



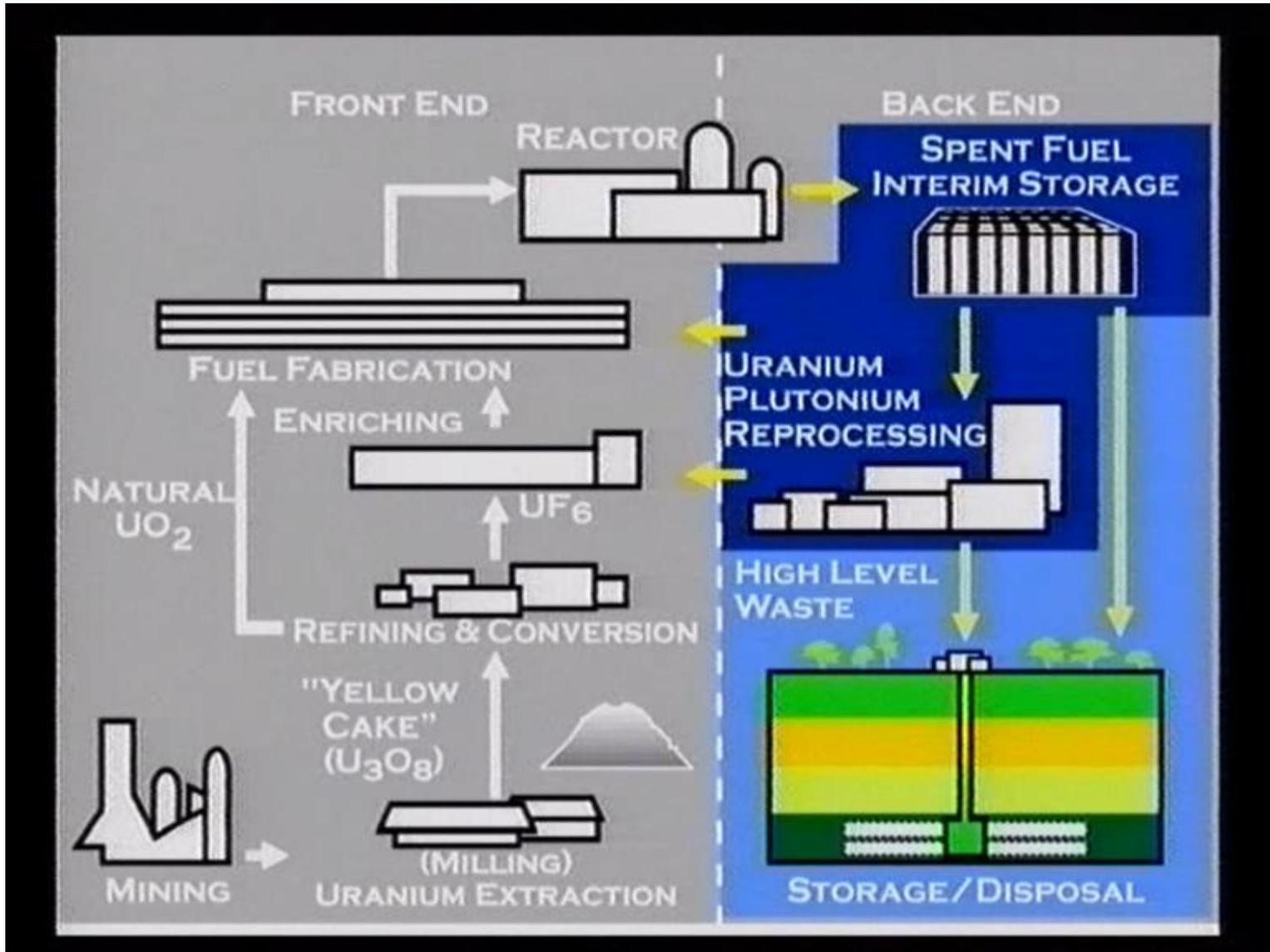
International Atomic Energy Agency

**Reprocessing, Waste Treatment and Disposal
Management of Spent Nuclear Fuel**

**Seminar on Nuclear Science and Technology for Diplomats
Vienna, 6 – 8 February 2007**

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Director***

Division of Nuclear Fuel Cycle and Waste Technology

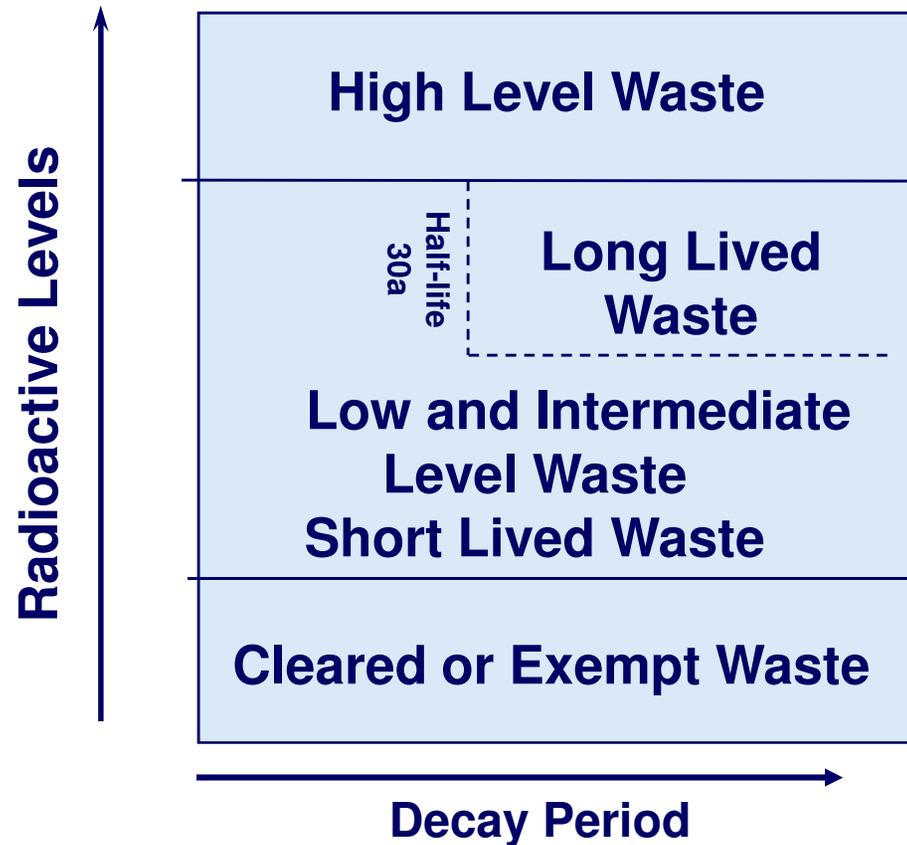


Sources of Radioactive Waste

- **Nuclear Fuel Cycle**
- **Research, Medicine, Industry and Agriculture**
- **Decommissioning of Nuclear Facilities**
- **Naturally Occurring Radioactive Materials (NORM)**



Waste Classification System



