

# **Importance of the waste form from a safety assessment perspective: The SR-Site experience**

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SKB**

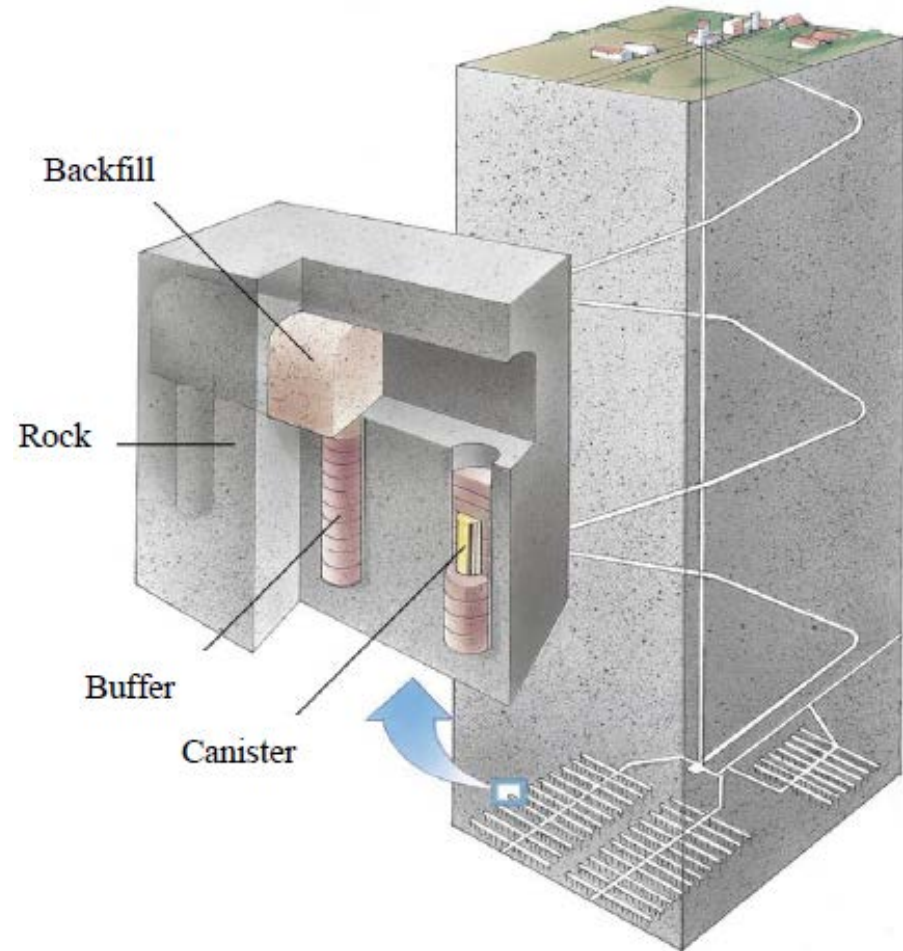
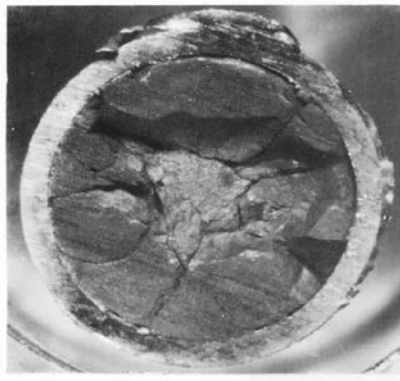
# Waste form considered in SR-Site

