Federal Office
for the Safety of
Nuclear Waste Management

Hypothetical measures on high-level radioactive waste

from the perspective of extended interim storage and final disposal

Results from a research project

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Federal Office
for the Safety of
Nuclear Waste Management

Site Selection Procedure - Germany

- Started in 2017
- Site selection will take several decades, followed by construction, operation, …
- Licences for interim storage were granted for 40 years (first to expire in 2034)

➡ New applications necessary for interim storage

Waste Inventory

Spent Fuel

© Posiva

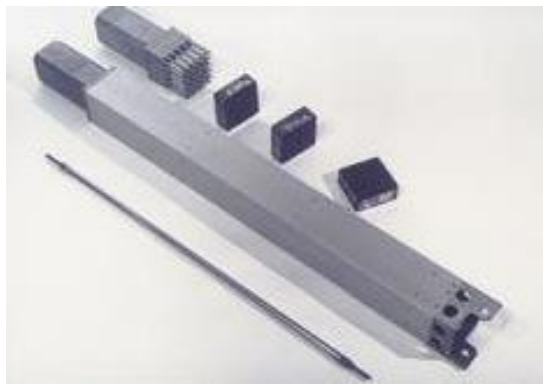
Vitrified waste

© CEA

Waste from Research and Test Reactors

© FZJ

© TUM



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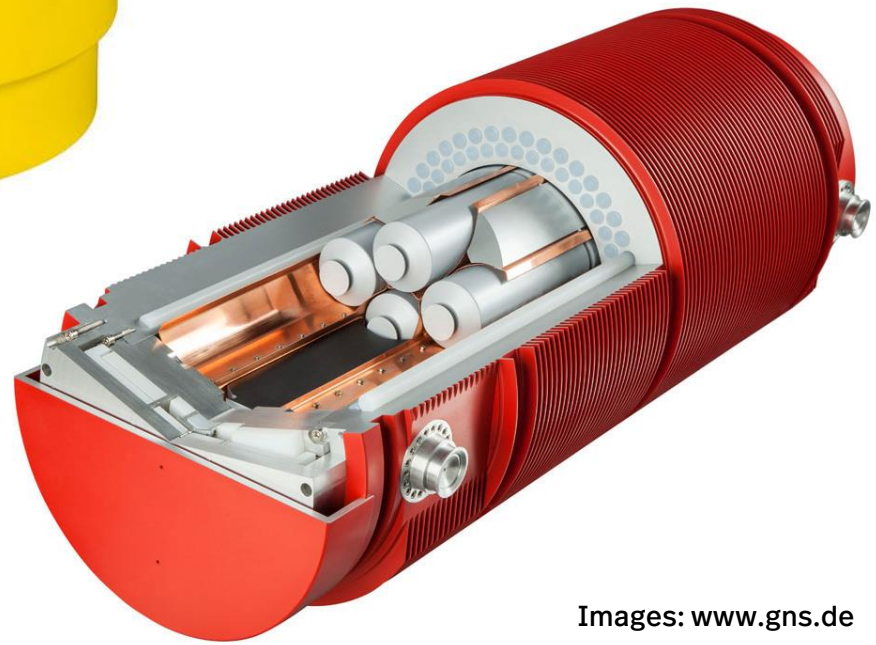
Dual Purpose Casks

Spent Fuel

Waste from Research and Test Reactors

Vitrified waste



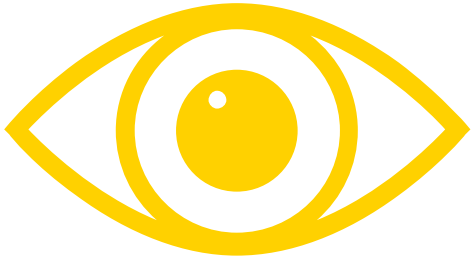
Images: www.gns.de

Hypothetical Measures?