Operational sequence

- **Waste generation (minimise)**
- **Collection and transport (segregate)**
- **Treatment (compaction, incineration),
conditioning (cementation, bitumenization)
and packaging (drum, container)**
- **Interim storage**
- **Disposal**



Interim Storage of LLW



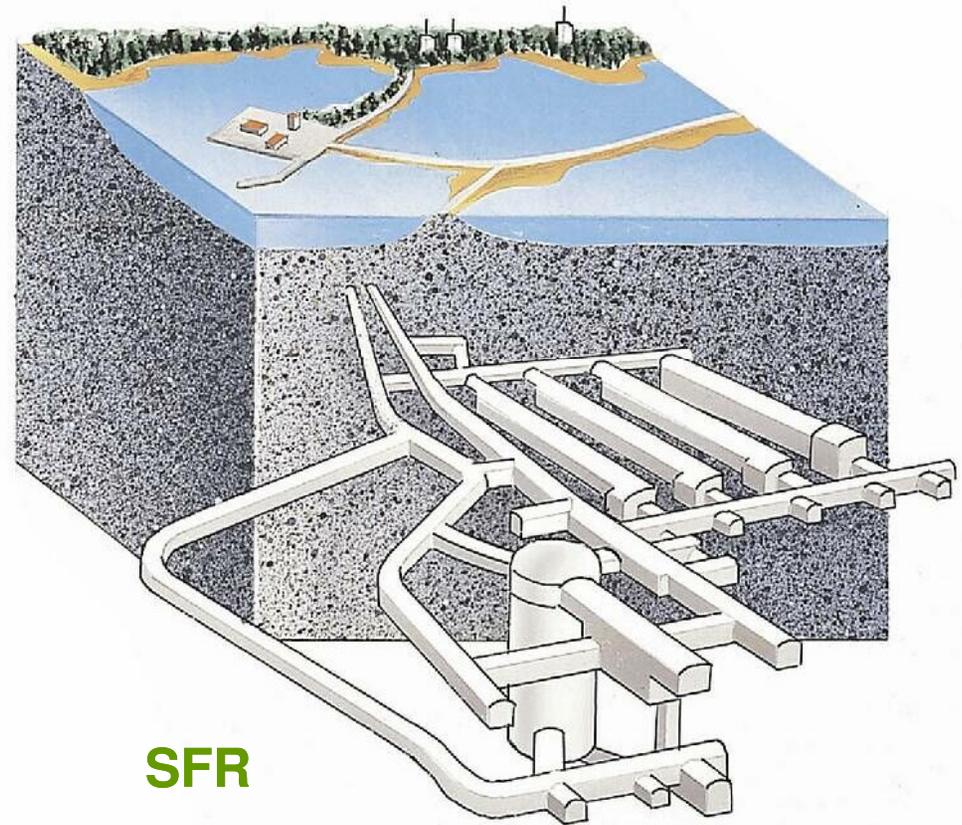
Types of Disposal

- **Short Lived Low Level and Intermediate Level Waste (LILW-SL)**
 - Near surface non-engineered disposal
 - Near surface engineered disposal
 - Subsurface disposal facilities
- **High Level Waste, Spent Fuel and Long Lived Waste (HLW and LILW-LL)**
 - Geological repositories



