UT-BATTELLE

Advanced Head-End Processing of Spent Fuel

Bill Del Cul, Rodney Hunt, Barry Spencer, Emory Collins (ORNL)

Brian Westphal, Kenneth Bateman, Paul Lind, Karen Howden (ANL)

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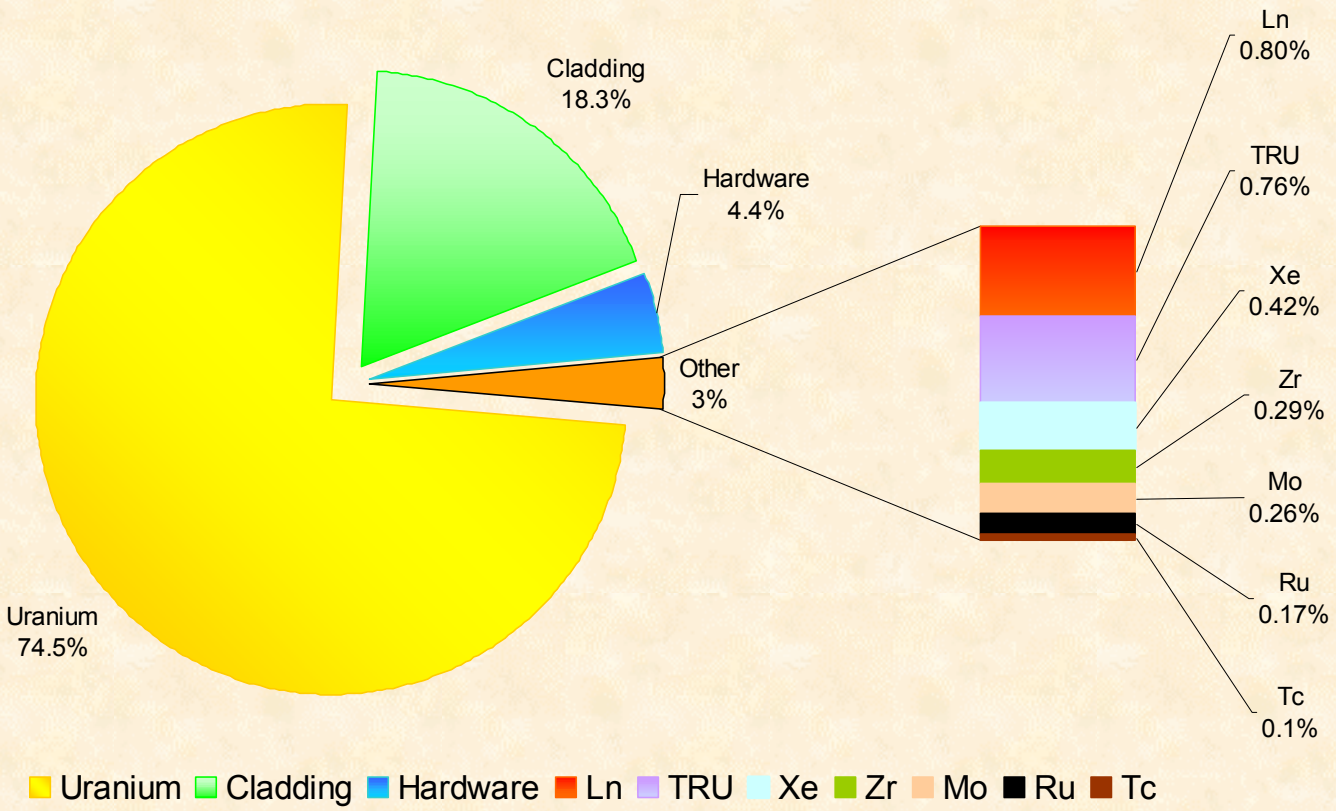
OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

INTRODUCTION

- Development efforts toward an advanced dry head end for the processing of U.S. spent fuel are underway and include previous experiences and lab scale experiments.
- The overall objective includes
  - Separation of the hardware and cladding with the minimum degree of retained contamination
  - Early removal of the volatile (e.g. ^{3}H, Kr, Xe, I) and semi-volatile fission products (e.g. Cs, Tc, Mo and Ru)
- The goal is to simplify the subsequent processing scheme and to reduce the processing and waste disposal costs.