**Spent nuclear fuel**

**UO<sub>2</sub>: BWR and PWR reactors,  
some MOX**

**Direct disposal**

**Canisters in bentonite  
at ca 500 depth in crystalline bedrock.**



# SR-Site safety assessment: input data (I)

**The whole repository system**

**Data from site investigations & analyses of material properties**

**Waste form plays a central role:**

**Instant Release Fraction (IRF),  
Corrosion Release Fraction (CRF),  
Dissolution rate, and Solubilities.**



# SR-Site safety assessment: input data (II)

**IRF, CRF**

**Dissolution rate**

**Solubilities**

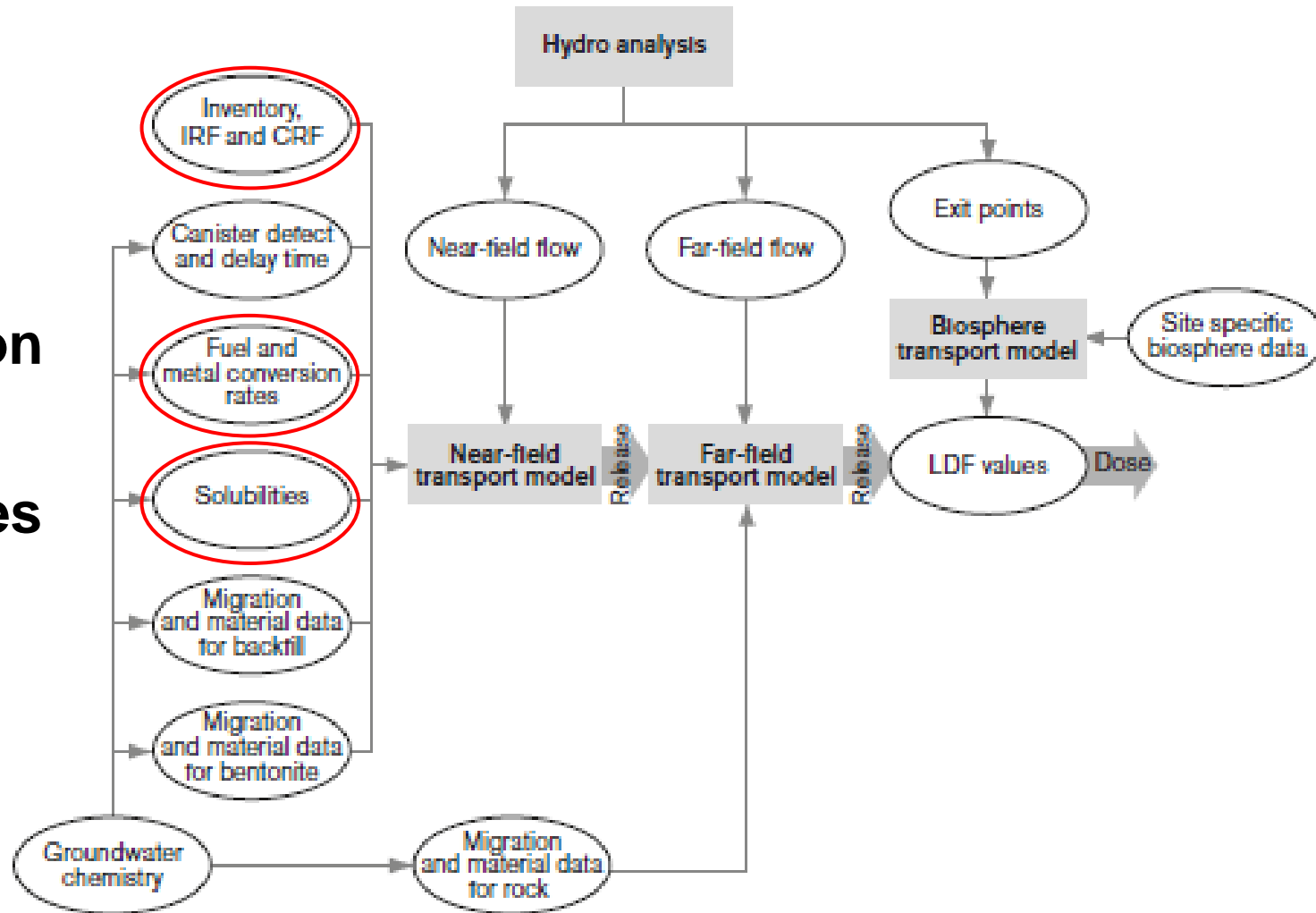


Figure 13-12. Models and data for the consequence calculations.

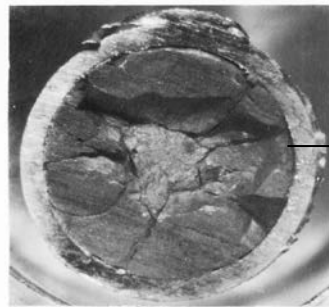
# Radionuclide release

When water gets in contact with the waste!

