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OPERATIONAL SAFETY AND RADIATION PROTECTION CONSIDERATIONS IN DESIGNING AN HLW REPOSITORY IN GERMANY

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Outline

- DBE TECHNOLOGY GmbH
- Reference disposal concept
- New approach to spent fuel direct disposal
- Operational safety
- Radiation Protection
- Incident Analysis
- Summary

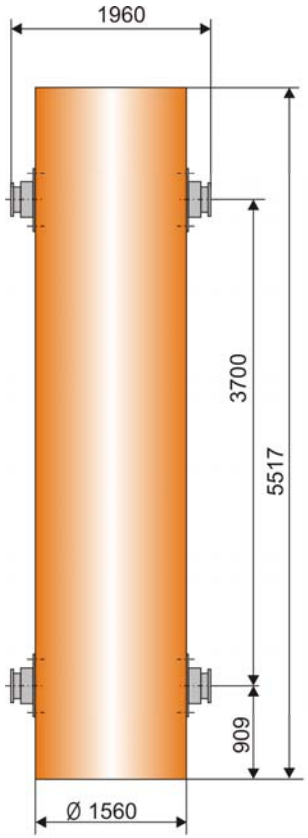
DBE TECHNOLOGY GmbH

DBE TECHNOLOGY GmbH provides consulting services for the management and disposal of radioactive waste and waste from uranium mining.

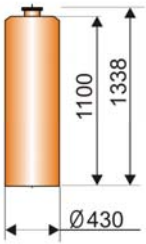
It relies on its own know-how and on that of its parent company, DBE, which as manager and operator plans, constructs, operates, and decommissions the German final repositories for radioactive waste.

Through dedicated R&D projects, DBE TECHNOLOGY GmbH expands its engineering basis to serve customers at home and abroad.

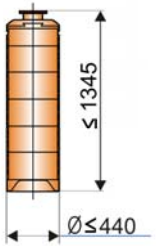
POLLUX Cask, HLW Canister and CSD-C Canister



