U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Clean. Reliable. Nuclear.

Nuclear Technology Research and Development

Material Recovery and Waste Form Development Campaign

Patricia Paviet, Director, Office of Materials and Chemical Technologies

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 Caponiti

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

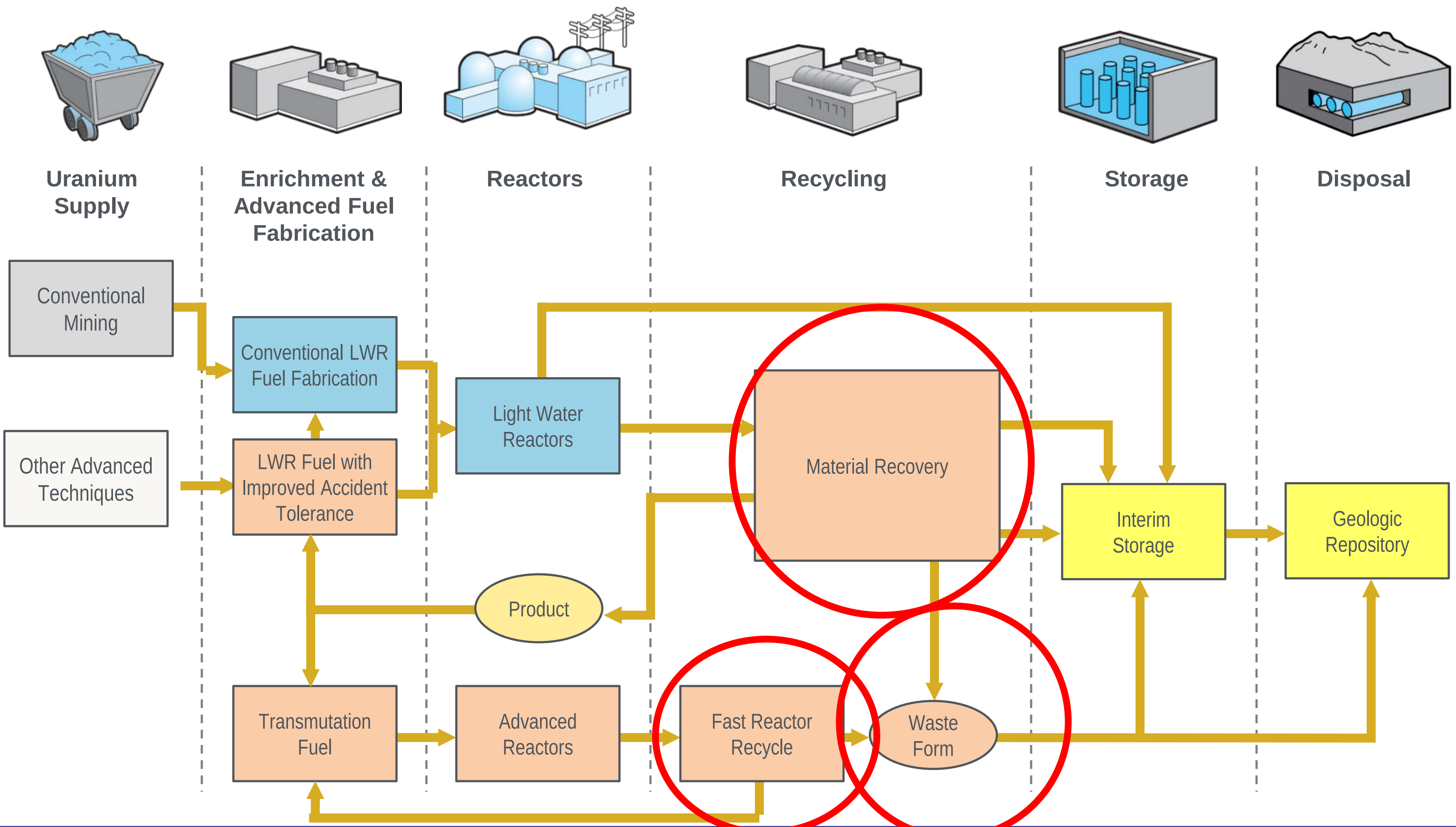
- **Advanced Fuels**
- **System Analysis and Integration**

Patricia Paviet

NE-43
Office of Materials and Chemical Technologies

- **Material Recovery and Waste Form Development**
- **Materials Protection, Accounting, and Control Technology**
- **Joint Fuel Cycle Studies**

