

**The U.S. Department of Energy's  
Advanced Fuel Cycle Initiative is  
Evaluating Potential Costs and Benefits of  
Partitioning and Transmutation**

*Presented to the Integration Group for the Safety Case  
by Abe Van Luik*

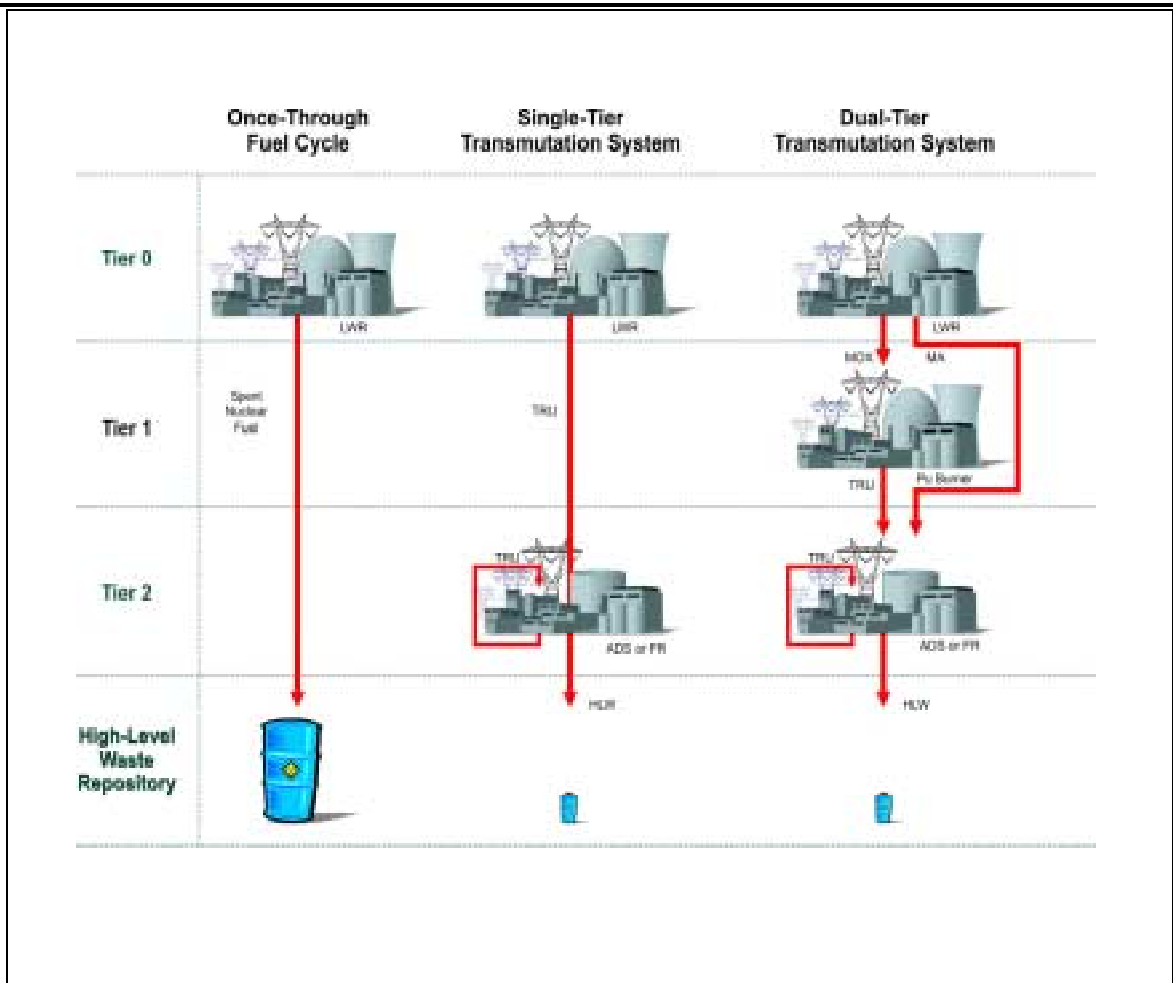
**Based on materials provided by P. J. Finck  
Advanced Fuel Cycle Initiative Program Manager at  
Argonne National Laboratory, and other sources**