Composition of Spent Nuclear Fuel



Potential Advantages

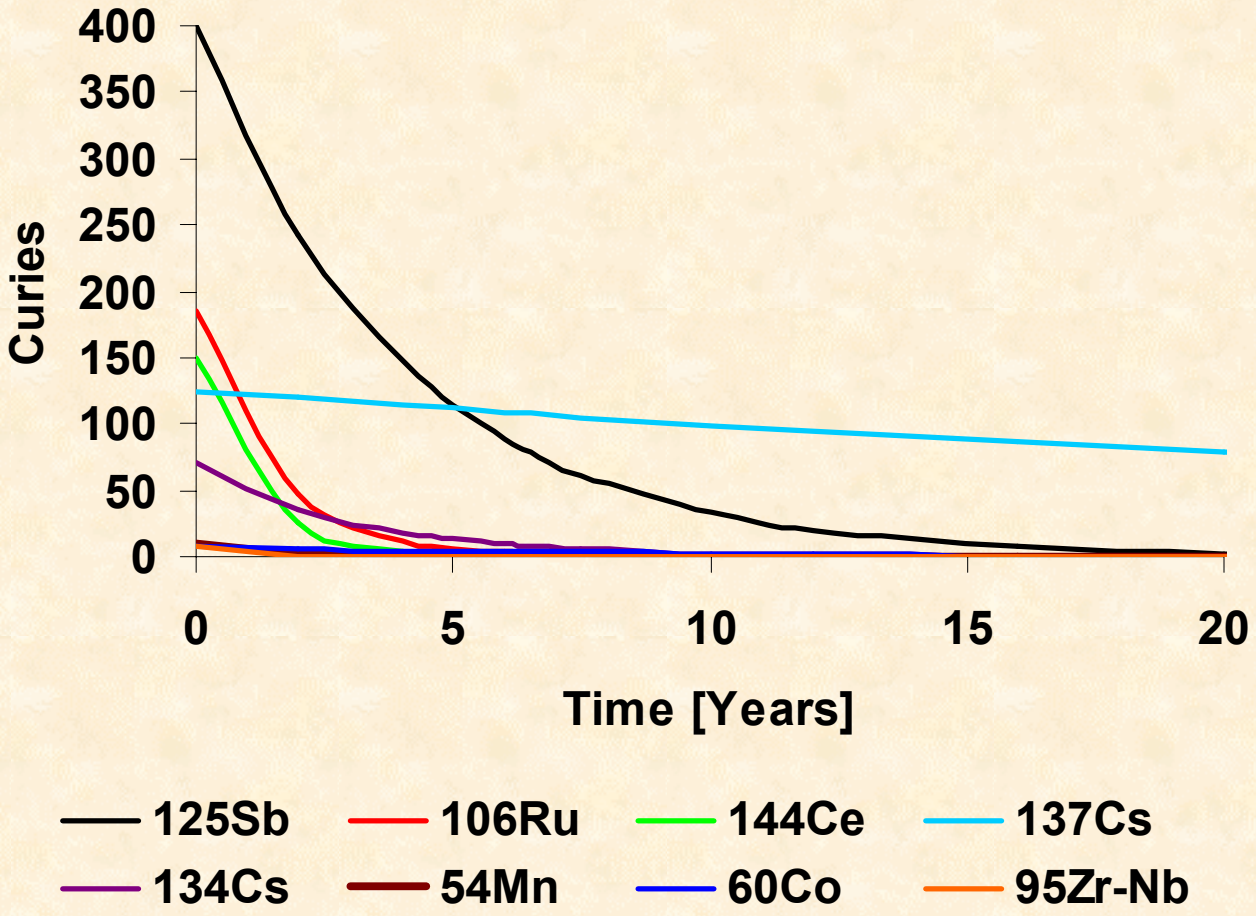
- Cs is a major source of radiation and heat and difficult to remove conventionally. Up-front removal reduces the need for shielding and limits the radiolytic degradation of the solvents down-stream.
- Most SNF management scenarios include separation of long-lived FP, including Tc. If not removed upfront, a significant amount of Tc follows the dissolver insolubles making it very difficult to isolate.
- Mo interferes with several downstream separation processes.
- Unless ^{3}H is separated upfront, it is not practical to isolate it during the aqueous processing.
- Iodine is a source of corrosion and complicates the treatment of dissolver off-gas.

