Advanced Fuel Cycles?

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Anything is Possible. Is it Practical?
US reactors currently discharge > 2,000 tUNF/y with a total inventory of >65,000 tUNF stored at reactor sites around the country.
# Number of Fuel Assemblies

<table>
<thead>
<tr>
<th>Year</th>
<th>Dry Storage</th>
<th>In Pool</th>
<th>Total</th>
<th>Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>39,460</td>
<td>177,397</td>
<td>216,857</td>
<td></td>
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<tr>
<td>2010</td>
<td>44,552</td>
<td>179,894</td>
<td>224,446</td>
<td>7,589</td>
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<tr>
<td>2011</td>
<td>49,951</td>
<td>182,448</td>
<td>232,399</td>
<td>7,953</td>
</tr>
<tr>
<td>2012</td>
<td>54,946</td>
<td>184,701</td>
<td>239,647</td>
<td>7,248</td>
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<tr>
<td>2013</td>
<td>60,986</td>
<td>186,159</td>
<td>247,145</td>
<td>7,498</td>
</tr>
</tbody>
</table>
Burn-up of US Assemblies

Percentage of Assemblies

Burnup Range (MWd/MTU)

- PWR
- BWR

Taken from paper:-Fuel cycle potential waste disposition FCR&D-USED 2010-000031
Used Nuclear Fuel
Where do we go from here?

Important to keep options open
Drivers Influencing Recycling in US

- 40 CFR 190 Regulates Iodine and Kr.
  - Prepared at time when US would thought to have 1,000 reactors and would be recycling over 100,000 tUNF per year.
  - Covers the entire uranium fuel cycle. Regulates I and Kr
  - Assume capture technology would be relatively inexpensive to deploy.

- Repository Driven.
  - Final repository will determine the optimum requirements for MA separations or Gen IV reactors?

- Future US Energy Policy

- Self protecting nature of UNF.
Integrated UNF Management Site – Dry Storage Pad / RD&D Platform

Phased Approach – leaves options open
Centralized Storage
Integrated UNF Management Site – Dry Storage, UNF Unloading Facility, Storage Pool

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Options

- Continued storage of fuel on the pad.
- Repackage and direct disposal in a geological repository.
- Size reduce and direct disposal in a geological repository.
- Pilot recycling facility.
- Or a combination of all the above
Integrated UNF Management Site-Recycling Facility and RD&D Platform

Evolutionary technology benefiting from over 40 years of operating experience
Initial Pilot Recycling Facility

- Balanced fuel cycle
  - Recycling capacity matched to product demand
- Propose an initial “Pilot” 800 tHM/y capacity plant that builds on best available technology to minimize risk
- COEX™ Separations process so “NO” separated Pu
- Manage product using existing nuclear infrastructure while DOE develops Gen IV Reactor (50 plus years for first commercial Unit.)
- LWR MOX is therefore an “interim” step for closing the cycle.
- Pilot Facility could supply fuel to,
  - Limited number of existing LWR’s or
  - ~4 x Gen III+ reactors or
  - ~2 x 500 MWe SFR
Major Impact on Region from Primary and Secondary Jobs

Work Force (800 MT/y plant)
Classic Recycling of UNF

Fresh Fuel ×8  →  LWR  →  Used Fuel Recycle  →  MOX Fuel ×1  →  LWR  →  Used Fuel Recycle  →  Recycling once

Used Fuels ×8  →  1-through cycle  →  Waste (FP, MA)  →  Used Fuel ×2

ERU Fuel ×1

• Actual value depends on fuel burn-up and enrichment
Recycling of UOx, RepU, MOX
LWR Recycle with MA Burning in Limited Number of Gen IV
Incorporating Advanced Separations

- New Vitrification Feed Tank
- TRUEX PROCESS
- TALSPEAK
- Am to Fuel
- VITRIFICATION
- Existing Vitrification Feed Tank

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Incorporation of Advanced Technology in Pilot Facility

Technology Evolution

Advanced Separations and Transmutation Fuel Production are an addition to the Pilot Facility and not a replacement.
Development Plan for TRUEX and TALSPEAK

- Chemistry Study
- Solvent Stability Test
- Solvent Cleanup
- Process Control
- Planning for Bench Demo
- Bench Scale Tests
- Design of Integrated Demo
- Build Demo Facility
- Continuous Flowsheet Demo
- Modeling of the Advanced Process
- Alternative Advanced Process Development
- Industrialization, Design, Build, Commission
Conclusions

- US is unique due to the large stockpile of UNF we have.
- US has specific regulations that will influence the fuel cycle.
- Nuclear industry takes a long time to develop and deploy technology.
- We have many options to choose from.
- Phased approach to recycling is proposed, “Pilot Plant”
  - Do not commit the country 100% to anyone technology.
  - Can be adapted and upgraded with new technology.
- Must develop a simple business case for any future fuel cycle.
- Fuel cycles will overlap.
- Final geological repository will drive fuel cycle deployment.