**INTRODUCTION**

- **Policy Statement from Department of Energy  
Undersecretary Card: the Department is interested in  
partitioning and transmutation (P&T) to the extent that  
“... transmutation is technically feasible and will reduce  
the toxicity of the waste to a point that makes it technically  
and economically justified ...”**
- **Therefore, making the case for P&T within the  
Department requires an evaluation of its potential costs  
and benefits**

## Background

- **Partitioning and Transmutation (P&T) strategies have been studied over the past 15 years as a way to:**
  - Reduce radiotoxicity (Long Lived Fission Products, Minor Actinides)
  - Reduce dose (I, Tc, Np)
  - Reduce proliferation potential
  - Reduce volume of high level waste
  - Reduce heat load
  - Provide a path for effective waste management
- **Summary of Studies**
- **AAA and AFCI programs**



## International Approaches to Transmutation

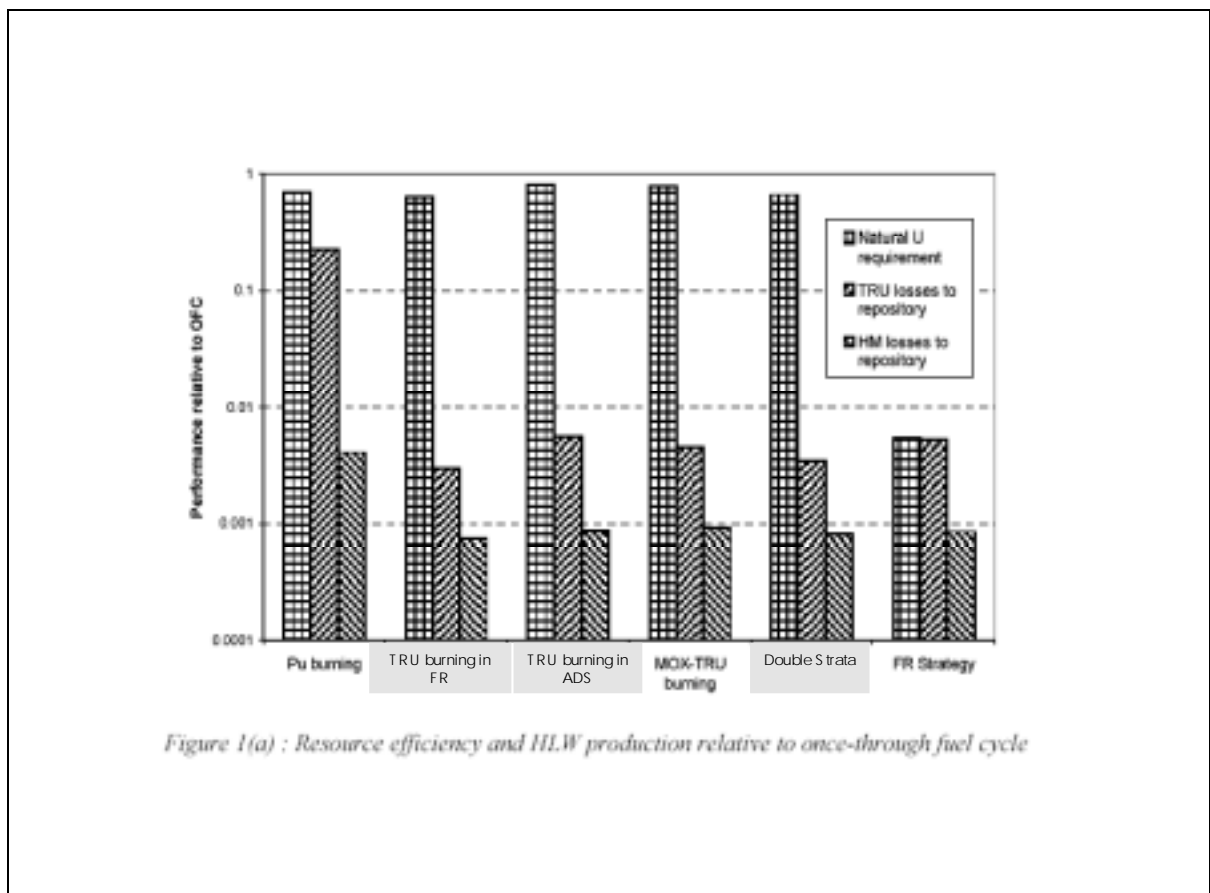
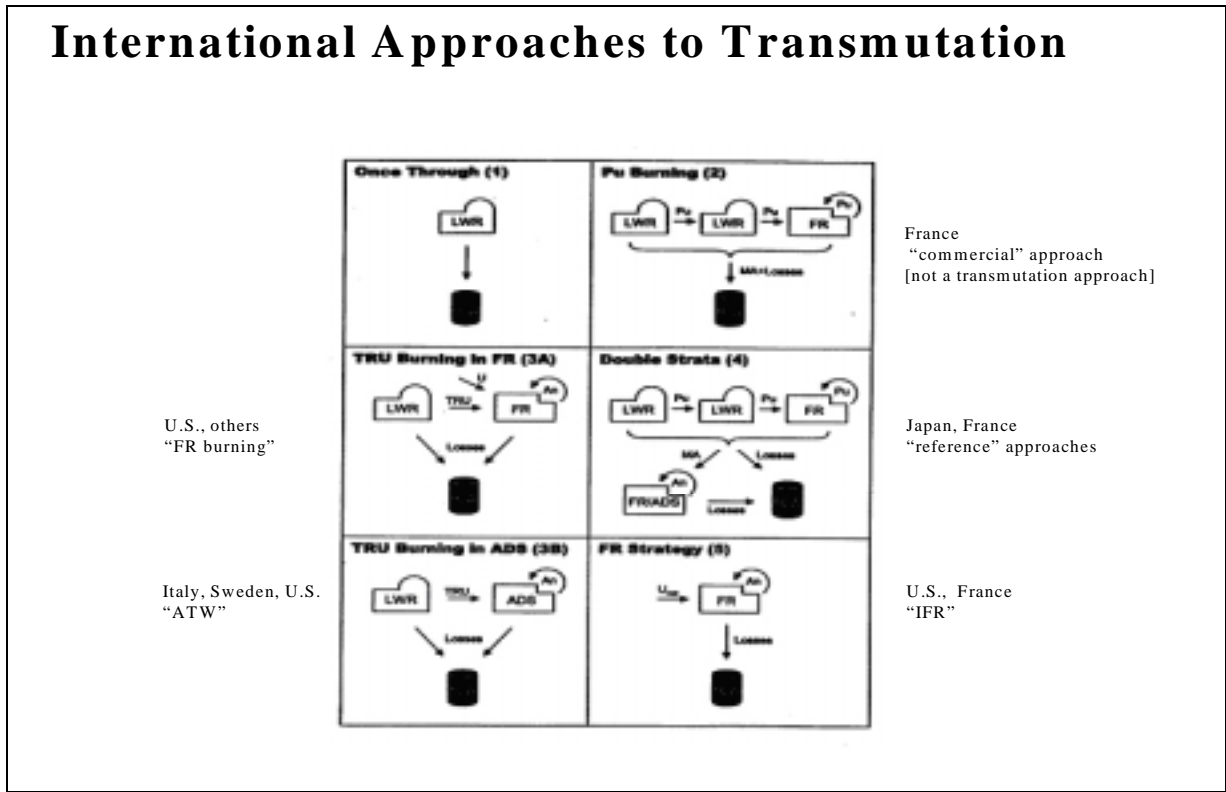
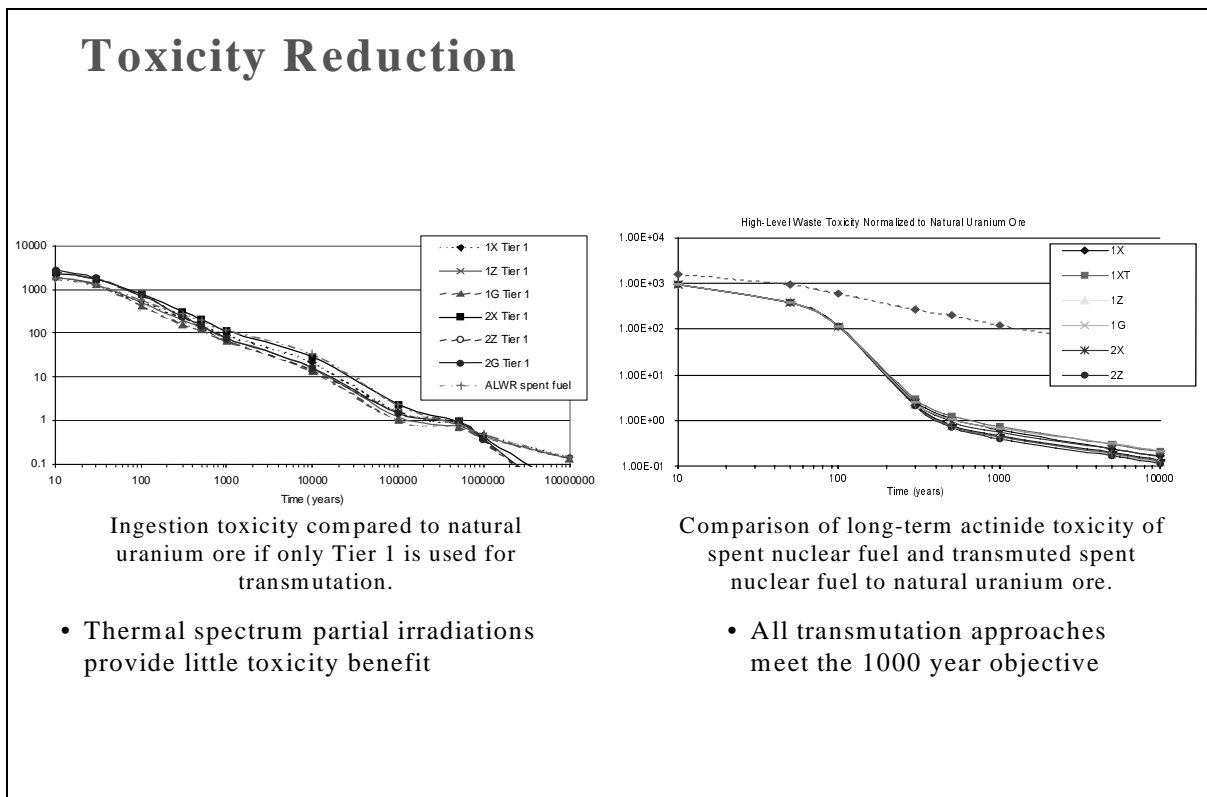
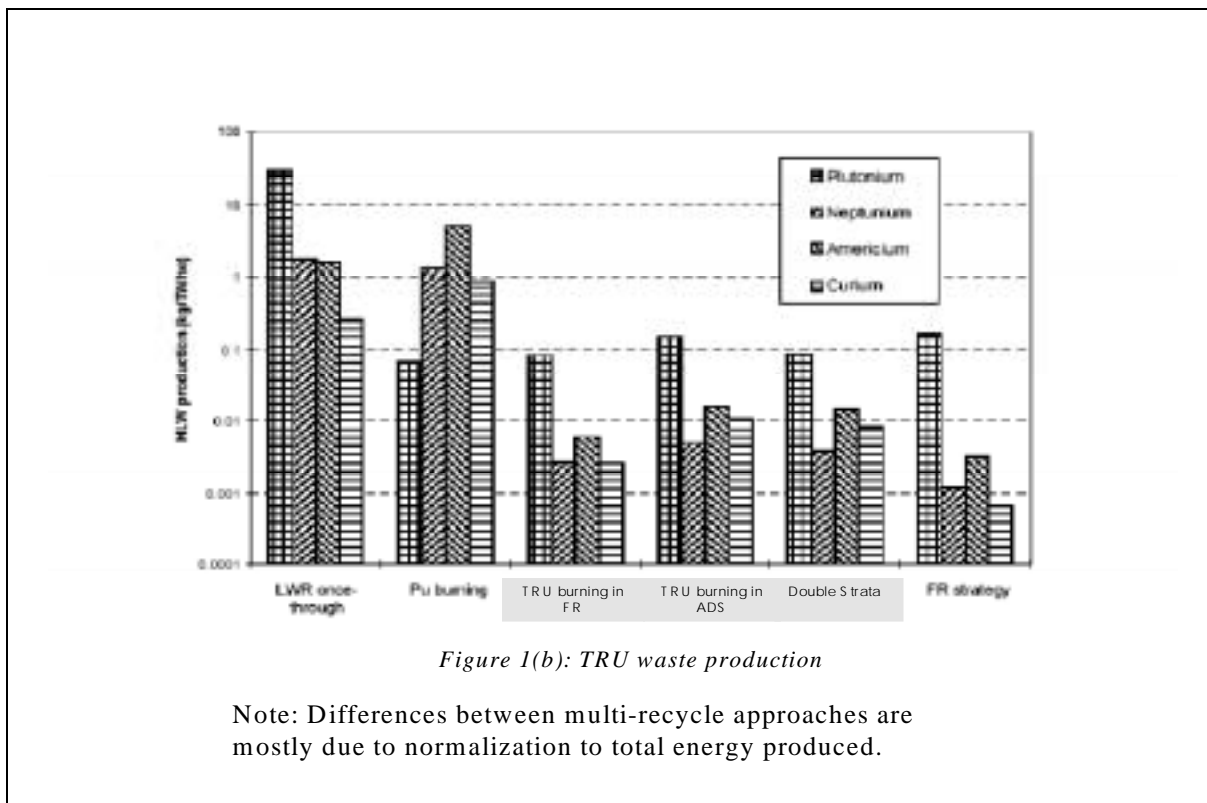


