Long-Term Safety of Deep Borehole Disposal in Comparison with Disposal in a Mined Facility

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Based on work performed under contract from the Swedish Nuclear Fuel and Waste Management Co., SKB
Outline

• Why has SKB done work on DBD?
• Concepts compared
• Important safety functions
• Pertinent questions about DBD … and answers?
• Conclusions for the Swedish situation
Why is SKB involved in DBD

• Diverse research programme on the management of nuclear waste and the decommissioning of nuclear facilities required since 1984 by the Act on Nuclear Activities

• Projects on assessing and ranking several repository concepts including DBD launched in the second half of the 1980s

• An EIA must describe “alternative embodiments” - NGOs pushed the DBD issue in the public consultation process – work has been going on since 2005
Concepts compared

KBS-3

DBD

- 914 mm borehole
- 762 mm casing
- 711 mm borehole
- 610 mm casing
- 566 mm borehole
- 473 mm casing

Perforated 406 mm casing hanging from 473 mm casing at 3000 m depth. Non-perforated and uncemented from 3000 m to the surface.
Important safety functions

KBS-3
- Long-term containment in corrosion resistant canister
- Canister protected by a compacted bentonite buffer
- Reducing conditions
- Low flow rates and retardation
- Many safety assessments

DBD
- Hard to obtain a long-term containment EBS
- Stagnant, density-stratified groundwater
- Reducing conditions
- Low groundwater turnover
- Long migration path
- No comprehensive safety assessments
Pertinent questions for long-term safety of DBD

• Availability of sites with suitable density stratification of the groundwater and long-term stability of the stratification under natural conditions?

• Influence of the repository on the groundwater stagnancy?

• Sealing needs and challenges?
Availability favourable site conditions and their stability?

Model formulated 1998 based on four boreholes:
- Gravberg 1, KLX02, Böttstein, RH-12
- Not contradicted by newer observations

Long-term stability affected by:
- Washing out
- Land uplift due to post-glacial rebound
Influence of a DBD repository

Gas due to corrosion

- Single-phase vapor
- Gas plug flow hydraulic lift
- Annular flow
- Slug flow
- Bubbly flow

Thermal buoyancy
Sealing needs and challenges
Sealing needs and challenges

Rock stresses lead to breakouts in the borehole
DBD Conclusions

- Difficult to design and implement an EBS providing long-term containment
- Risk of contamination of the groundwater around the deposition zone within the first 1000 years
- The repository introduces buoyancy forces resulting in risk of vertical transport of contaminated groundwater
- Rock stresses will likely deform the hole making efficient sealing difficult
- The depth complicates both site investigations and the disposal process
- Dose assessments are premature

- Too many question marks to make the concept attractive for Swedish conditions