POLLUX Cask = 65 t



HLW Canister = 0,5 t



CSD-C Canister = 0,85 t

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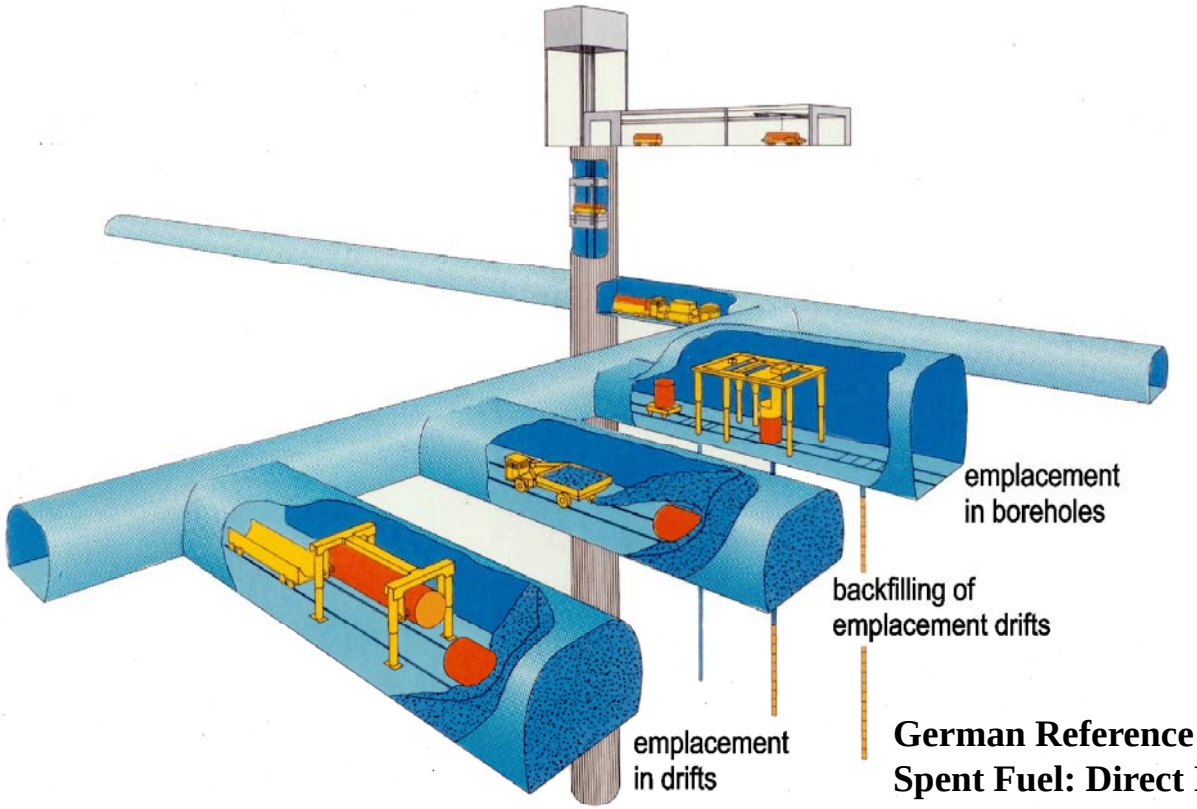
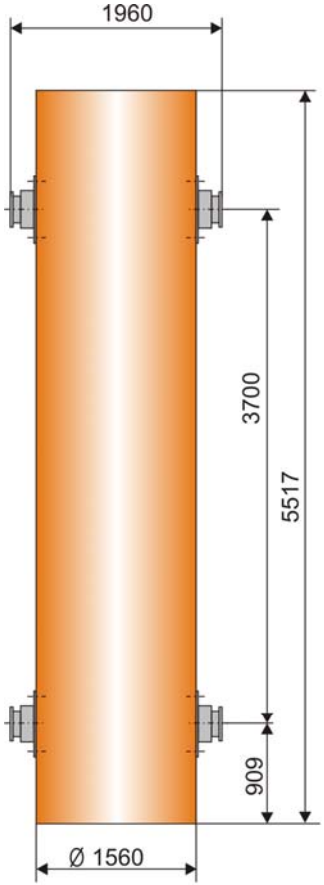
German Reference Concept



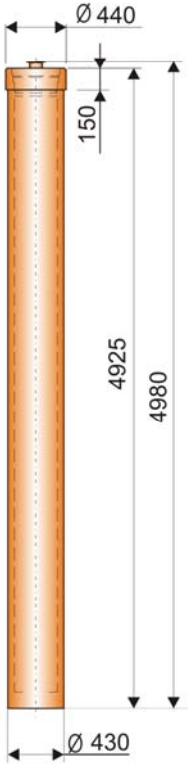
German Reference Concept for HLW and Spent Fuel: Direct Disposal in Rock Salt

- Deep geological disposal (depth: 870 m)
- Emplacement of HLW canisters in boreholes
- Emplacement of spent fuel casks in drifts
- Backfill material: crushed salt