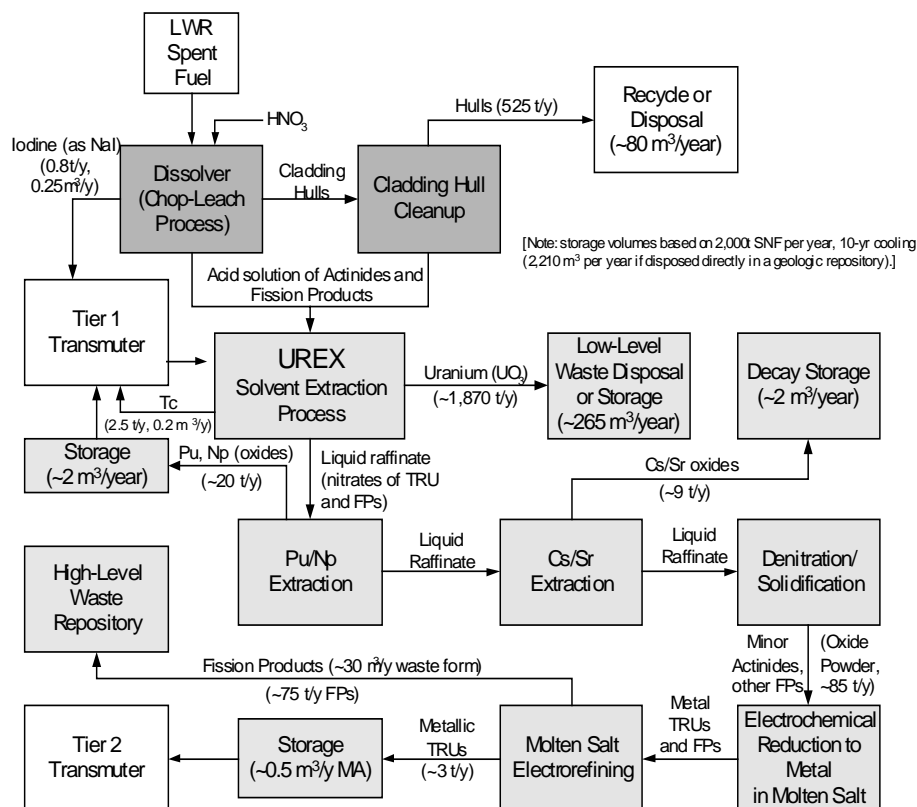
Figure 1(a) : Resource efficiency and HLW production relative to once-through fuel cycle