Nuclear Technology Research & Development



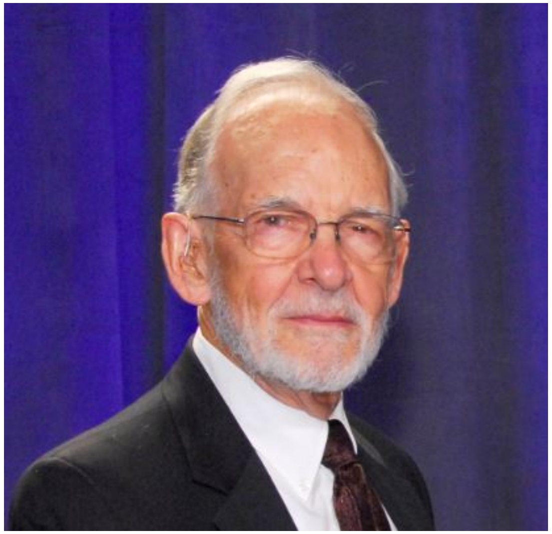
←----------------Safeguards and Security By Design-------------→

Optimize through Systems Analysis, Engineering, and Integration

Change in Campaign Leadership

Good bye to Jim, we'll miss your leadership.

- 74 years of experience and service
- USN, U Illinois, ANL, MIT, ORNL, NCSU, DOE



Dr. Jim Bresee

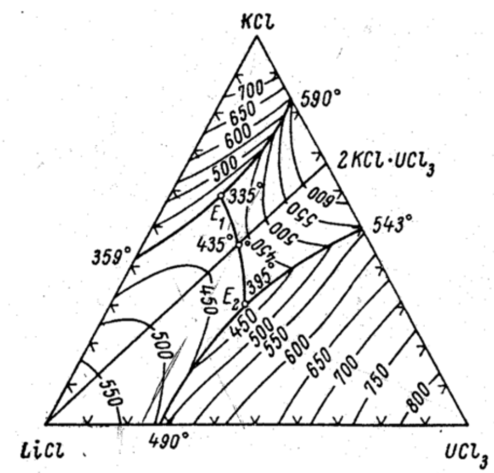
Material Recovery and Waste Form Development Campaign Objectives

- 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
  - These objectives haven't changed for several years, but…
  - We are shifting our focus in FY19 to begin planning activities for an integrated CoDCon demonstration with less emphasis on minor actinide separation
  - A new key objective is to develop and demonstrate options for enabling advanced reactors by making HALEU available

FC-1.1: Electrochemical Separations (Pyroprocessing)

Fission product solubility in molten chloride salts impacts the timing for salt treatment and recycle, or disposal

- Solubility data as a function of temperature and composition is available for many binary and ternary chloride systems especially those that contain alkali and alkaline earth chlorides
- Similar data is lacking for complex multicomponent chloride salt systems especially those involving the lanthanide and actinide elements



Example *phase diagram for ternary LiCl – KCl – UCl_3 system*

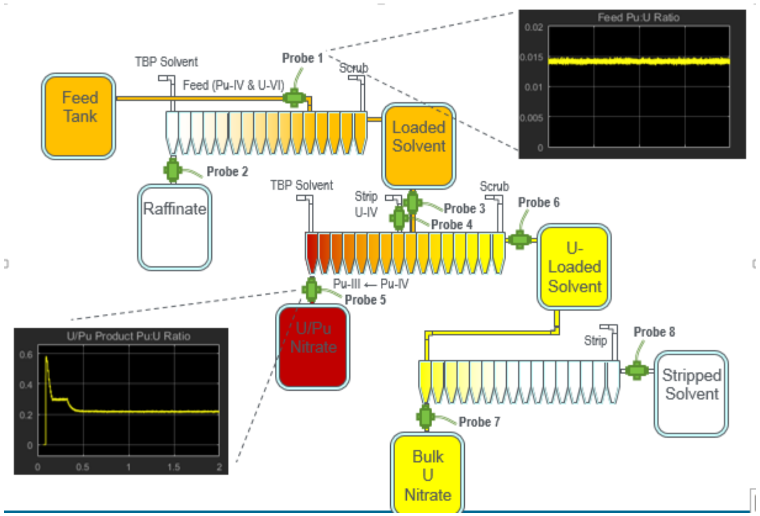
Proposals are requested to establish fundamental thermochemical data in chloride salt systems with an emphasis on multicomponent solubility of the fission product chlorides