New Approach to Spent Fuel Direct Disposal
POLLUX Cask and BSK 3 Canister



POLLUX Cask = 65 t



BSK 3 Canister = 5,2 t

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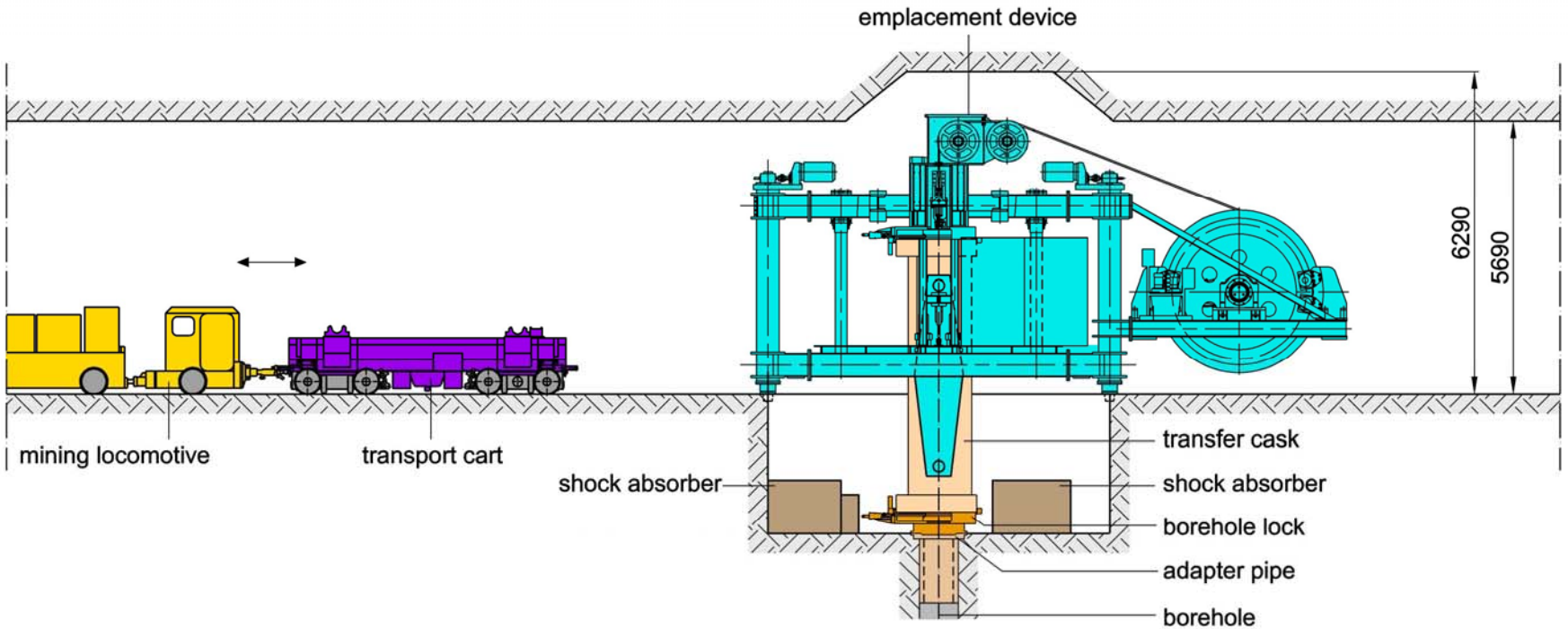
Borehole Emplacement System