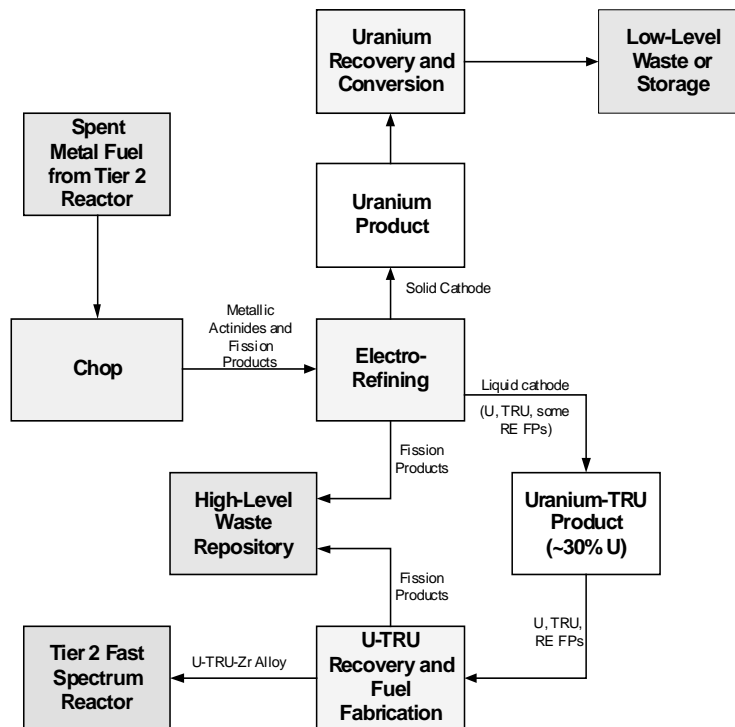
## The U.S. Approach

- **1999: ATW Roadmap**
  - Accelerator based transmutation
  - R & D program was launched:
    - *Separations*
    - *Fuels*
    - *Physics*
    - *Technology*
    - *System Studies*
- **2002: Report to Congress (In Progress)**
  - System studies in U.S. and Europe indicate preference for reactor based transmutation
  - DOE-NE proposes: isolation of Cs/Sr, recycle of Pu and Np in LWR's, and later recycle of MA's in fast reactors
  - Depending on the national nuclear power scenario, it may delay or avoid need for second repository

## Advanced Fuel Cycle System



## Tier 2 Metal Fuel Processing



## Potential Benefits

- **HLW volume reduction**
- **Management of short term heat load**
- **Reduction of long term heat load**
- **Radiotoxicity, long-term dose reduction**

Several issues need to be resolved to achieve these benefits, in particular:

- **Demonstrate new separations technologies-understand and manage waste stream**
- **Develop and qualify adequate waste forms**
- **Develop waste management strategy**
- **Implementation strategy and Yucca Mountain schedule**
- **National policy decisions to invest in necessary facilities**

