# Development of long-term safety requirements for an alternative design variant (KBS-3H) for spent fuel disposal

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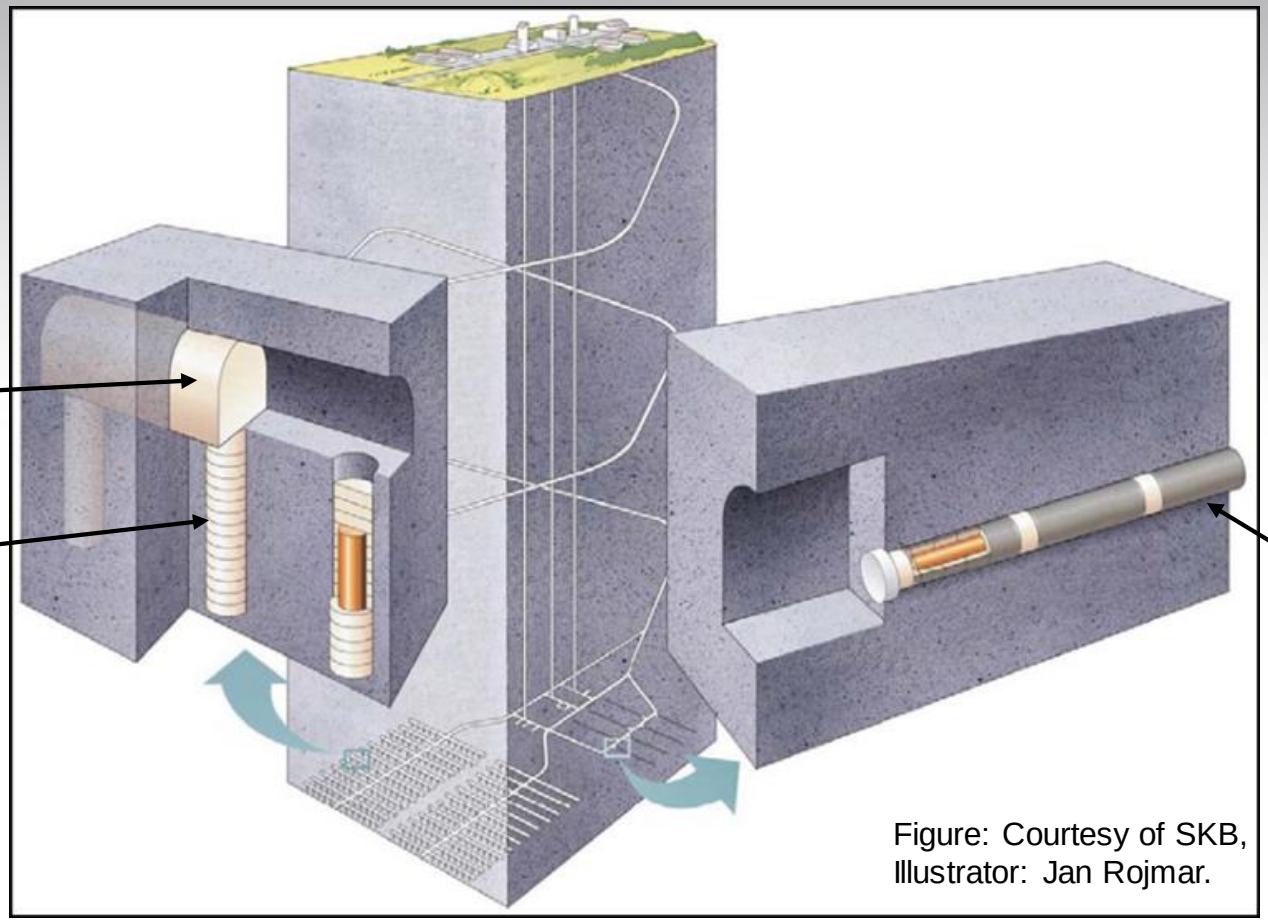
# Background on KBS-3H design alternative




KBS-3H is of interest because of several reasons, e.g. it minimises the volume of excavated rock and there is no need for deposition tunnel backfill