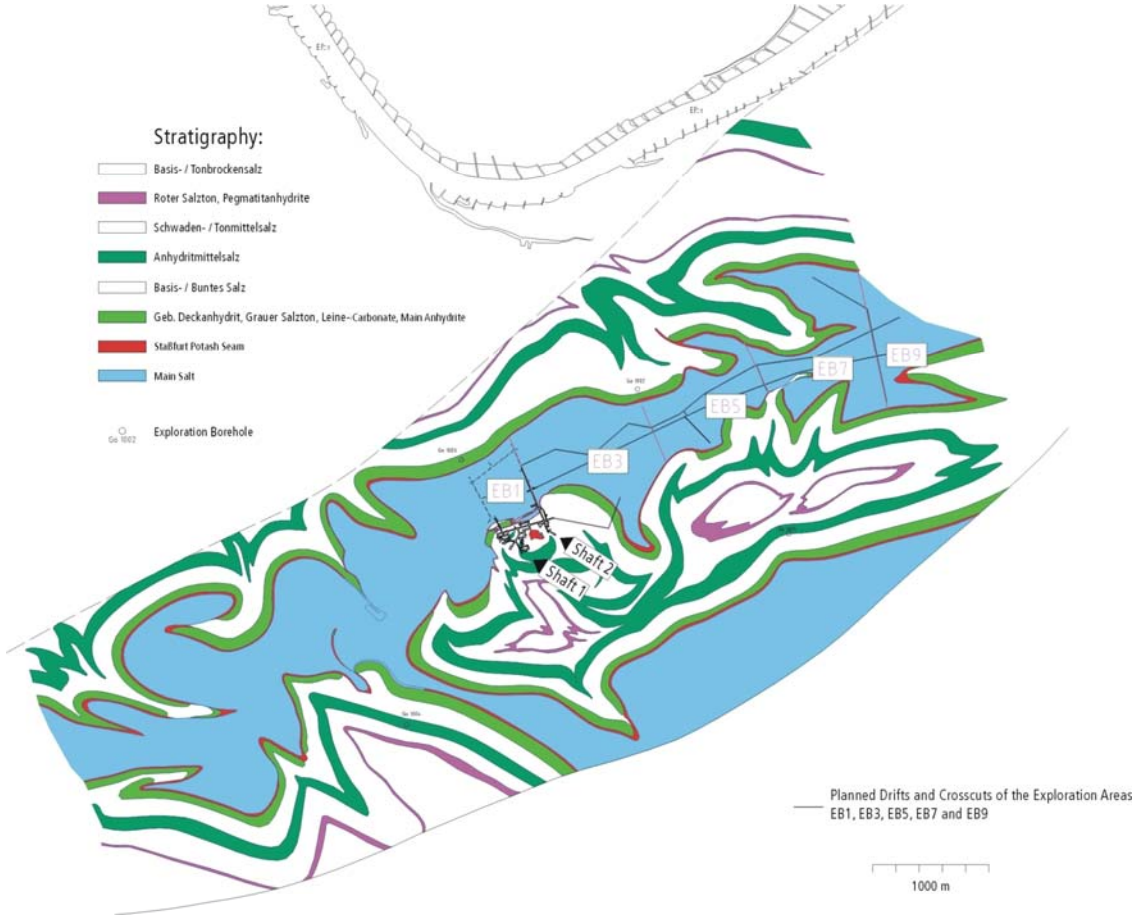


Operational Safety – Objective and Fundamentals

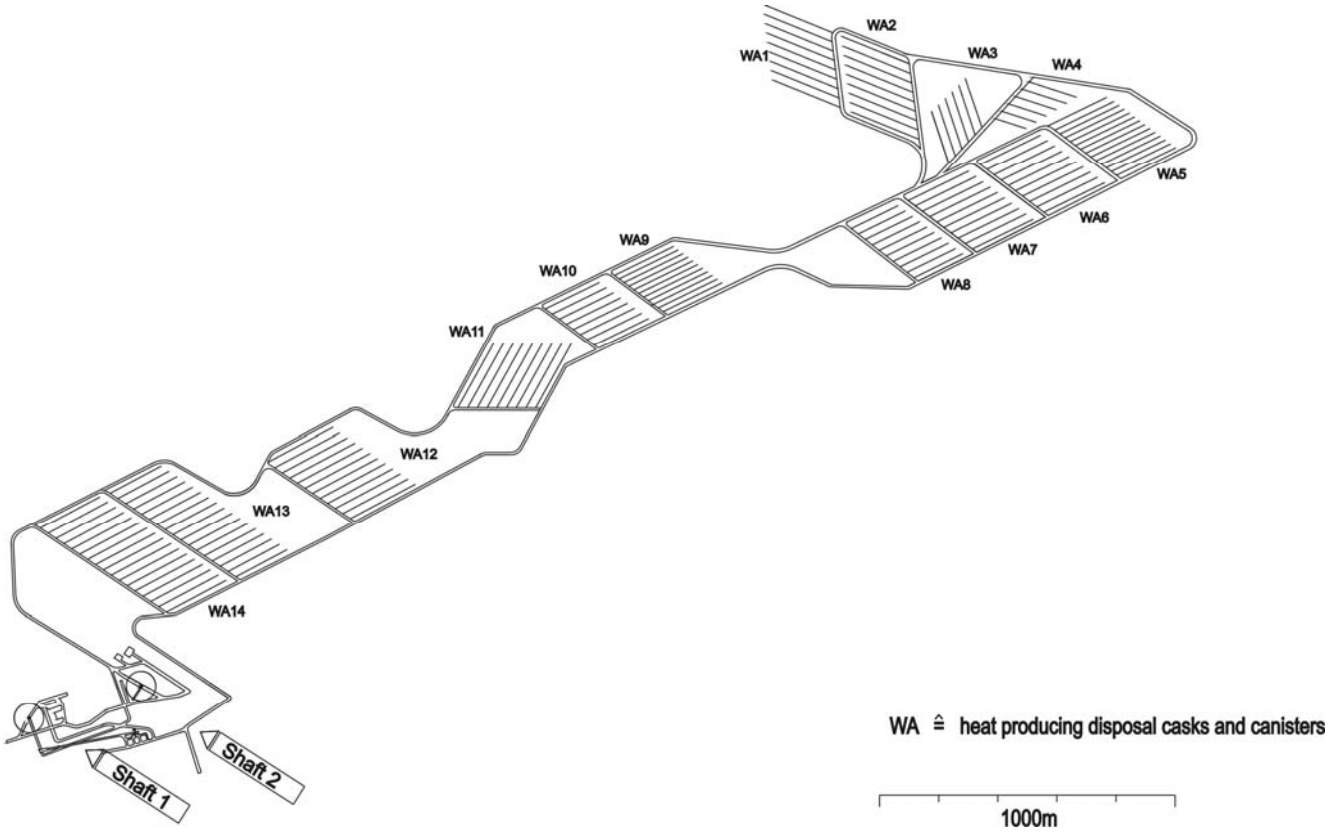
- Objective of the operational safety analysis
  - Identification of potential research requirements with regard to safety matter in the radiologically controlled area and the conventional part of the repository