Interim Storage	Conditioning?	Extended Interim Storage	Conditioning!	Repository

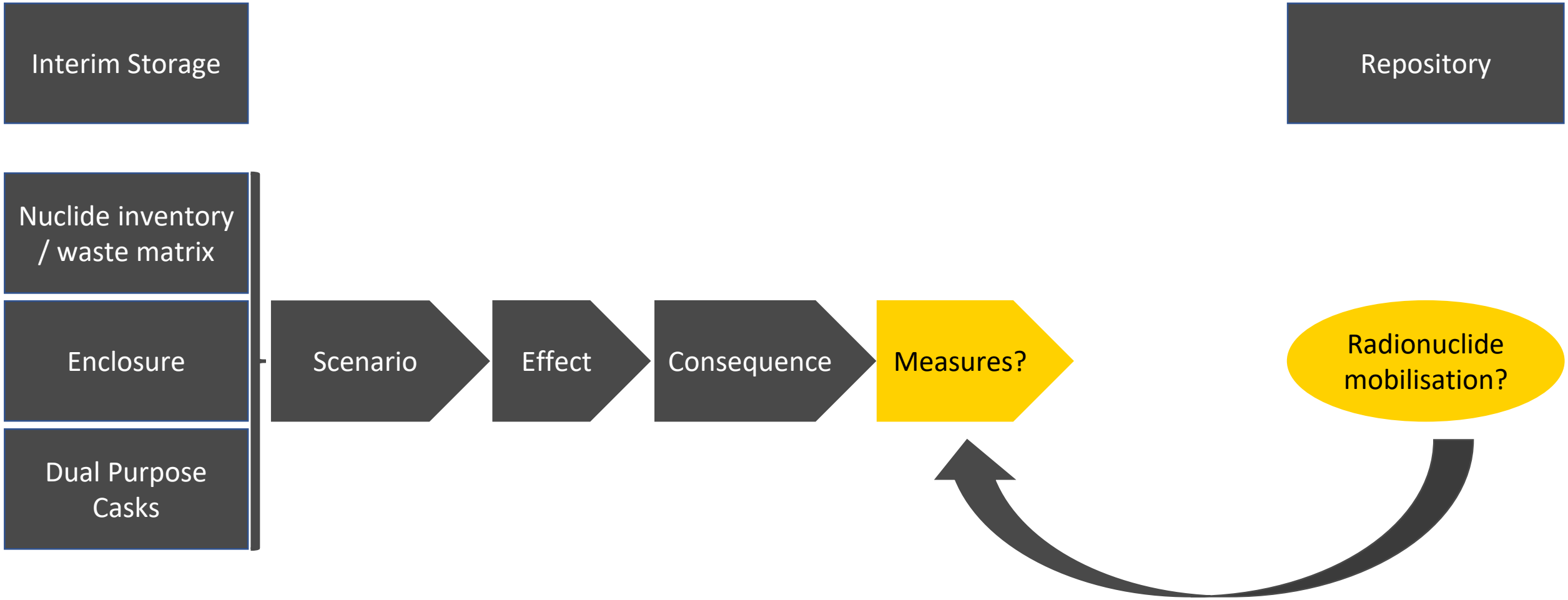
Interim Storage

- Currently, no evidence for systematic failures for up to 100 years (e.g. cladding)



- **Conceivable Scenarios:**
  Impairment of its safety by aging (e.g due to temperature, radiation and other effects of radioactive decay)

Hypothetical Measures?



