GE Hitachi Nuclear Energy

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Electro-Chem Brief

[Images of various industrial and environmental scenes]
The problem and our solution: Advanced Separations

The Advanced Recycling Center separates the TRU and Uranium for recycling
Transuranic disposal issues

The 1% transuranic (TRU) content of nuclear fuel is responsible for 99.9% of the disposal time requirement and policy issues.

Removal of uranium, plutonium, and transuranics makes a 300,000 year problem a 300 year problem.
What it is?
Electrometallurgical development

✓ NAS Committee Findings
  • No technical barriers for electrometallurgical processing of EBR-II fuel
  • DOE should seriously consider continued development as an alternative to aqueous treatment of uranium oxide spent nuclear fuel

✓ Prudent GNEP starting point
  • Domestic solution available today

1964-1969 Melt Refining
• AEC Funded
• Innovative design approaches

1984 IFR Program
• DOE funded
• Prove metal fuel

~1990 Japan
• Japanese Support
• Contributed $40M
• Committed $60M
• Contributed $6M for LWR oxide reduction

1989-1995 IFR Ends
• Program Terminated
• EBR-II shut down
• EBR-II 30 years of successful operation

1995-1999 EBR-II Fuel
• EBR-II Fuel Treatment
• Requires treatment
  ➢ Enrichment
  ➢ Na bond
  ➢ Pyrophoric
  ➢ RCRA
• DOE ROD
• NAS review

2000-2007
• EIS completed
• Processing EBR-II fuel currently
• 3T processed
• Best practices
What it does - “waste” into watts

The NFRC produces PRISM fuel from the recycled uranium and long-lived isotopes. The short-lived isotopes are isolated into stable waste forms.
Animation of electrometallurgical separations
How it works?
Electrolytic Reduction Process

Cathode

$\text{UO}_2$ reduced to $\text{U}$

Molten Salt

Anode

$O_2$

$O^{2-}$
Electrorefining is the Key Step
Metal fuel recycling

- Metal fuel used to successfully demonstrate the viability of a closed fuel cycle in EBR-II by 1969
  - 35,000 fuel pins irradiated, processed, remotely refabricated, and returned to core
  - Melt refining process employed
  - Did not recycle Pu from fertile blankets
- ANL electrometallurgical demonstration in 1990’s with EBR-II fuel
  - 100 driver assemblies (410 kg of HEU) processed in Mark IV electrorefiner
  - 25 blanket assemblies (1,200 kg of DU) processed in high throughput Mark V
  - Original proposal was to include Pu/TRU demonstration
  - Lawsuit forced DOE to only process U
The ALMR pyroprocessing flowsheet

From: ACNW&M WP
GEH’s oxide fuel processing flowsheet
GEH’s oxide fuel mass balance model
Scale-up issues

Mark IV

Mark V

Process scales on:
- surface area
- current density

Commercial Deployment
b. Separate handling of 99Tc, Cs, and Sr?

**Metallic**
- 99Tc is in the metal waste form

**Ceramic**
- Cs and Sr are in the ceramic waste form
Main Components of the ARC: PRISM and NFRC
### Assumptions that will change the number of ARCs

- Number of Operating Plants
- Years plants operate
- Average burn-up of LWR fuel
- Burn/breed ratio

### Assumptions for ARC Math

- 1% of UNF is TRU
- Current average burn-up for UNF used in these calculations as the average exposure increases your TRU content will have to increase

### Table

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<th>MT TRUConsumption/ARC/yr</th>
<th>MT UNF consumed/ARCd/yr</th>
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|                       | Surplus (Deficit)| 0                         | (1200)                  |
Starting the Nuclear Fuel Recycling Center

**Conceptual Design**

**Path 1**
- Licensing
  - Use existing Wilmington Part 70 LWR Fuel License
  - Conduct Integrated Safety Analysis (ISA)

**Path 2**
- Simulation
  - Build deployment simulation model
  - Start design optimization

**Path 3**
- Component Testing
  - Fabricate select components
    - Electrorefiner
    - Cathode processor
    - Fuel casting equipment
  - Test components

**NFRC Deployment**
- Follow EBRII fuel disposal system
- Integrate simulation into design process

Benefits:
- Reduced time for prototypic separations
- Immediate ability to license under Part 70 at Wilmington, NC facility
- Completion of ISA
- Takes advantage of existing GEH processes
- Optimize design through iteration
Backups
Pyroprocessing Block Flow Diagram

NAS Committee . . .
‘no technical barriers for processing of EBR-II fuel’
Cumulative Quantities of EBR-II Spent Fuel Treatment