- Fundamentals
  - Repository layout
  - Operational processes

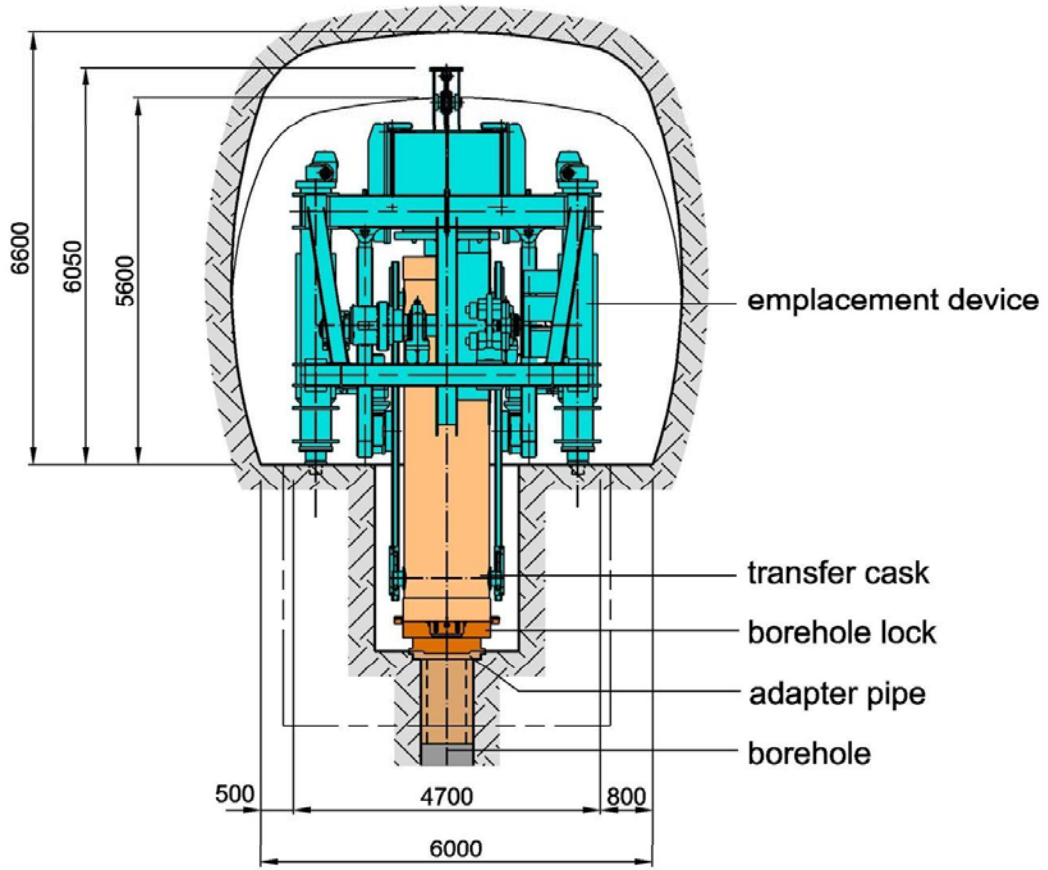
Gorleben – Prognostic Geological Map



Disposal Drifts



Cross Section of Disposal Drift



Analysis of Possible Impacts

- Ventilation failure (solved)
- Electrical power failure (solved)
- Rock mechanics effects (unsolved)
  - drift convergence
  - uneven floor uplift
  - roof safety / rock fall
  - excessive pressure onto disposed waste canisters in borehole
- Inflow of solutions and natural gases (unsolved)
- Internal fire (solved)
- Derailment of loaded transport cart (solved)

Open Questions

Main priorities for R&D work:

- Possible rock mechanics effects
- Consequences of inflow of solutions and natural gases
- Analysis of radionuclides that fall out in the mine after a release incident
