Final disposal of radioactive waste – Research at Chalmers

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Final repository for radioactive waste – a multi-barrier concept

The Swedish concept for a final repository for radioactive waste consists of a set of facilities, each engineered to handle different kinds of radioactive waste under different timescales.

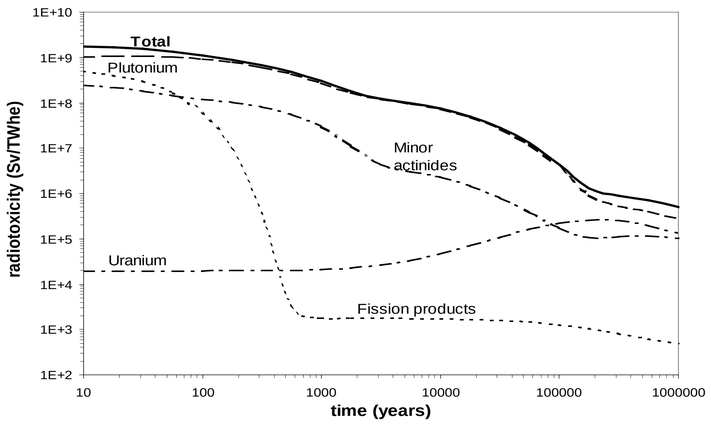
•CLAB (Centralt Lager för Använt Bränsle) is an interim storage facility for spent nuclear fuel. The fuel is kept in water pools for 30-40 years to cool down before transport to SFL. Operational: 1985. Capacity: 8 000 tonnes of fuel

•SFR (Slutförvar För Radioaktivt driftavfall) handles operational waste from the Swedish nuclear power plants and consists of several rock vaults and a silo were waste packaged in concrete and steel containers are placed for up to 500 years. Operational: 1988. Capacity: 63 000 m^3.

•SFL (Slutförvar För Långlivat radioaktivt avfall) is the planned final repository where long-lived radioactive waste will be kept for up to 100 000 years. It will be built at 500 m depth in the granitic bedrock near Forsmark. SFL 2 will house high level nuclear waste, whereas SFL 3-5 will house the intermediate level waste. The facility will consist of rock vaults with deposition holes, accessed via a tunnel system. A multi-barrier concept (see Figure below), protects the environment. Operational: 2023. Capacity: about 40 000 m^3

What are the time-scales?

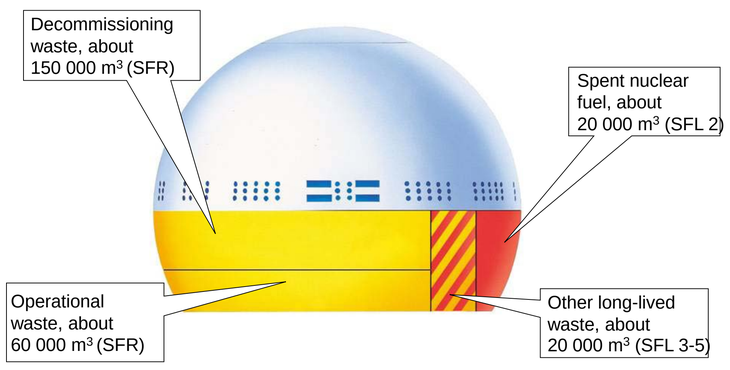
- The fission products decays in 1 000 years
- Pu and minor actinides reach levels of natural uranium first after 100 000 years



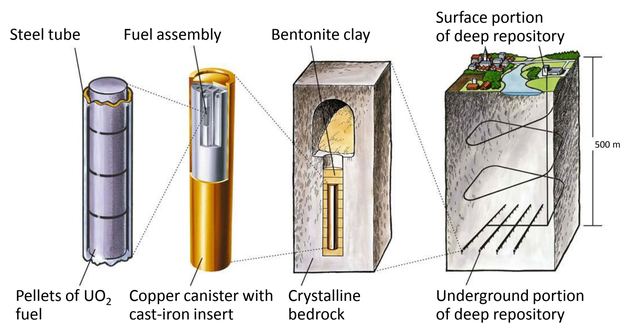
How much waste is there?