LILW-SL Disposal: Industrial Practice

Centre de l'Aube



SFR

Forsmark, Sweden



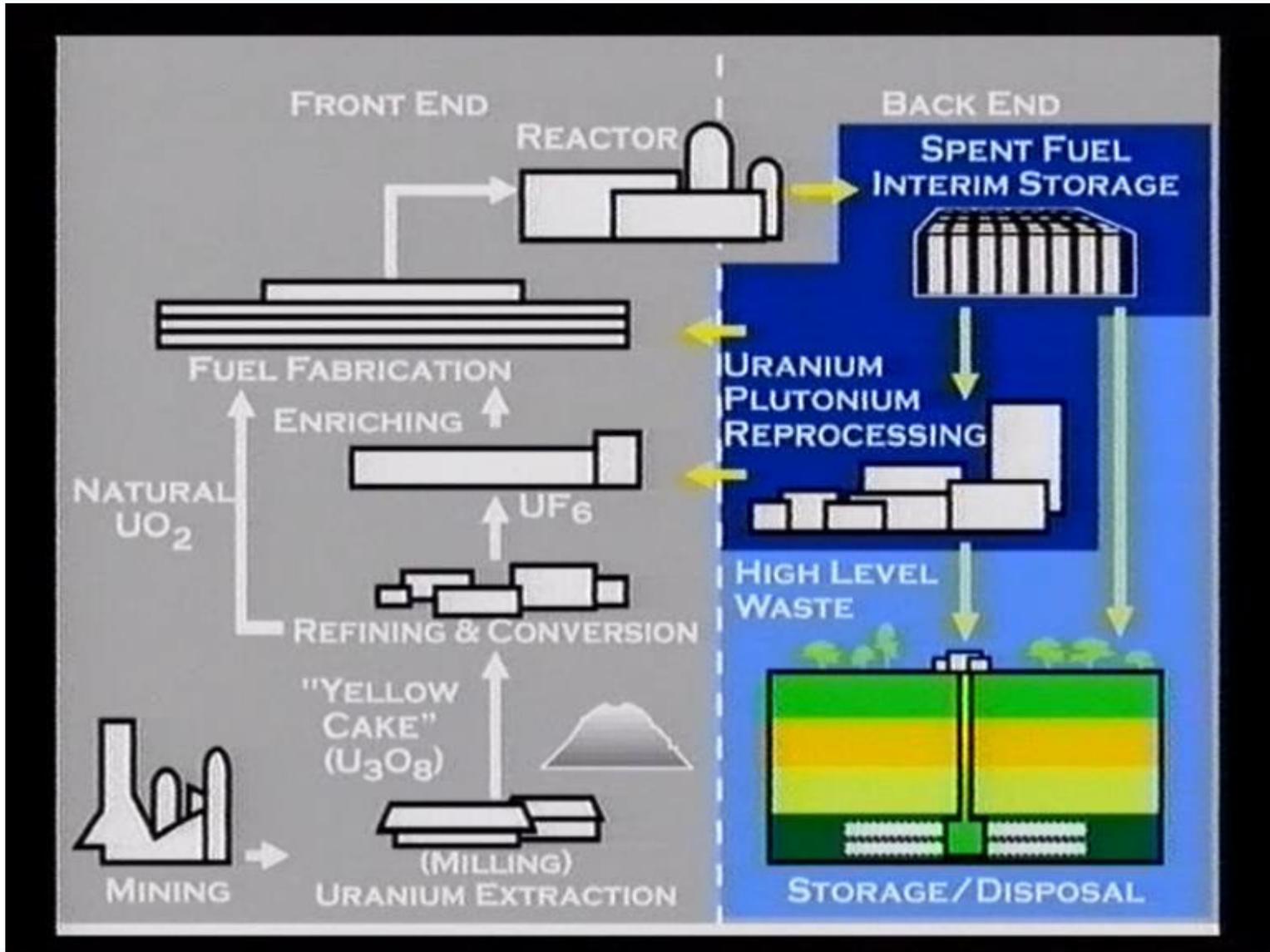
*Rock chamber for low- and intermediate level waste
Forsmark, Sweden*

Baseline for Sound Radioactive Waste Management

- ***SAFETY*** is always, at all steps, in each activity, for all parties, the first concern

(Even when I do not repeat it systematically)



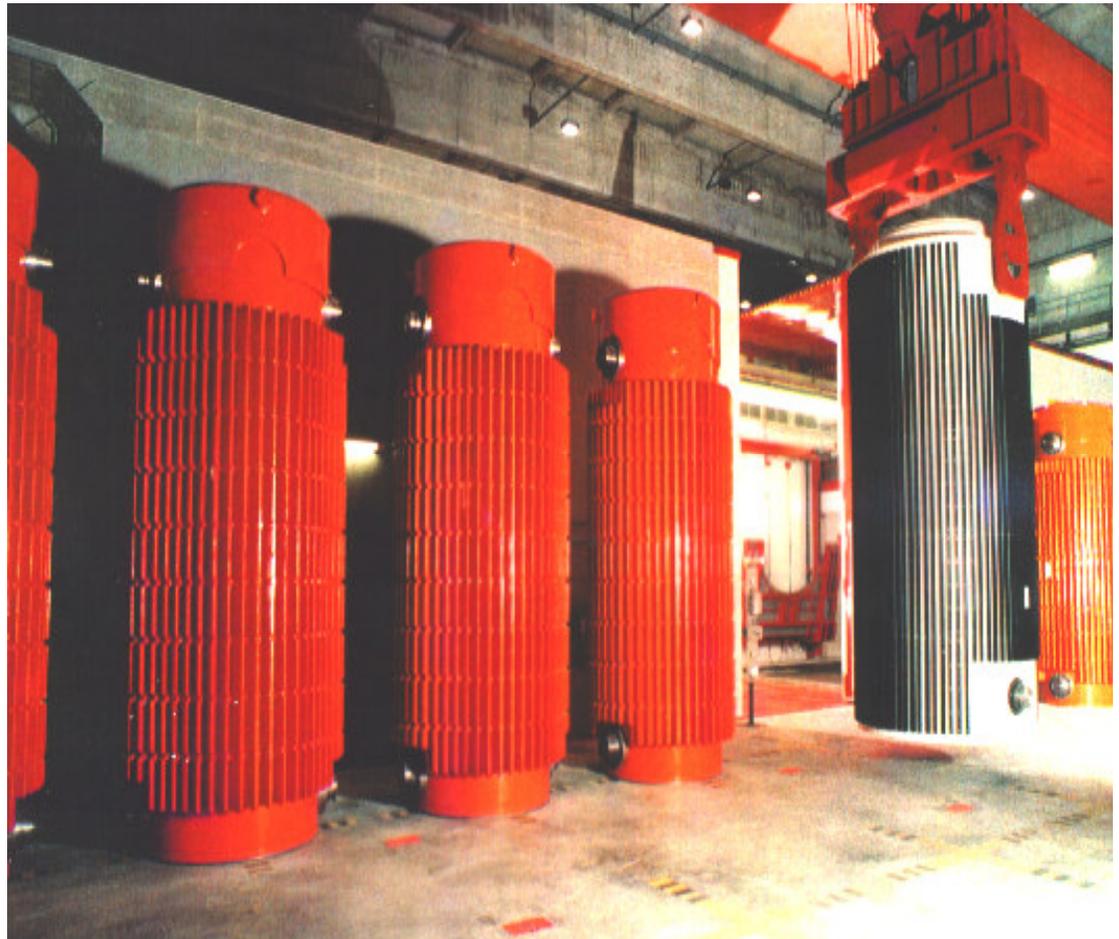
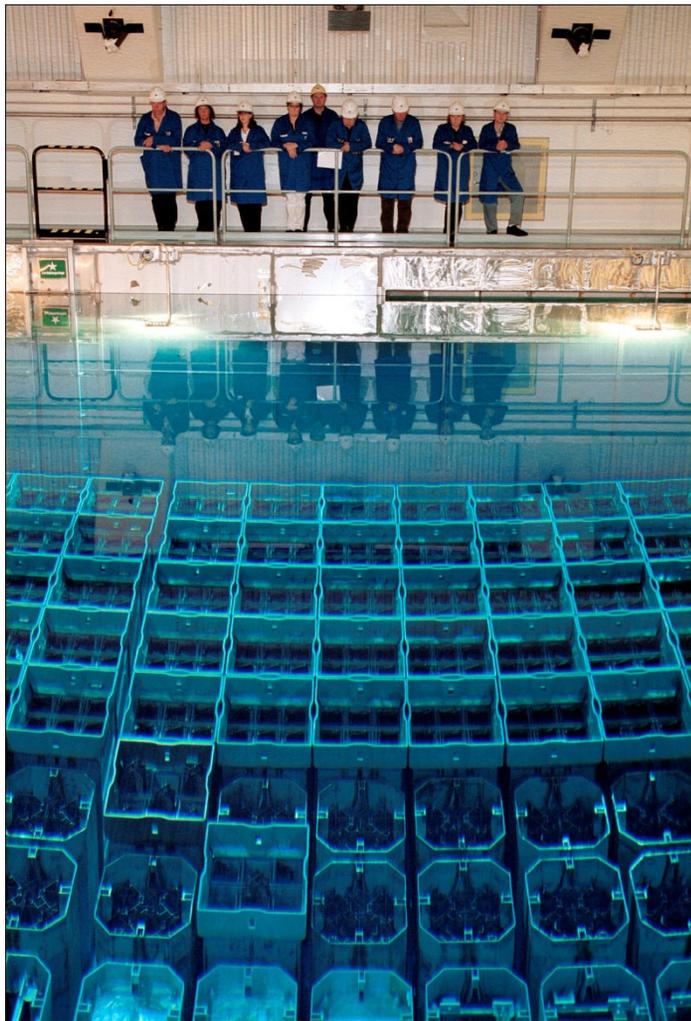