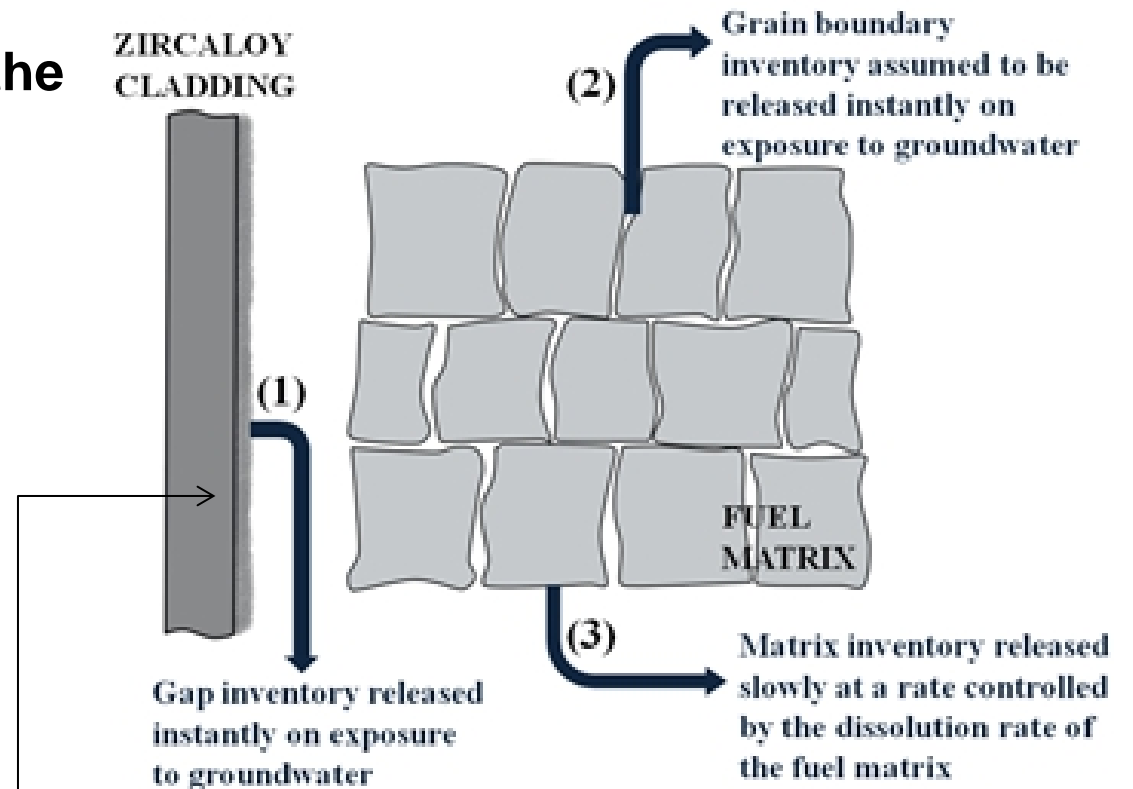
How and when are radionuclides released?

Distribution in the different parts of the fuel.

Example IRF: I-129 and Cs-137.



**+ metal parts**



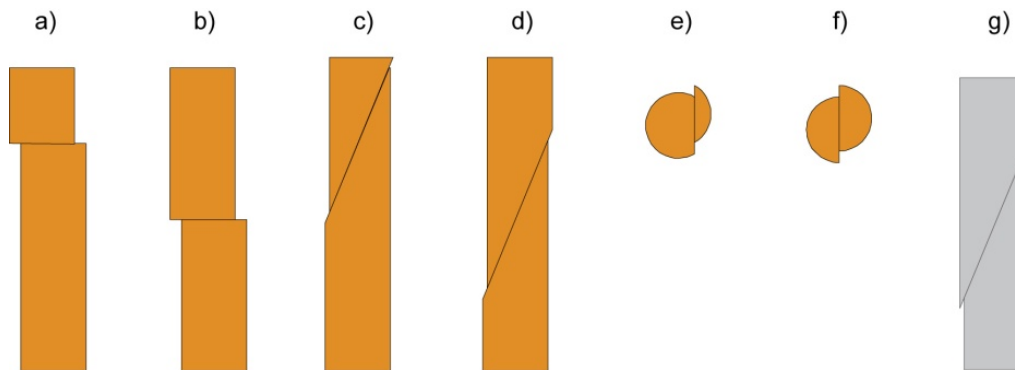
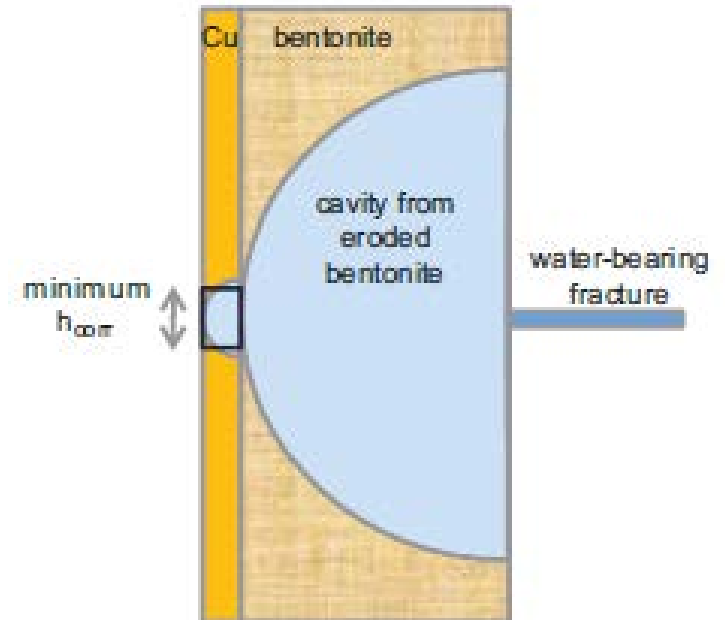
# Scenarios: effect on barriers