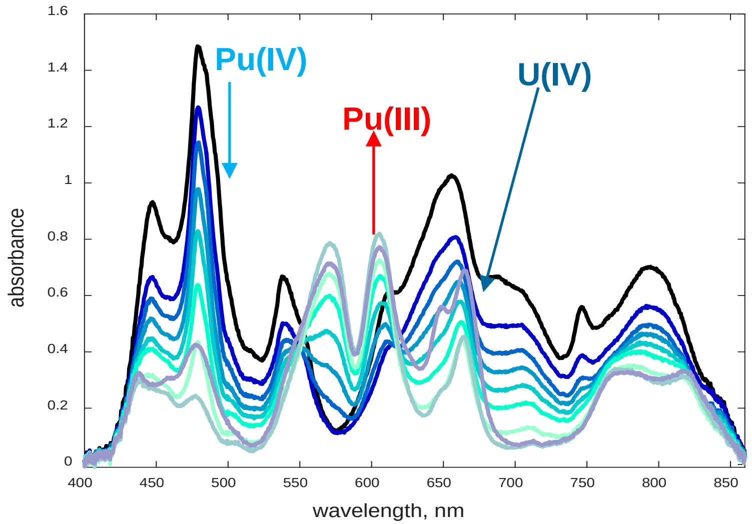
- Experimental work may be supplemented by thermodynamic data simulation to yield a more complete understanding and predictive models of the solid-liquid equilibria in the complex chloride systems

Program Contacts:
Federal POC: Dr. Stephen Kung, 301-903-8074, Stephen.Kung@hq.doe.gov
Lab POC: Dr. Mark Williamson, 630-252-9627, Williamson@anl.gov

CoDecontanimation Process - CoDCon

The CoDCon project was established in FY-16 to measure the current capability to control the chemical product of a used nuclear fuel separations process and to perform near real-time material balances of the contained actinides





The process is performed using a modified PUREX process within which Pu(IV) and U(VI) are extracted by tributyl phosphate (TBP) from fuel dissolved in nitric acid.

Pu is then back-extracted from the bulk of the uranium by reduction from its original valence of four to a TBP-insoluble valence of three.

Process control is based on a dynamic process model coupled with on-line spectroscopic measurements.

