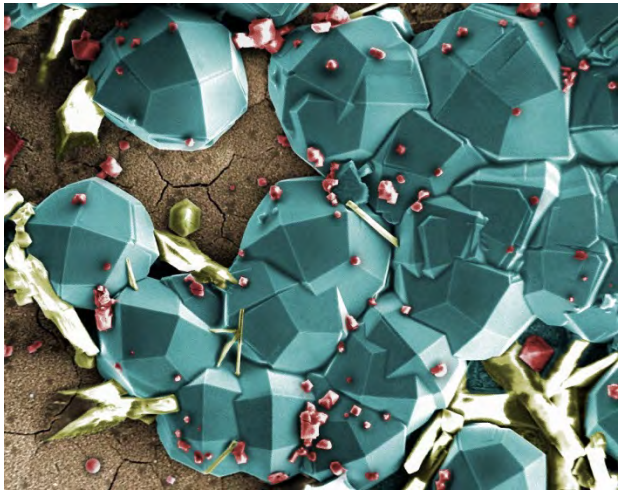
Identifying solution conditions conducive to the formation of rate-affecting phases will allow the long-term behavior of borosilicate waste glasses to be modeled more accurately.

Threshold concentrations required to generate zeolites must be determined to support modeling behavior over temperature ranges of 25 to 90 °C and pH 8 to 13.

Proposals are sought to determine the composition/temperature/pH boundaries for the formation of alumino-silicate zeolites that have been identified to impact borosilicate waste glass corrosion rate and to determine the rates of precipitation as functions of the same parameters.



Glass corrosion with acceleration, Ebert & Jerden, 2016. FCRD-MRWFD-2016-000296, ANL



SEM micrograph of analcime & other alteration products on corroded glass, Jiricka et al. JNCS 2001, 292 (1-3), 25-43

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Summary

- The NTR&D Programs are 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 Material Recovery and Waste Form Development management team considers NEUP Principal Investigators to be an integral part of our research programs!
  - We encourage and actively seek close engagement with the campaigns

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