Characteristics of spent fuel

- **Geometrically and structurally intact – can be handled as an assembly**
- **Highly radioactive**
 - **Emits very strong radiation – needs shielding**
 - **Emits heat – needs cooling**
 - **Contains many different nuclides – with very different half life (seconds to millions of years)**
- **Contains valuable material (U, Pu, Cs, Pd)**



Storage of Spent Fuel

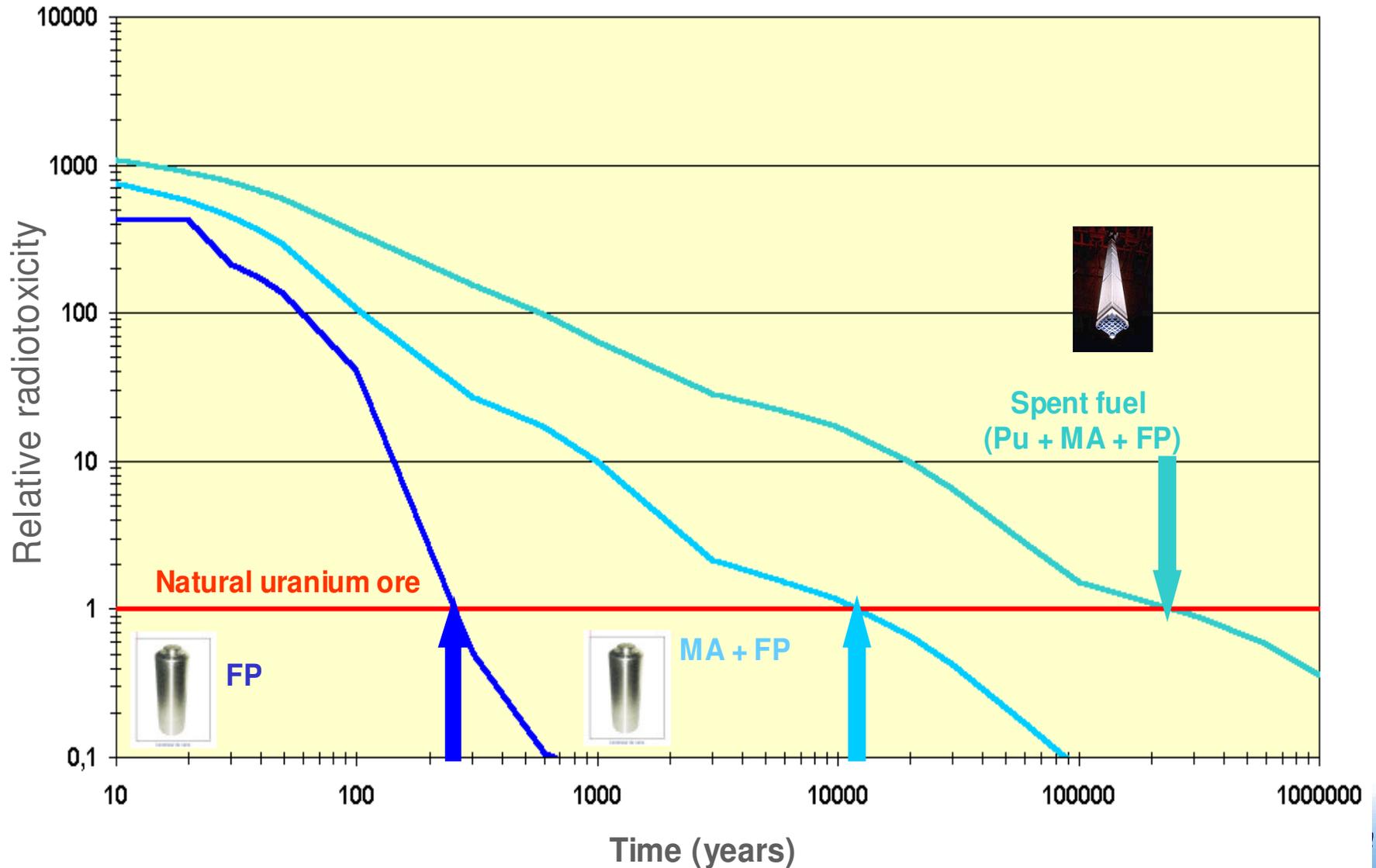


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Radio-toxicity of Spent Fuel