- Acquisition of failure rate data for equipment and systems

Possible Rock Mechanics Effects

Assessment of:

- Convergence of the boreholes
- Convergence of the drift
- Influence of the decay heat from the waste

Inflow of Solution and Natural Gases

- Inflow into a drift
- Inflow into a borehole
- Inflow of hydrocarbon gases into a borehole

Fallout in the repository mine

- Beneficial effect of the fallout of airborne radioactive particles created during accidents

Acquisition of Failure Rate Data

- For Equipment & System
  - data on failure rates must be obtained
    - ➢to perform a probabilistic safety analysis

Best option:

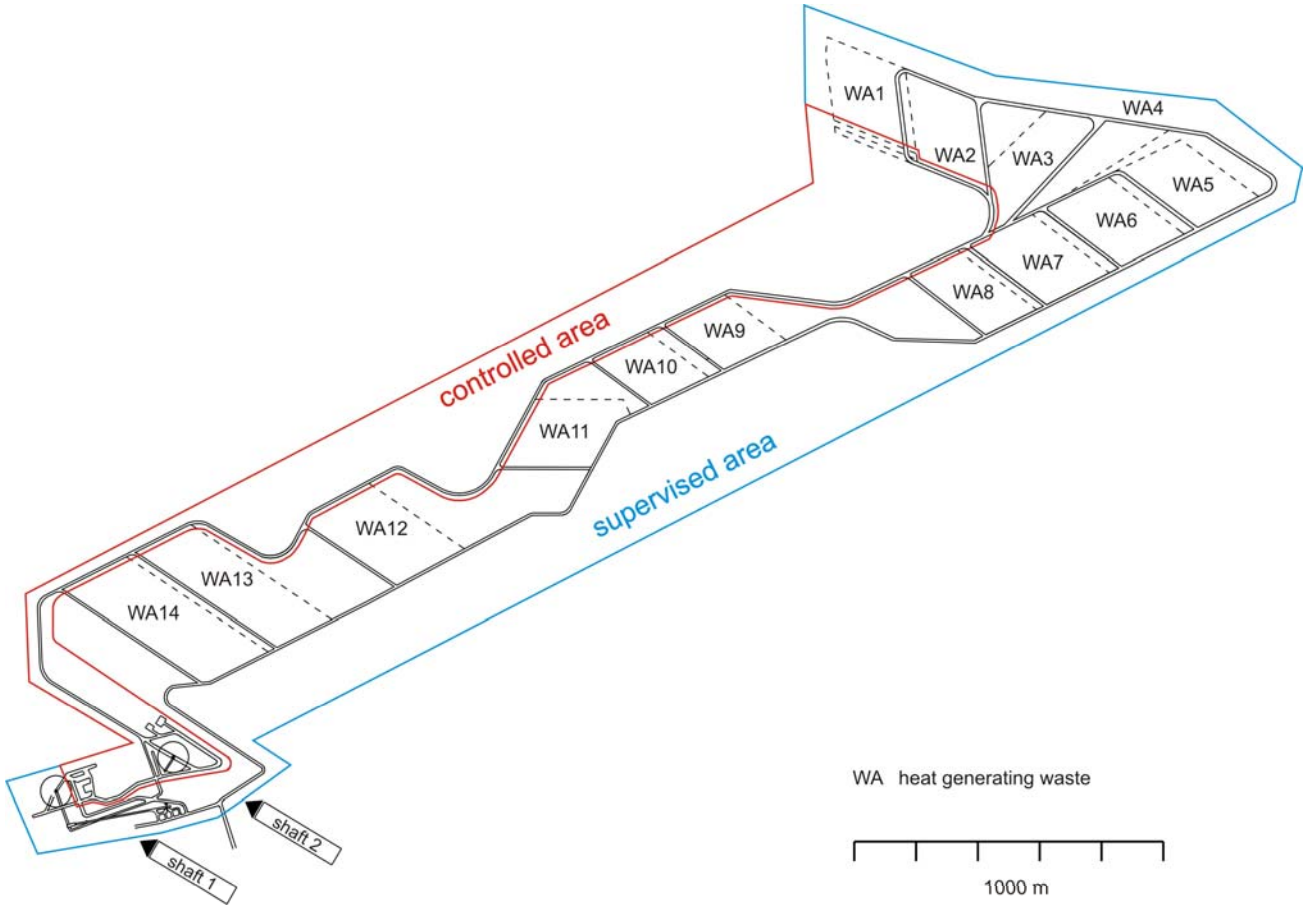
- Dedicated tests
  - sufficient number of cycles
  - adequate scale