## Repository Benefit Analyses - Example: Effects of Spent Fuel Processing

- **The goal of ongoing work is to quantify the benefits to the repository from spent fuel processing, including**
    - effect of removal of contributors to the potential dose
    - effect of removal of contributors to the heat load
    - identify useful strategies for improving performance
  - **The results of the study will allow an assessment of which alternatives can be economically useful in**
    - increasing the repository capacity
    - reducing the potential hazard from the repository
    - reducing uncertainties associated with the performance of the repository
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## Repository Benefit Analysis - Example Effects of Spent Fuel Processing (continued)

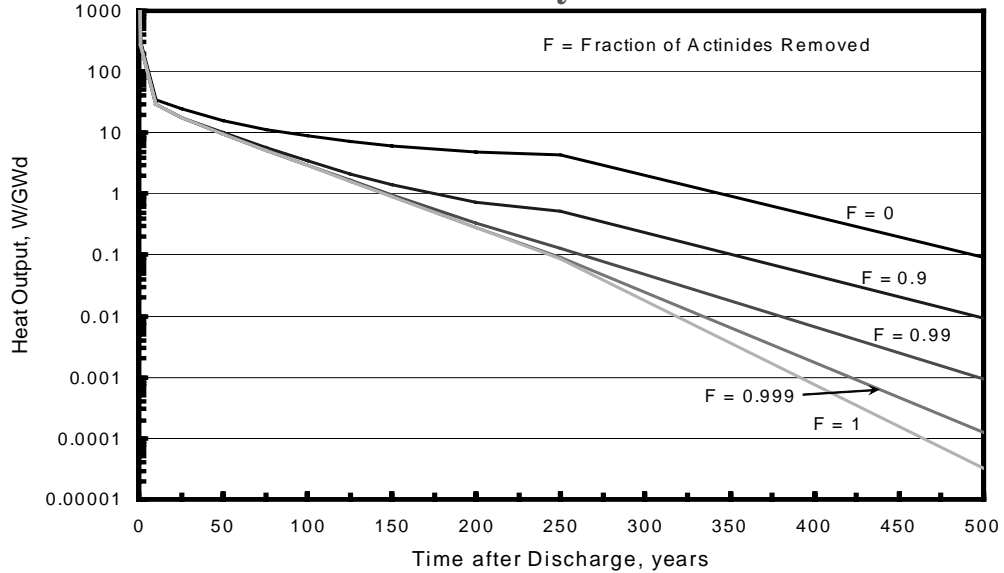
**Projects on quantifying the effects of actinide removal have been in place for several years**

- **Scoping studies using the Yucca Mountain Project GoldSim models of the repository, along with thermal models of Yucca Mountain**
- **Initial results are promising concerning**
  - *increased capacity*
  - *shorter times at high temperatures*
  - *increasing predictability of waste package performance*

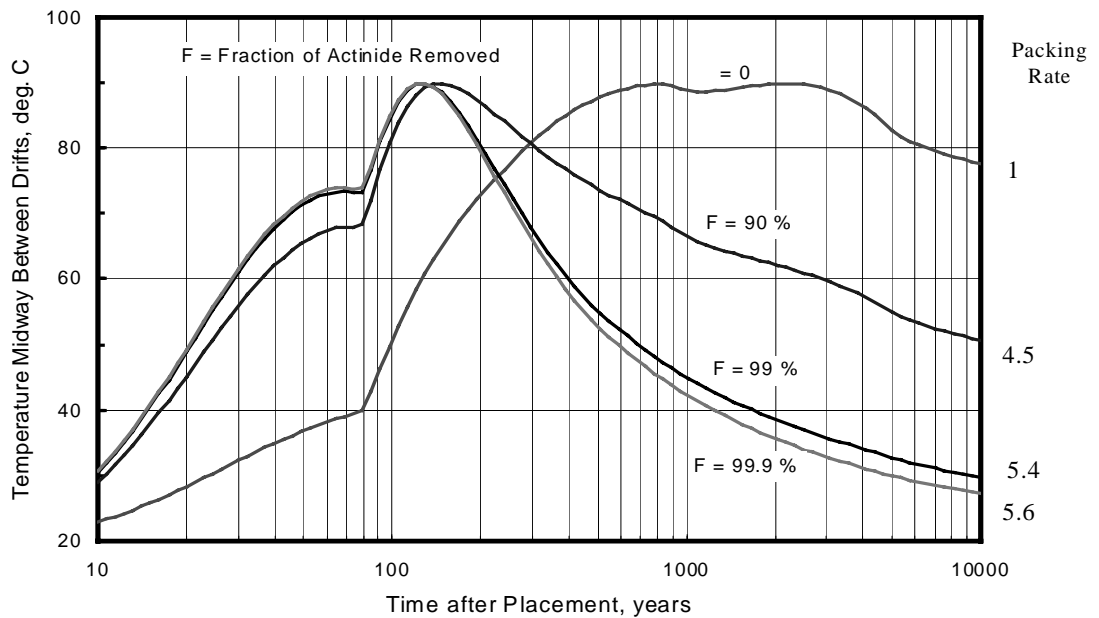
**Detailed analyses are planned that will allow better quantification of the impact, along with an economic assessment to determine if the approaches are viable**