SPENT FUEL COMPOSITION AFTER IRRADIATION

RECYCLABLE
MATERIALS

U 480KG (96%)

PU 5KG (1%)

WASTE

FP 15KG (3%)



Basic Options for Spent Fuel Management

- 1. *Once-through cycle* – spent fuel stored and then disposed**
- 2. *Classical closed cycle* – spent fuel reprocessed Pu + U recycled and waste disposed**
- 3. *Advanced closed cycle* – spent fuel reprocessed Pu+U+actinides recycled and waste disposed**

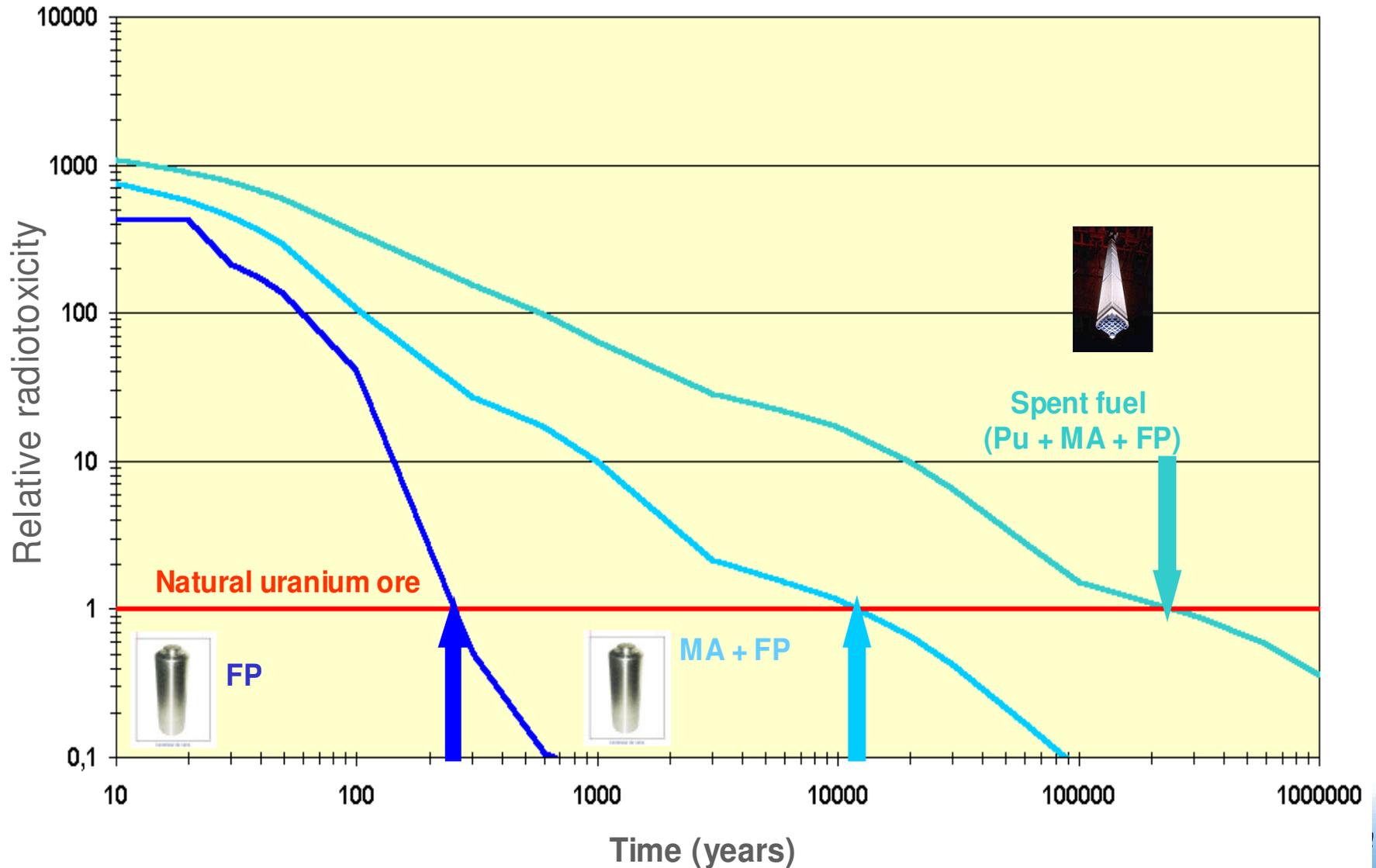


Objectives of reprocessing

- 1. Utilise the natural resource better by recycling uranium and plutonium***
- 2. Remove material that will require safeguards***
- 3. Reduce the long-term radiotoxicity to simplify disposal***
- 4. Reduce the heat load to improve repository capacity***
- 5. Provide possibility to separate other valuable material***