Radiation Protection

- Radiologically controlled areas
  - handling and disposal of waste packages above ground and underground

- Supervised areas
  - conventional mining

Location of Radiation Protection Areas



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Incident Analysis

The proof of accident control is done by means of a safety analysis.

- In this case, it will be distinguished between deterministic and probabilistic safety analysis.

Deterministic Safety Analysis

- Proof of completeness
- Compilation of relevant effects
- Determination of design basis accidents
- Proof of the required precautions against damages

Proof of Completeness

- Description of emplacement procedure
- Compilation of activity inventories
- Specification of the possibilities of release considering existing barriers
- Determination of the basic radiological principals

Compilation of Relevant Effects

Internal effects

- criticality
- canister crash
- mechanical damage by fall of heavy loads or by vehicle collision
- cage crash
- rope slide
- cage overwinding
- disturbance of heat dissipation
- failure of safety-relevant systems

Compilation of Relevant Effects

Internal effects (continued)

- fire
- explosion
- rock mechanics accidents
- intrusion of mine waters
- gas generation
- gas leakage
- operating error (human error)
- actions of third parties

Compilation of Relevant Effects

External effects

- aircraft crash
- effects of hazardous materials
- earthquake
- lightning strike, floods, wind, ice, snow
- external fire
- gas leakage
- other site-related effects

Determination of Design Basis Accidents

- Examination whether possible events and event combinations could lead to considerable activity release
- Selection of subsystems for detailed analyses

Proof of the Required Precaution against Damages

Description of

- initiating events
- course of events
- barriers becoming effective
- consequences mitigating measures

Probabilistic Safety Analysis

Currently, there is no licensing requirement to perform probabilistic safety analyses for a final repository

Results of the PSA should

- supplement the deterministic safety assessment
- be used to determine the necessity and urgency of safety improvements
- be able to find weak points by comparing the frequencies of individual non-controllable system conditions
- facilitate the safety equilibrium of the system concept

Conclusion

1. Resolve all open issues regarding the operational safety
2. Meet the requirements of radiation protection
3. Perform the incident analysis

Result: The HLW repository can be licensed based on the parameters considered in steps 1 to 3

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Thank you
for your attention.