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### Repository Benefit Analysis - Example Actinide Removal and Decay Heat

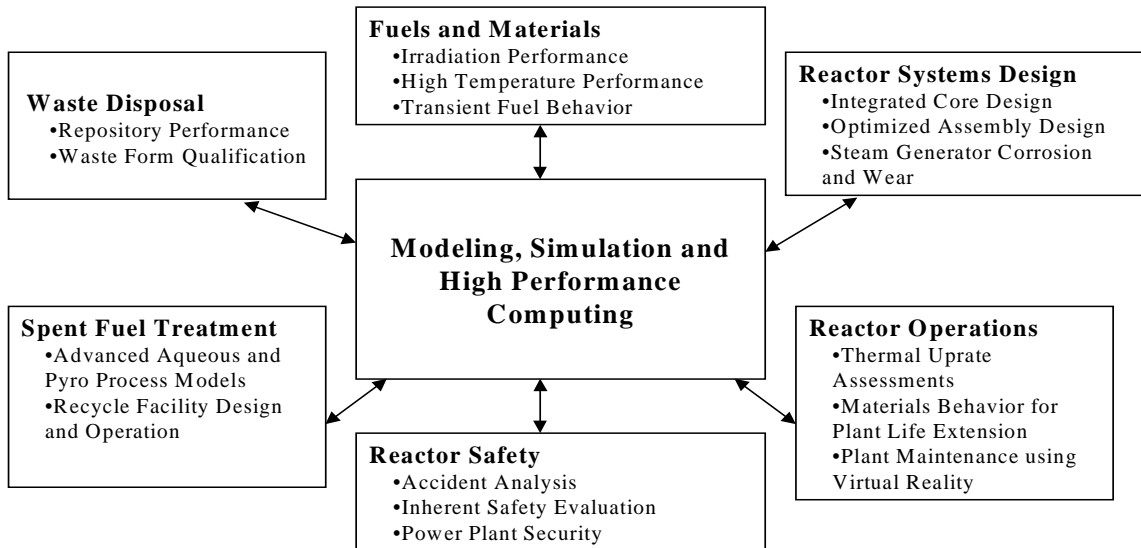


### Repository Benefit Analysis - Example Actinide Removal and Temperature





## Example of Proposal: Simulation-Based Engineering to Integrate All Aspects of Nuclear Energy



## Yucca Mountain Project FEIS on Potential Impacts of Separation & Transmutation

- **Section 9.1.3 of the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (DOE/EIS-0250)* addressed S&T**
- **Acknowledged that S&T could:**
  - **eliminate/reduce certain radionuclides in the inventory and thus add flexibility to the design of the repository, and**
  - **reduce uncertainties about repository performance**
- **DOE commits to incorporating information from future S&T studies in its decisions**
  - **during preparation of a Mitigation Action Plan for the EIS**
  - **during the repository licensing process, if necessary**