Radio-toxicity of Spent Fuel



Spent Fuel Reprocessing



Spent Fuel

**Chemical
and
Physical
Processes**

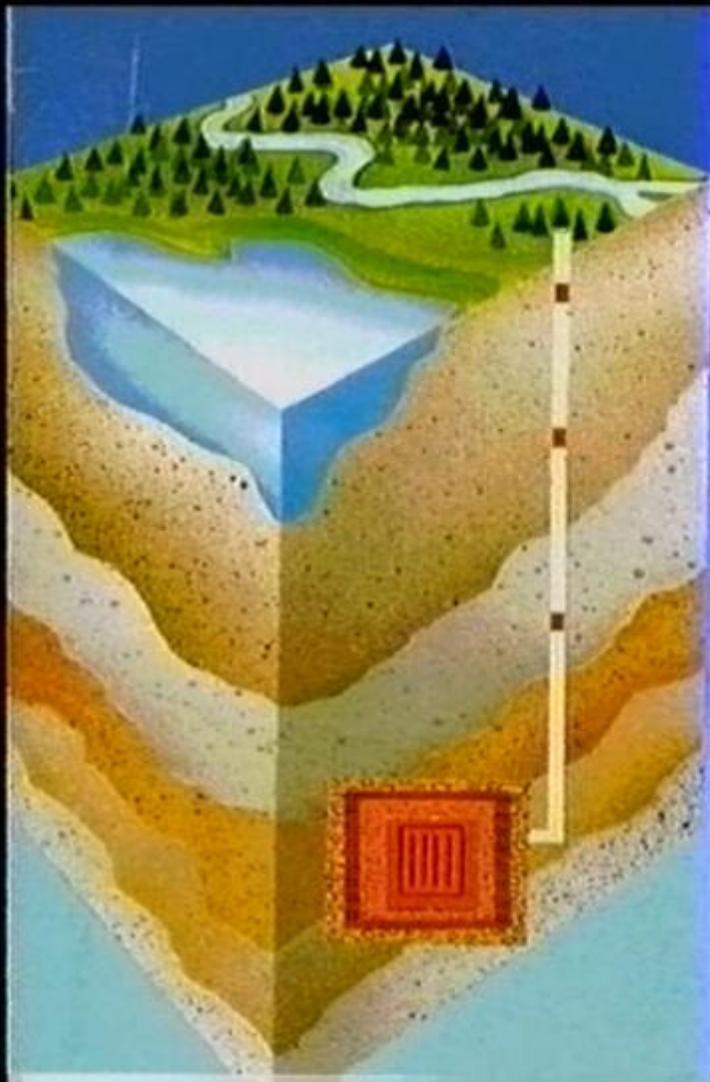


U
Pu

**Gaseous Waste (Kr, Xe, I)
Solid Waste
(Cladding Material)**

**Liquid Waste (HLW)
(Cs, Sr, Zr, Ni, La, Pr, Y)**





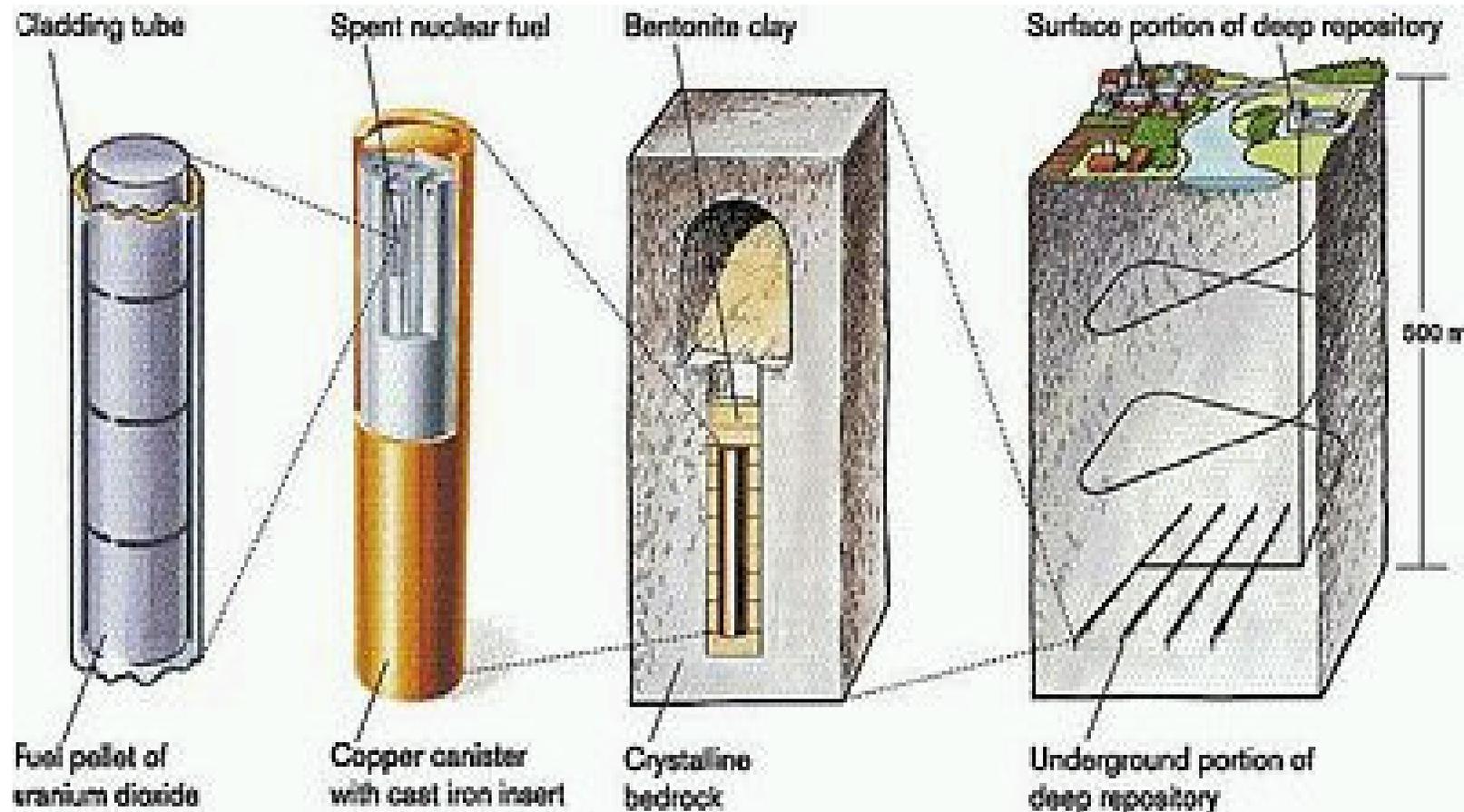
DEEP GEOLOGICAL DISPOSAL SITE

Geological Disposal of Waste

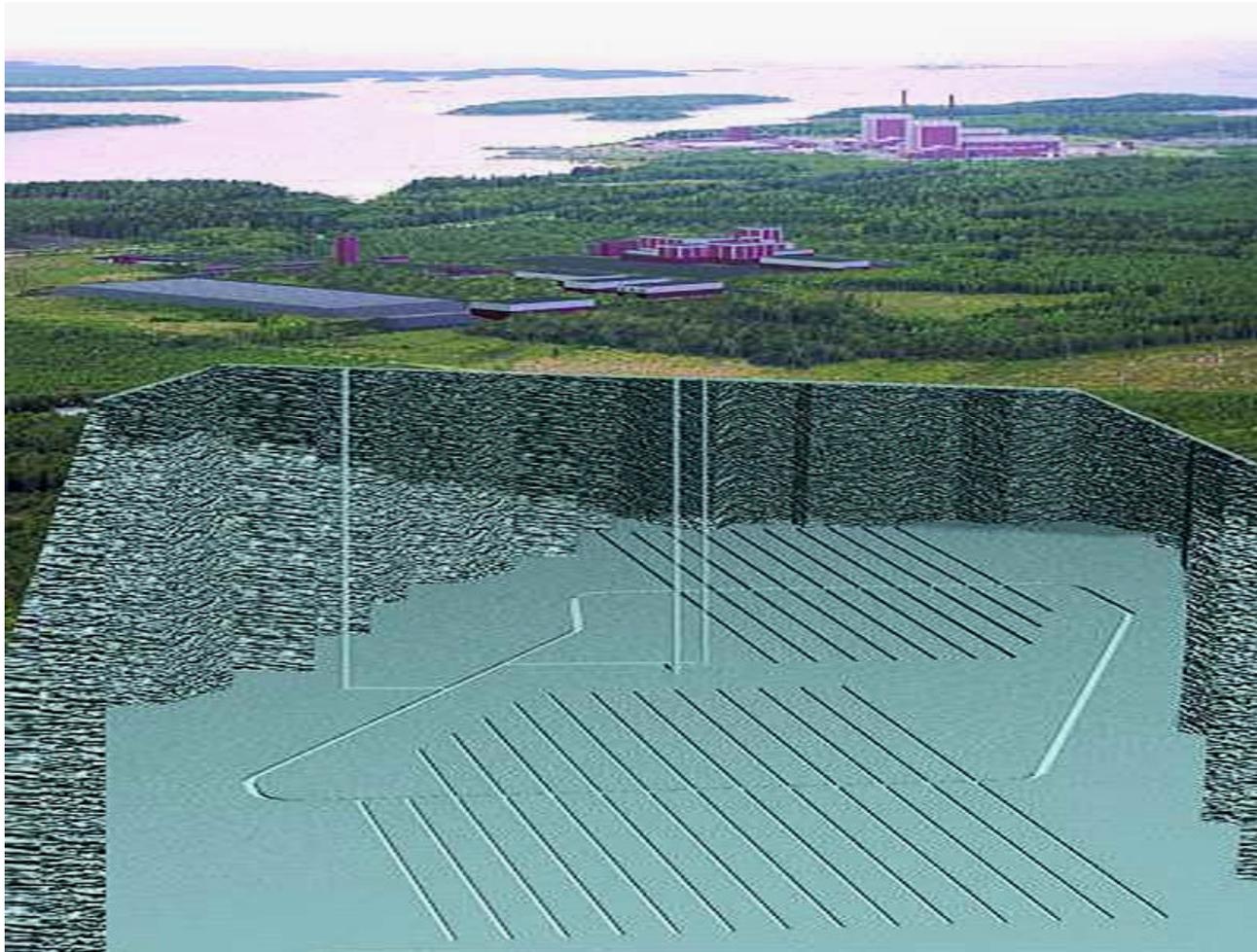
- **Technical solutions are available for geological disposal but only one, WIPP in USA in operation for long-lived LILW.**
- **Good progress for repositories for HLW or spent fuel in USA, Finland and Sweden**
- **Efforts need still to be focused on societal issues to solve the problem of siting (stakeholder involvement in decision-making process). Stepwise approaches are being applied**
- **Geological repositories are designed to be passively safe through multi-barrier system**