**Evaluate the probabilities for containment failure**

**Describe the consequences, in terms of dose and risk**

**Primary safety function: containment**  
**Secondary: retardation**

**Consequence of containment failure: Radionuclide release and transport**



# Consequences in failure scenarios

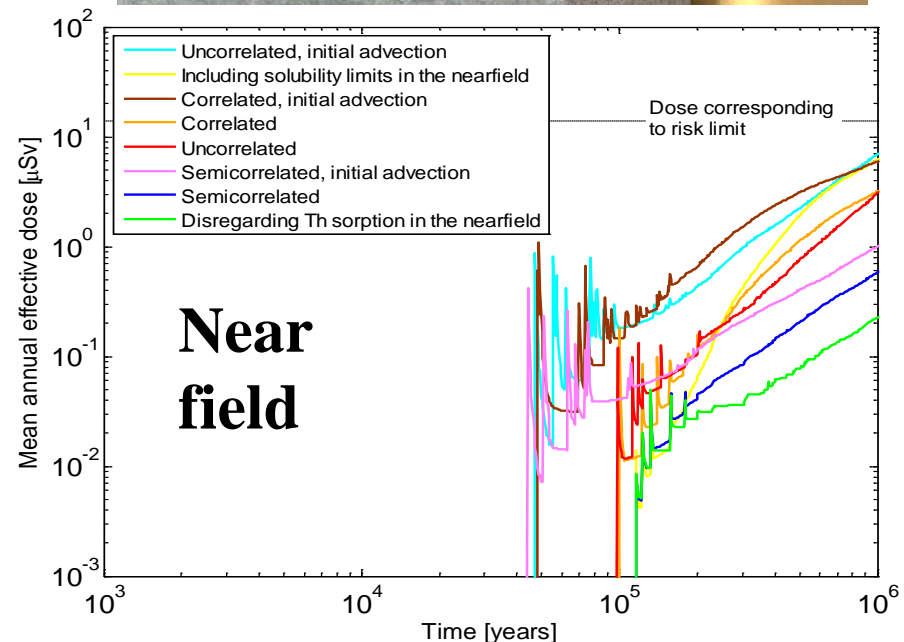
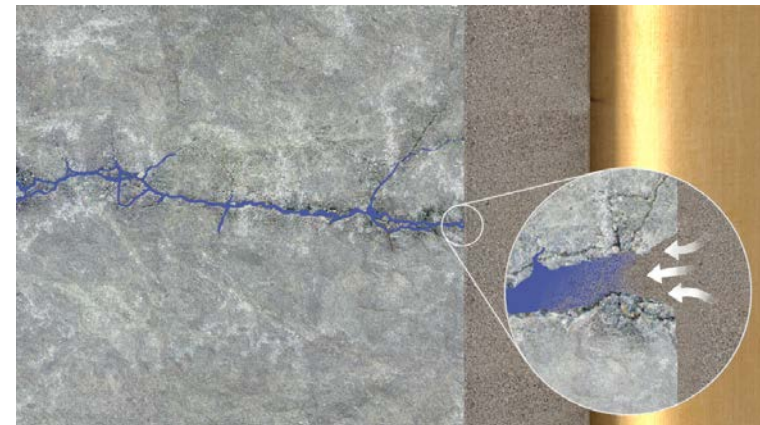
**Example:**

**Canister corrosion  
& bentonite erosion:  
0.12 canister in 1 Ma.**

**“High” flow rate deposition holes  
high erosion rate, high corrosion rate**

**Fuel dissolution rate significantly  
impacts the result**

**Importance of the stability,  
in the repository environment,  
of any other and future waste forms**



# Some reflections

Providing input data vs. the larger view:

How to choose data - sound scientific method!

Decades of research for fundamental process understanding

Any safety assessment concerning geological disposal of nuclear waste requires a research programme devoted to the stability of the waste form.