•The largest volumes are low-level waste from decommissioning of nuclear plants

•The largest amount of radioactivity will be in the spent fuel itself



The multi-barrier concept in SFL



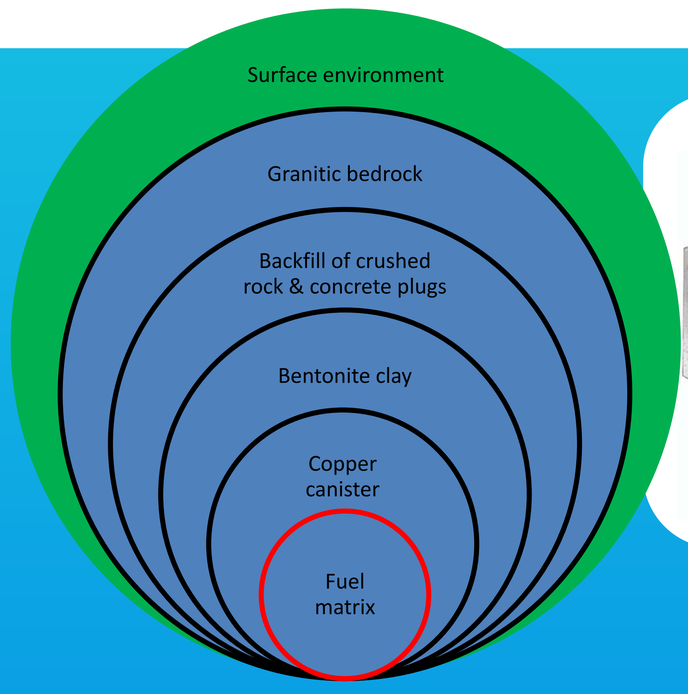
Several barriers hinders the fuel to get in contact with the environment:

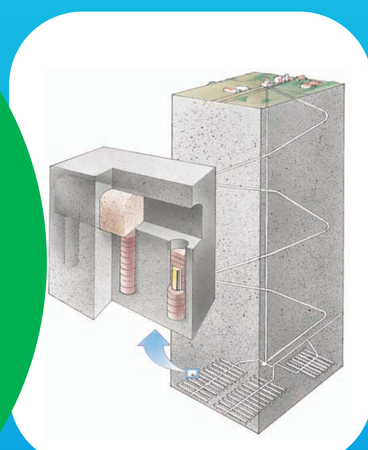
•low solubility of the UO_2 fuel

•very slow corrosion of the copper canister

• compacted Bentonite clay hinders water transport

• 500 m depth of granitic rock in low conductive zone





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Dissolution - under what conditions and how fast can the fuel dissolve if contacted with water?

Diffusion – how fast can dissolved waste move in stagnant water zones?

Complexation– how does dissolved waste react with other compounds in the water?

Precipitation – under what conditions and how fast can dissolved waste precipitate to secondary solid?

Sorption – how much of the dissolved waste becomes attached to surfaces?

The Research at Nuclear Chemistry concerns a worst case scenario

The worst case scenario of a broken copper canister will bring the fuel in contact with the groundwater. A number of processes, most of them of chemical nature, will then limit the spread of radioactivity to the environment:

•**Fuel dissolution**: UO_2 is the primary solid phase. How fast is the dissolution of this solid and what conditions will influence the process?

•**Precipitation**: once dissolved, the waste may precipitate to secondary solid phases. How can these be characterized?

•**Complexation**: describes reactions between dissolved waste and other chemicals present in the environment. Which are these reactions?

•**Diffusion**: the process of diffusion is the only way the dissolved waste can spread in stagnant water zones. How fast can the waste diffuse?

•**Sorption**: sorption describes how dissolved waste reacts with solid surfaces and may become fixed to them. The most important surfaces are those consisting of bentonite clay, granite and concrete. How strong do the waste stick to these surfaces?

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