U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Fuel Cycle Research and Development

Materials Recovery and Waste Form Development Campaign Overview

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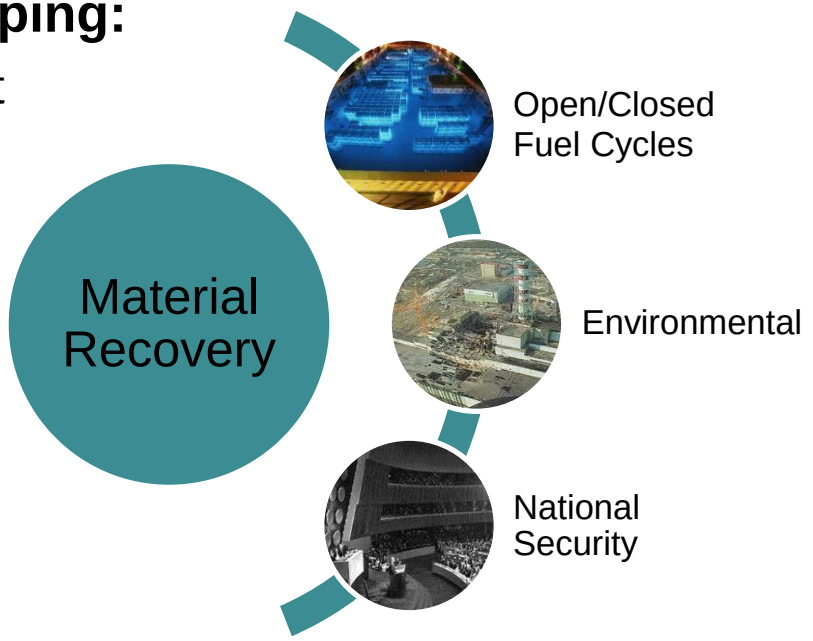
Campaign Objectives

- **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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MRWFD Campaign Structure
Aimed to Improve Once-Through and Enable Recycle

Campaign Mgt & Integration	• Provide technical leadership in separations and waste forms, leading to effective options for future fuel cycles • Manage Campaign research and development to include: prioritization, planning, reporting, and technical reviews • Collaborate with university researchers, other campaigns, program offices, and international organizations
Reference Tech & Alternatives	• Provide a framework and data to evaluate technology improvements, performance targets, and identify gaps • Develop and demonstrate material recovery technologies that enable processing a broad range of fuels with stringent separation requirements (focused on aqueous processing of LWR oxide fuel)
Minor Actinide Sigma Team	• Develop and demonstrate technologies that enable TRU separations from LWR fuel • Develop cost effective separations processes for MA recycle
Off-Gas Sigma Team	• Develop and demonstrate technologies that enable fuel treatment under current regulatory environment • Develop cost effective solutions to off-gas management from fuel treatment and other nuclear applications
Advanced WF & Processes	• Develop next generation, high performance, waste forms consistent with advanced separations technologies • Demonstrate waste processes cost effective, reliable fabrication of next generation waste forms
Waste Form Characterization	• Enhance disposal options for existing and high-performance waste forms • Develop fundamental understanding of waste form behavior in a variety of disposal environments • Work with international partners to develop consensus degradation rate law(s)
Fund Science & Mod/Sim	• Develop advanced methods and fundamental understanding of separation chemistry and processes • Develop predictive models based on fundamental data
Domestic Echem Process	• Develop and demonstrate deployable and sustainable technology to enable recycle of U/TRU for metal fast reactor fuel
Fuel Resources	• Develop and demonstrate extractants and engineered systems to further improve performance and lower cost supply of uranium from seawater

Instrumentation and Controls needs

- **Advanced fuel cycles, if deployed, will likely be implemented in 2-3 decades**
- **There is a need for monitoring process operation in near real time**
  - Currently, only tank volumes, temperatures, pressures, etc. are monitored, chemical analysis of the process is obtained, via sampling, which has a lag time of several hours from the time the sample is taken until the operators know the results of the analysis
- **Chemical performance data (i.e. concentrations of key chemical species at any given time) would greatly improve operations and reduce the need for taking and analyzing samples**
- **Separation process operation would benefit from the near-real-time analysis of a number of chemical species**

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On-line Monitoring

- **The MRWFD campaign has been developing methods to monitor key chemical components of a separation process, in near real time**
- **Aqueous processing**
  - Presented by Sam Bryan
- **Electrochemical processing**
  - Presented by Mark Williamson