Overall scheme

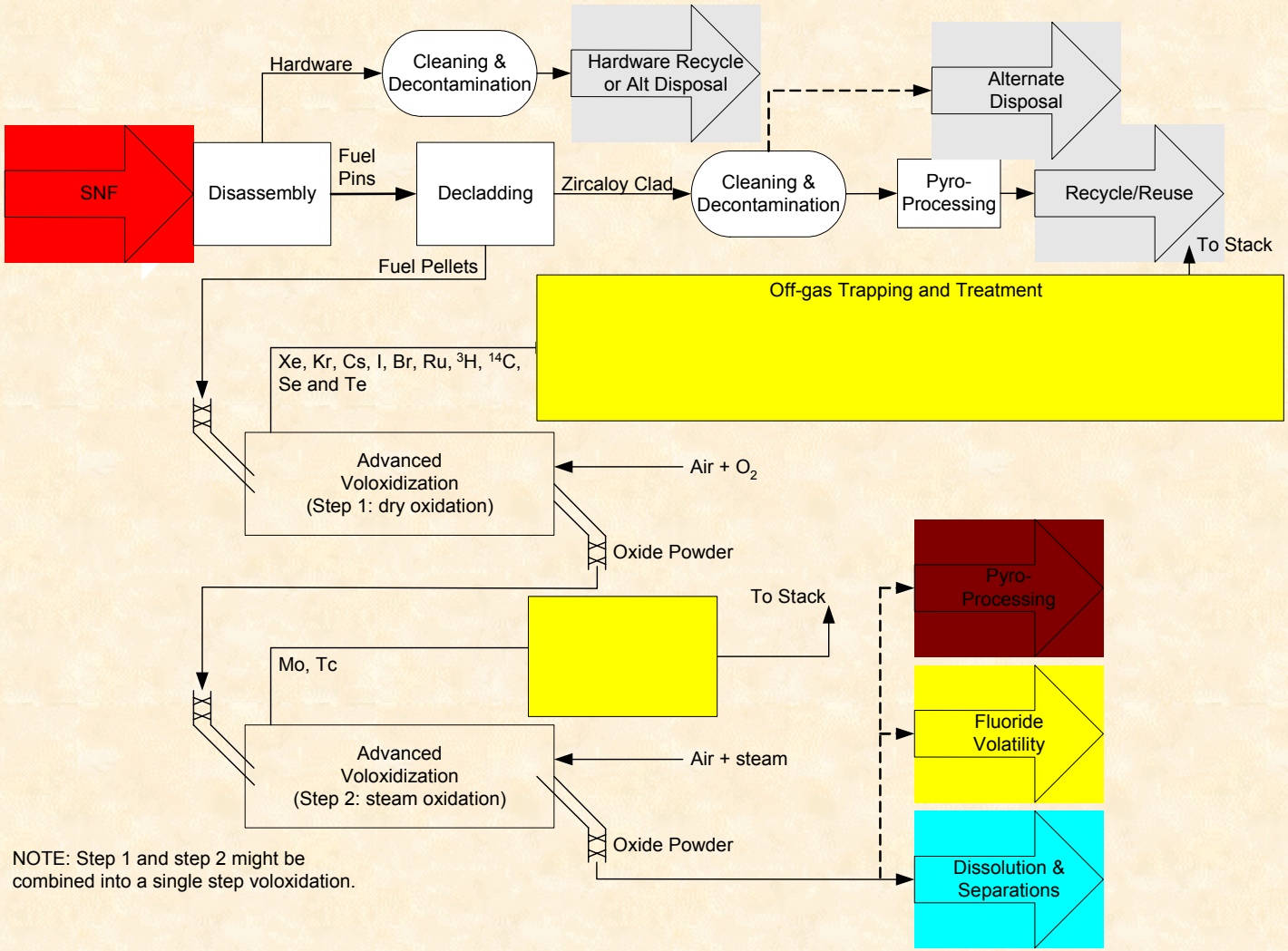
- The envisioned advanced head-end processing has the following steps:
  - Disassembly of the spent fuel elements by cutting the end rods and retrieving the fuel pins.
  - Decladding of the fuel pins to cleanly recover the fuel for further processing.
  - Cleaning and decontamination of cladding and hardware for potential reuse or lower cost disposal.
  - Treatment of the fuel using a controlled atmosphere (e.g. air, O_2, steam, O_3).

Cladding Activity [Curies/MTIHM]

