Depleted uranium: Hearing a different drummer

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What are we talking about?

Depleted uranium inventory (outside of USA)

<table>
<thead>
<tr>
<th>Country</th>
<th>Quantity of Depleted Uranium (tU)</th>
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<tbody>
<tr>
<td>Russia</td>
<td>680 000 – 700 000</td>
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<tr>
<td>France</td>
<td>260 000</td>
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<tr>
<td>Germany</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>80 000 – 85 000</td>
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<tr>
<td>Netherlands</td>
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Physical form of intermediary storage

- France developed a defluorination process in the 1980s and, since then, is converting on line its depleted UF₆ into U₃O₈

- Meanwhile, other countries were storing their depleted UF₆

- Lately, all of them moved to more stable forms of storage
  - Russia
    - Conversion to UF₄ at Angarsk (project Cedar)
    - Conversion to U₃O₈ at Zhelenogorsk (using AREVA’s technology)
  - UK: Conversion to U₃O₈ (project in progress using AREVA’s technology)
  - Germany and Netherlands: conversion to U₃O₈ sub-contracted to AREVA
Focus on the French situation
Technical status

- Depleted UF₆ coming from EURODIF is de-fluorinated into U₃O₈ in the W facility at Pierrelatte.
- AREVA U₃O₈ is conditioned in containers of 10 MT capacity and stored on two sites in France.
- Containers are piled up, either in dedicated depleted uranium storage facilities or as radiation shielding in reprocessed uranium storage facilities.
Depleted uranium: legal status

- In all European countries and in Russia, depleted uranium is not considered as a waste as long as there are possibilities for re-use.

- In general, it is the responsibility of the industrial owner of depleted uranium to decide if a resource or a waste.

- The French « Environmental Code » says, in the article L542-1-1:

  […]

  A radioactive **material** is a radioactive substance for which further use is **forecast or contemplated**, after treatment if need be.

  […]

  Radioactive **waste** is a radioactive substance for which no further use is **forecast or contemplated**.

  […]
Utilization of depleted uranium

▶ Current utilization

♦ Radiological shielding in RepU storage facilities

♦ MOX fuel fabrication for LWR
  • more than 100 tU per year

▶ Present and mid-term utilization

♦ Re-enrichment of tails
  • Recent program based on gaseous diffusion enrichment technology: READ

▶ Long term utilization

♦ Fast neutrons reactor fuel
Re-enrichment of depleted uranium
AREVA experience – The READ Campaign

- Campaign launched in 2008 with objective to re-enrich 15,000 tU of depleted uranium into LEU
- Technical success
- Campaign stopped early 2009 at 7,800 tU because of dropping price of natural Uranium

Feed:
- 7,800 tU
- chemical form: U₃O₈
- assay: .33%

Product:
- LEU
- equivalent to 1,800 tU of natural uranium

Tails assay: .22%
Re-enrichment of depleted uranium
Lessons learned

▶ Conditions for future re-enrichment

◆ Sustainable price for natural uranium: the trend seems right
◆ Availability of enrichment capacity
◆ Ability to lower the secondary tails assay will increase the share of depleted U eligible for re-enrichment
◆ Having the richest tails under the right form
  • Re-conversion from $\text{U}_3\text{O}_8$ to $\text{UF}_6$ represents a significant part of the re-enrichment cost

“Richest tails should be kept as UF6”
Fuel for fast neutrons reactors

- Worldwide renewed interest for fast neutrons reactors
  - Prototype Fast Breeder Reactor (PFBR) in India
  - BN800 in Russia
  - ASTRID in France
  - PRISM in the USA…
  - and work ongoing in Japan

- A strategic inventory
  - Today’s French inventory of depleted uranium can feed for more than 300 years the FBR component of its future nuclear fleet (assumed to be 20%)

Present intermediate storage options are acceptable for such an horizon
In the past decades, most countries considered depleted uranium as a valuable resource for the next generation of reactors, at a distant horizon requiring several decades of intermediate storage.

Status of depleted uranium and storage policies have been defined accordingly.
But the world is changing

Annual Uranium production

- Evolution of uranium
- Reactors demand
- Long term indicator
- Secondary resources
- Planned (@ 50% probability)
- In development (@ 80% efficiency)
- In operation (@ 90% efficiency)
The nuclear renaissance triggered a durable increase of price of uranium, and even some concerns about its future availability.

Lowering of tails assays in new enrichment facilities will increase the spectrum of historical depleted uranium eligible for re-enrichment.

This evolution has changed the horizon for re-utilization of depleted uranium.

“Status and storage policies should be revisited accordingly.”
Thank you for your attention