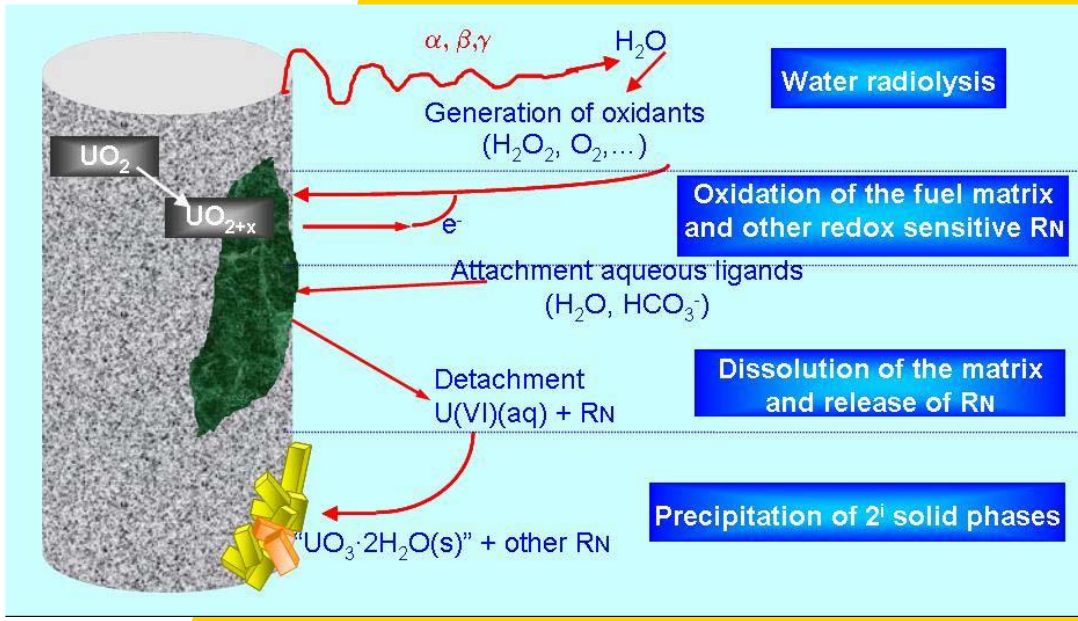
Disposal

Mobilisation and mobility of radionuclides

- Impact of interim storage and repository concept
- Near field

Method:

- Reference concepts with **boundary conditions:**
  - **Temperature:** Inventory (heat generation), loading of containers, distance, features of host rock and geotechnical barriers
  - **Fluid:** composition and availability



Taken from: Grambow et al., MICADO - Model Uncertainty for the Mechanism of Dissolution of Spent Fuel in Nuclear Waste Repository, ISBN 978-92-79-17652-4, doi 10.2777/25846

Reference Disposal Concepts

Salt (Former German)

- POLLUX® cask
- $T_{0,cask}$ = 200 °C

Clay (Swiss)

- Steel cask
- Bentonite (Mx-80)
- $T_{0,cask}$ = 150 °C

Crystalline (Swedish)

- KBS-3 (iron and copper cask)
- Bentonite (Mx-80)
- $T_{0,cask}$ = 100 °C

Assessment (Interim Storage)

	Hypothetical Measure	Inventory	Radionuclide mobility	Radiation protection	Handling
1	Thermal treatment	Vitrified rad. waste	lower	Possibly higher (collective) dose	no impact
2	Earlier removal from interim storage	All	No effect	Higher dose rate/ higher (collective) dose	identical
3	Heating	Spent Fuel (LWR)	No effect	Possibly higher (collective) dose	identical
4	Gentle procedures	Spent Fuel (LWR)	No effect	Possibly higher (collective) dose	identical

Assessment (Conditioning, repository)

	Hypothetical Measure	Inventory	Radionuclide mobility	Radiation protection	Handling
1	Ealier removal / conditioning	Vitrified rad. waste, spent fuel (LWR, WWER)	No effect / possibly earlier	Higher dose rate / Possibly higher (collective) dose	identical
2	Overpack, capsulation, welding	All	No effect / delayed	Possibly higher (collective) dose	restored
4	Thermal treatment	Vitrified rad. waste	Lower	Possibly higher (collective) dose	no impact
5	Heating / cooling	Spent fuel (LWR)	No effect	Possibly higher (collective) dose	restored
6	Interim storage DPC as disposal container	Spent fuel (LWR, RR)	No effect/ possibly delayed	Possibly **lower** (collective) dose	minimized

Summary and Results

- Proposal of hypothetical measures for extended interim storage and repository concepts
- Assessment of mobilisation of radionuclides in final repository

- ➢ Hypothetical measures could ensure or restore handling
- ➢ Most measures would increase the collective radiation dose
- ➢ Low impact on radionuclide mobilisation and mobility in repositories

Conclusions

- No mandatory measures regarding extended interim storage
- Measures depend on waste acceptance criteria of repository concepts

Images

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