Upper 18” of rod from assembly B05, H.B.Robinson PWR Reactor 22000MWd/MTIHM



Overall Scheme



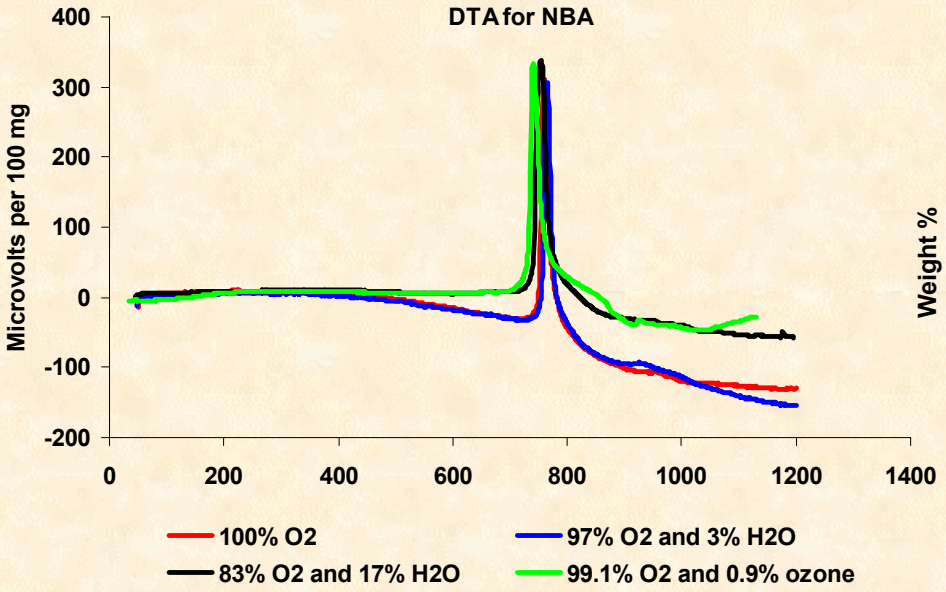
Approach

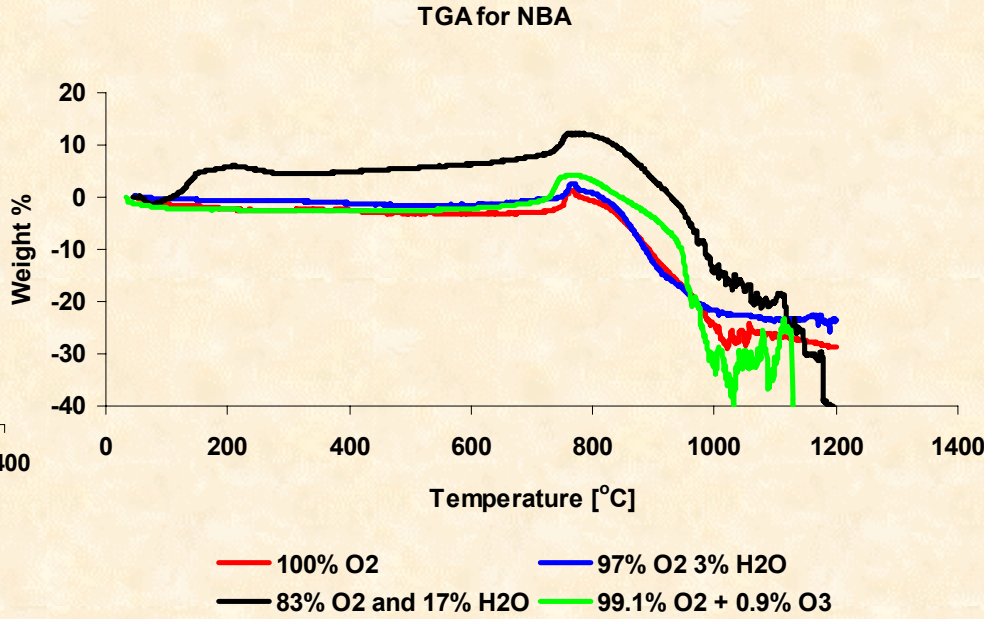
- Joint collaboration between ORNL and ANL-W
  - Recently I-NERI with KAERI
  - Possible collaboration with Scientech on disassembly & decladding
- Cold surrogates
  - (UO_2, NBA, CsI, Cs_2MO4, Cs_2Te, Re, etc., zircalloy)
- Actual cladding and SNF