Barriers for Geological Disposal



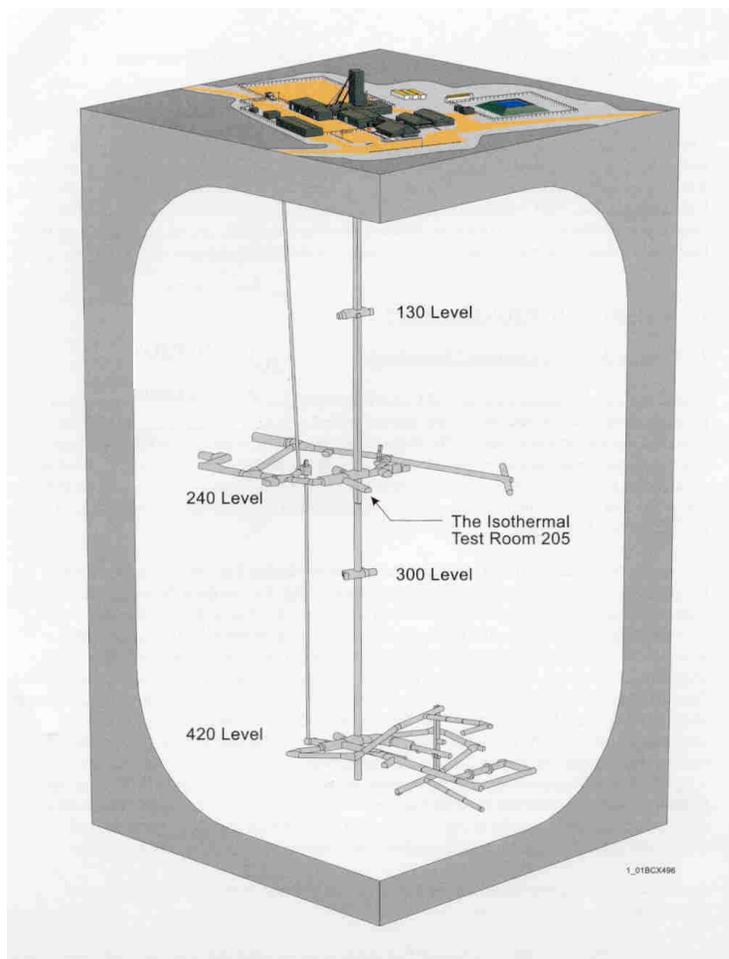
Eurajoki (SF): NPP site of Olkiluoto



Yucca Mountain (USA)



Underground Research Laboratories



Spent Fuel Management

- **10 000 tHM/y spent fuel unloaded**
- **About 20 – 25 % is reprocessed. Industrial reprocessing in France, UK and Russia (and Japan and India). Pu recycled in MOX fuel.**
- **Increasing interest in recycling for the long term**
- **Most spent fuel still stored
Good experiences with storage**
- **No geological disposal facility in operation. Delays in many programmes**
- **Long term storage is becoming a reality**



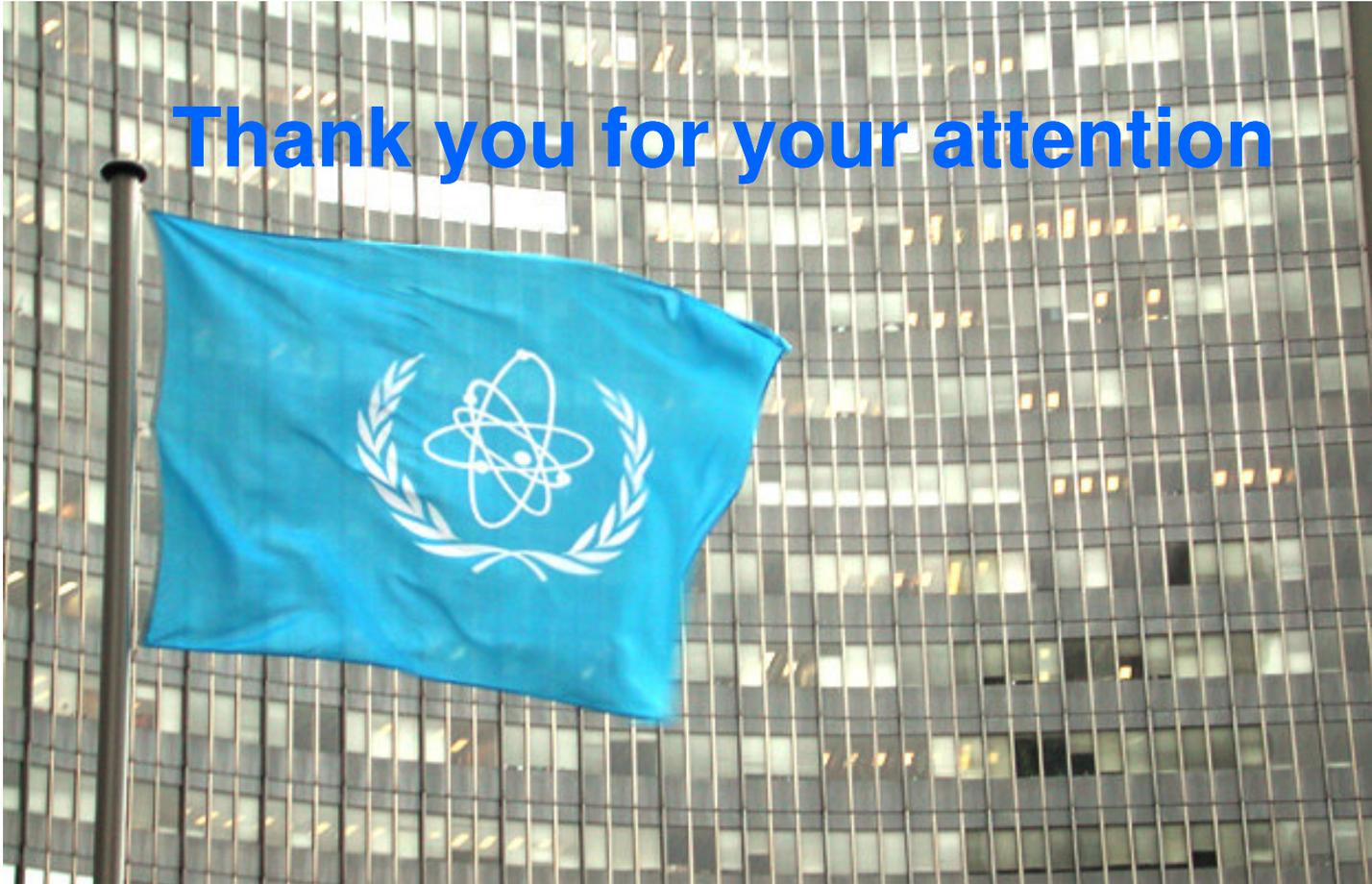
Joint Convention on the Safety of Spent Fuel and the Safety of Radioactive Waste Management

- *Represents a commitment by participating States to achieve and maintain a consistently **high level of safety** in the management of spent fuel and of radioactive waste for ensuring the **proper protection** of people and the environment*
- *43 contracting parties (January 2007)
98 % of HLW/SNF, ~ 90 % LILW,
30 % of Member States*
- *In force since 2001*
- *First review meeting - November 2003*
- *Second review meeting – 15–24 May 2006*



IAEA

Thank you for your attention



...atoms for peace.