Reprocessing And Recycling: Waste Management

U.S. Nuclear Regulatory Commission
Reprocessing Workshop
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Reprocessing And Recycling
Mass And Waste Balances

• Mass quantities and waste categorizations depend on processes and efficiencies

• In general:
  – PUREX process is the Baseline - most developed/used and well defined
  – PUREX variations can have large differences in mass quantities, waste generation, and categorization
  – Other processes less defined for waste quantities and categorization

• Contact handling (e.g., Recycling – fuel fabrication) requires high efficiencies and decontamination factors, and potentially simplifies the waste area
Modern PUREX - Top Level Balances
(All Values Are Approximate)

**SNF:** 1,000 MTIHM (e.g., per year)

**Uranium (NU or DU)**

For MOX Fuel:
190 MTHM

**Emissions and Effluents:**

- Kr-85: 27,940 g, 11E6 Ci
- H-3: 95.4 g, 9.21E5 Ci
- C-14: 455.3 g, 2,030 Ci
- I-129: 313,300 g, 55.3 Ci

**MOX Fuel**
200 MTHM, 5% Fissile

**Reprocessed Uranium (REPU)**
940 MTHM, 340 m3

**HLW:** 50 te
- HLW (vit): 200 te, 100 m3

“HLW/GTCC: 300 te” (e.g., Zr hulls)
- Circa 100 m3

**LLW:** facility, PPE etc.
- 1,200 m3

*Values derived from literature references, e.g., NRC, 179th meeting of ACNW&M, May 16th, 2007*
Radioactive Wastes

• In general:
  – HLW – highly radioactive and hazardous for many 100s or 1,000s of years, can be self-heating, geologic isolation generally needed
  – Non-HLW – radioactive and hazardous for 10s or a few 100s years, not self-heating, engineered isolation generally needed

• Waste categorization primarily by generation and source (origin), not hazard
HLW - High Level Waste

• Definition in 63.2 and 72.2:
  – Highly radioactive material from reprocessing SNF (liquid or solid), including liquid waste produced directly and any solid derived from such liquid waste containing sufficient concentrations of fission products
  – Irradiated nuclear fuel (SNF)
  – Other highly radioactive material NRC determines by rule that requires permanent [geologic] isolation

• Generated by all reprocessing processes but quantities and forms vary
HLW And PUREX

• First cycle liquid waste
  – Vitrified (a glass), inside containers
  – Stored onsite

• Fuel rod cladding – “hulls”
  – Technically not HLW
  – But hard to separate and verify separation from HLW, and, thus, usually handled as HLW

• Other HLW-like streams small, usually routed to vitrification (e.g., scrubber solutions, alpha and TRU materials)
Photos Of HLW Storage
Non-HLW

• Normally considered to be low level waste (LLW). Typically includes:
  – Non-repaired equipment
  – Facility waste (e.g., filters, ion exchange media, catalysts, solvents)
    • Includes radioiodine adsorbents
• PPE – Personnel Protective Equipment
• Reprocessing plants overseas sometimes generate another waste type called intermediate level waste (ILW) between LLW and HLW
Other Materials

• Reprocessed uranium – recycle, store, or disposal
  – Large amount
  – Slightly enriched
  – Contact handled (PUREX) but slightly more radioactive

• Plutonium – reuse as a fuel material (e.g., MOX)
  – Isotopic mixture depends on burnup and decay time

• Volatiles
  – Usually released via scrubbers

• Potential reuse of materials for catalysts, radiation sources etc.
Potential Points For Discussion

- Onsite storage of SNF
- Onsite storage of HLW
- Onsite storage of non-HLW
- Onsite storage to allow decay
- Parameters for onsite storage – form, radiation limits, activity limits, active vs passive (cooling, monitoring)
- Reuse – current, future – parameters
- Risk-inform waste categorization based upon hazards
- Include additional waste categories (e.g., ILW)