Tasks

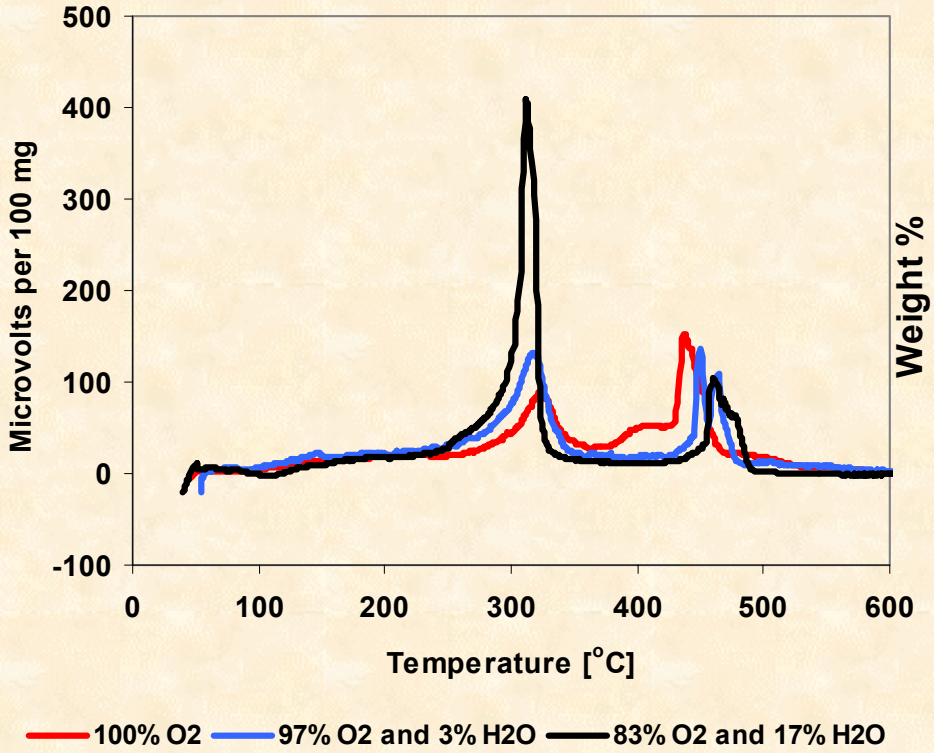
- Disassembly & Decladding
  - Hardware and cladding recovery
  - Alternative reuse or disposal
- Treatment of SF pellets
  - Fission products removal
  - Trapping and recovery
  - Wasteforms

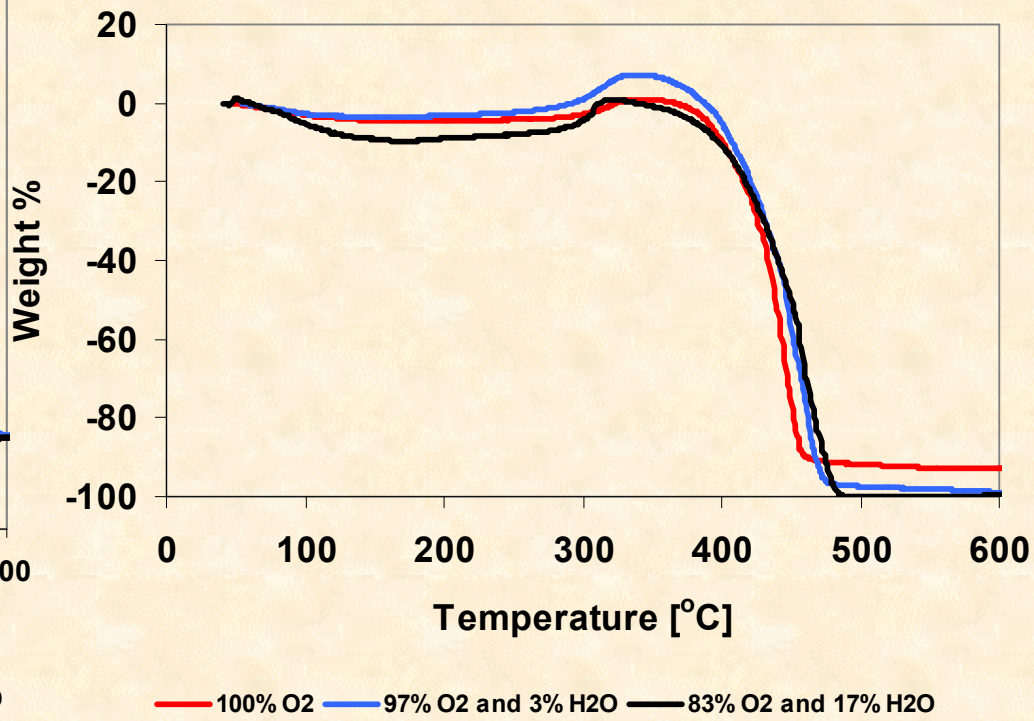
DTA-TGA of Noble Metals Alloy (Mo, Ru, Pd, Re and Rh)





DTA-TGA of Rhenium





Conclusions

The R&D efforts are underway.

The information collected from spent fuel processing (Voloxidation, AIROX, etc.), from the analysis of potential releases during severe reactor accidents, and from previous developments in disassembly and decladding seems to indicate that the overall process appears to be reasonable

- **Preliminary hot and cold test seem to indicate that all of the goals can be achieved**