Rapid aqueous release of fission products from high burn-up LWR fuel: Experimental results and correlations with fission gas release

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**Fuel and canister process report for the safety assessment SR-Site**

Svensk Kärnbränslehantering AB

December 2010

**Technical Report**

**TR-10-46**

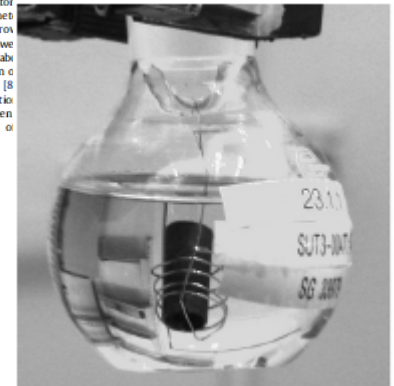
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Fission products from UO<sub>2</sub> and MOX fuel are of interest for the disposal of spent fuel, because of the associated potential contamination. Studies have shown that correlations between fission products released from various long-lived fission products can provide a useful indication of the release of fission products. Previously, these studies have been limited largely to fuel irradiated in PWR and BWR reactors. Collaborative studies involving SKB, Studsvik, Nagra and PSI have been conducted for a number of fuels irradiated in a research reactor. A method for analysis of leaching solutions for <sup>76</sup>Se was developed. The fractional release of <sup>137</sup>Cs is usually much lower than that of <sup>134</sup>Cs. Fractional <sup>137</sup>Cs releases are somewhat larger, but only for fuel irradiated in the core. Despite the expected high degree of fission <sup>137</sup>Cs and <sup>134</sup>Cs in the high burn-up rim, no evidence was observed from the rim region. The method for <sup>76</sup>Se analysis developed here, based on the detection limit, the results suggest that the release of fission products from spent fuel is lower than expected.

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of interest in safety assessments, because some of the preferentially released radionuclides (e.g. <sup>129</sup>I and <sup>36</sup>Cl) are both long-lived and geochemically mobile [5]. In PWR and BWR reactors, spent fuel is irradiated in PWR and BWR reactors composed of UO<sub>2</sub> pellets clad in Zircaloy. In recent years, the mixed oxide fuel (MOX) has also become more common. The operating conditions have a significant impact on fuel microstructure and on the segregation of some radionuclides from the fuel grains. In particular, fission gases and elements such as <sup>137</sup>Cs and <sup>134</sup>Cs can experience significant in-reactor release from spent fuel. Fission gas release (FGR) is a particularly important performance indicator for spent fuel.

important parameters and grain growth as linear growth rates exceeding about 10 μm in the rim of the fuel pellets. Structure changes [8] during leaching conditions have been observed. Rapid release of





# Without research programme...

**As illustration:**

**effect of lack of data and scientific understanding**

**Fuel residues in epoxy: estimate contribution to risk**

**– no research, no relevant data, what to do?**

**Conservative approach:**

**Epoxy-samples in one (1) canister**

**ca 3% of U compared with one normal**

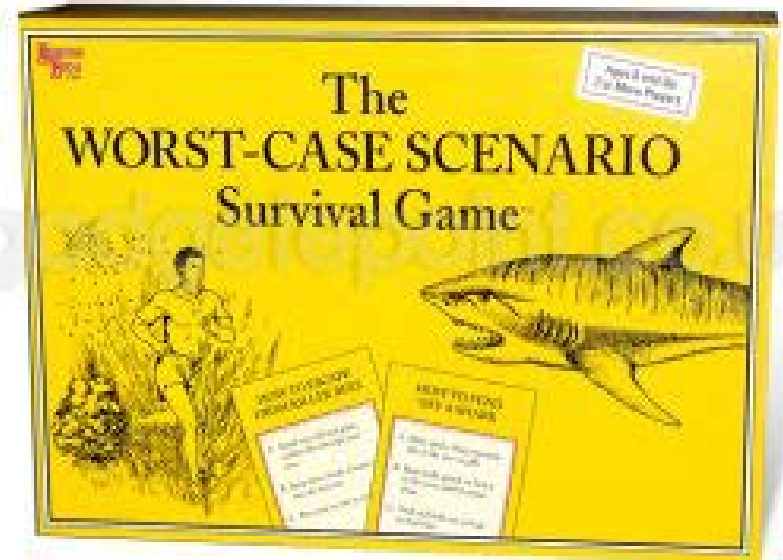
**PWR canister, ~ 0.0005% of all U in repository.**

**...BUT all this **assumed rapidly released.****

**Contribution of ca 5% of overall risk**

**- epoxy-U elevates risk a factor 10,000**

**compared to “normal” U**



**⇒ Unrealistic & extremely conservative estimation**

**Thank you for listening!**