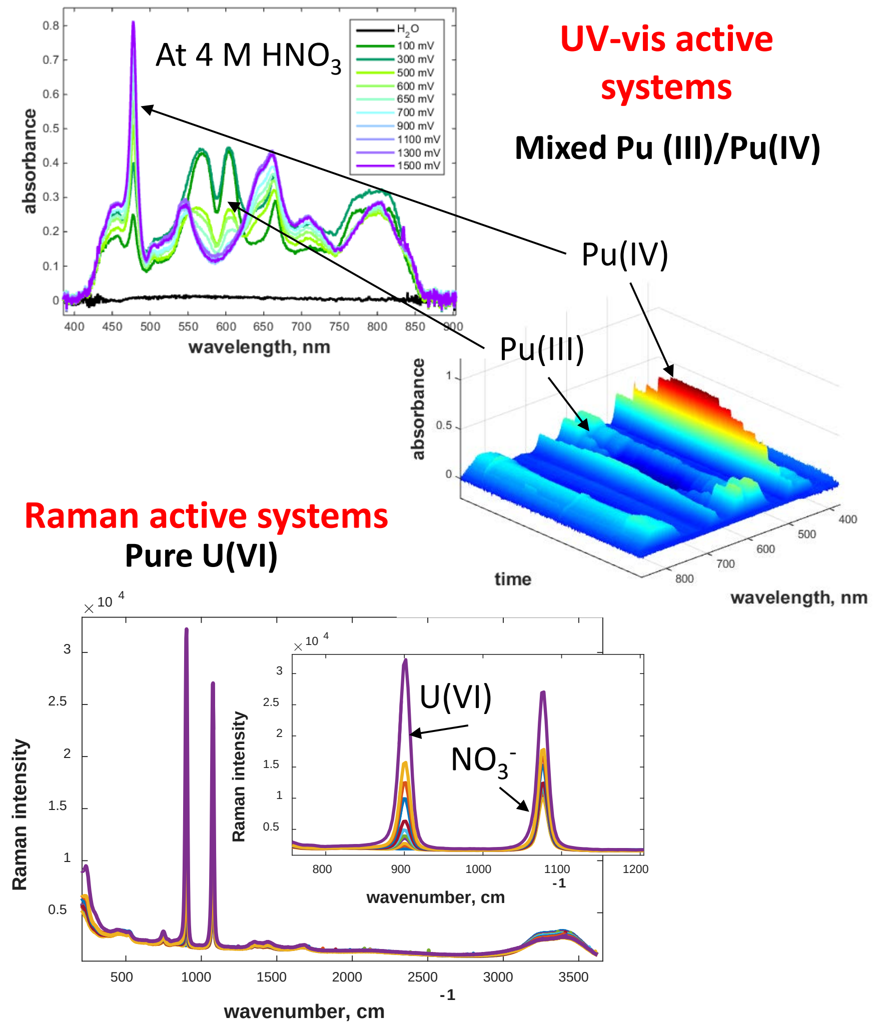
FC-1.2: Materials Recovery

Solvent Extraction Chemistry and Radiation Chemistry

Fundamental knowledge and understanding of the chemical speciation and partitioning of multivalent cations (e.g. Np, Tc, Zr) in advanced PUREX based extraction process using n-Tri-Butyl-Phosphate (TBP) as solvent under high gamma irradiation fields is required to improve processes being currently studied such as CoDCon.

Gamma radiation is known to produce radicals that can affect the oxidation states of multivalent cations in solution.

This research effort will provide insight into the speciation of multivalent cations under gamma irradiation dose as well as the effects of the speciation on partitioning in a tri-butyl phosphate separations process (e.g. PUREX, COEX, CoDCon, etc).



Program Contacts:

Federal POC: Dr. Daniel Vega, 208-526-3365, Daniel.Vega@hq.doe.gov

Lab POC: Dr. Terry Todd, 630-252-9627, Terry.Todd@inl.gov

FC-1.3a: Advanced Waste Forms – Design, Processing and Testing

Ceramic waste forms can be an effective means of immobilizing newly generated HLW.

In addition, modern materials fabrication techniques may enable low cost processes to fabricate HLW forms applicable to high radiation environments such as:

- low handling,
- easy containment,
- minimal access to fine particles)

Proposals are requested to develop a robust waste form for commercial fuel recycling HLW stream and demonstrate low-cost processing methods that are applicable to high radiation environments.

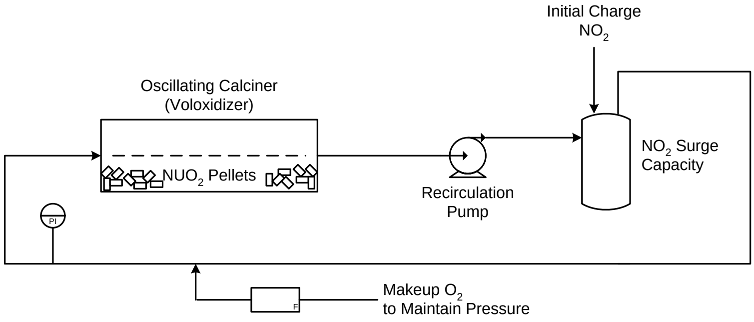
The successful waste form would allow for higher waste loadings than typical HLW glass compositions and be processable in plants with lower construction (e.g., size) and operating (e.g., manpower) costs

Photo from: Zwitkowski 2010. *ANSTO Annual Report 2009-2010, Australian Nuclear Science and Technology Organization, Lucas Heights New South Wales, Australia*

Program Contacts:
Federal POC Ms. Kimberly Gray, 301-903-8209, Kimberly.Gray@hq.doe.gov
Lab POC: Dr. John Vienna, 509-372-6201, John.Vienna@pnnl.gov

FC-1.3b: Iodine Capture from Highly Oxidizing Off Gas Streams

US regulations could require the removal of both iodine and tritium from the off-gas stream of a used nuclear fuel reprocessing facility.



Advanced tritium pretreatment is a pretreatment step that uses high concentrations of NO_2 (60% to 80%) in a gas stream to volatilize tritium and iodine from the oxidized UNF prior to traditional dissolution.

The gaseous effluent from this process would then require treatment to remove tritium and iodine, but high levels of NO_2 could have a detrimental effect on the ability of various solid sorbents to remove the volatile radionuclides.

Proposals are requested for the development of a robust iodine sorbent for use in this highly oxidizing environment.

The proposed iodine loaded sorbent material must also have a direct pathway to a suitable waste form for ultimate disposal in a deep geologic repository.

Program Contacts:
Federal POC Ms. Kimberly Gray, 301-903-8209, Kimberly.Gray@hq.doe.gov
Lab POC: Dr. Bob Jubin, 865-574-4934, Jubinrt@ornl.gov

Questions?

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Dr. Patricia Paviet, 301-903-1542, Patricia.Paviet@nuclear.energy.gov