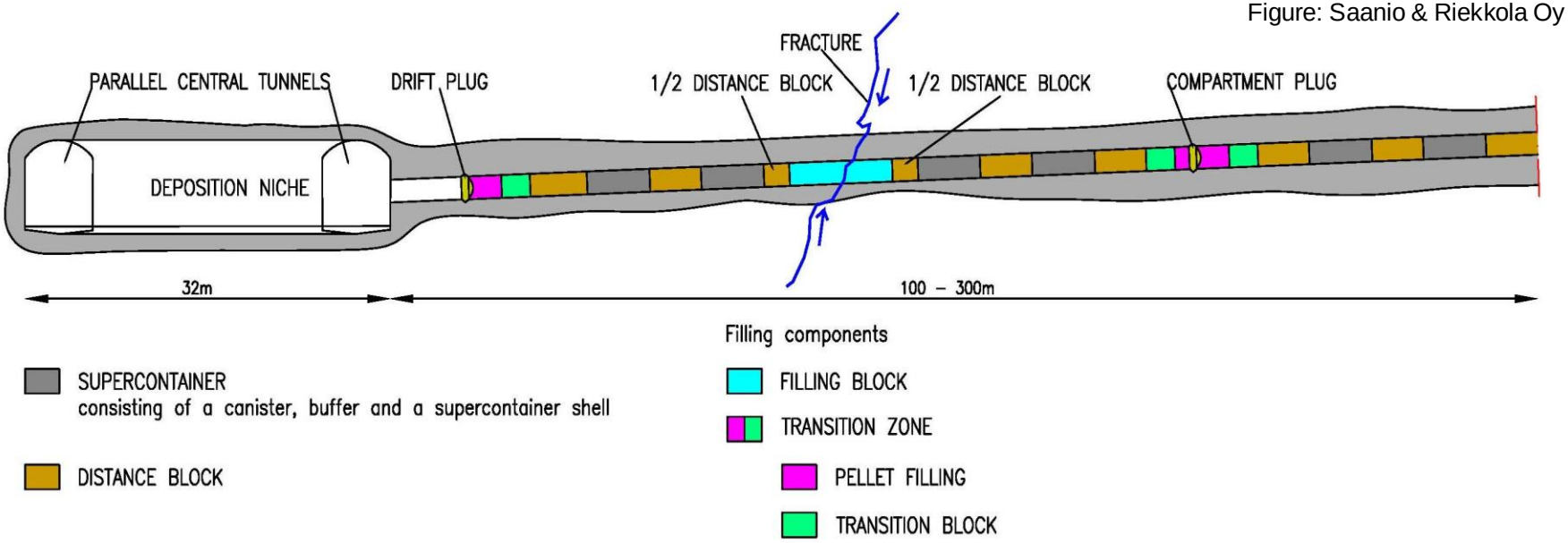
# Background on KBS-3H design alternative

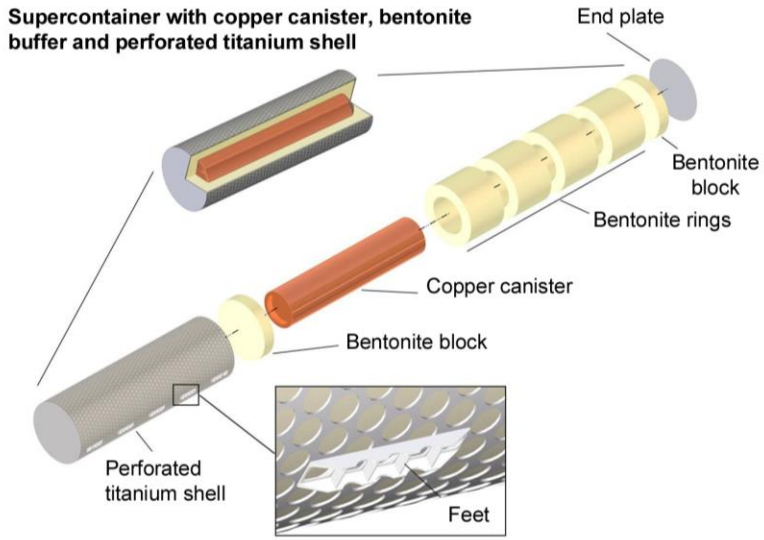
- KBS-3 method studied since the 1970s, KBS-3V being the reference design
- Horizontal variants proposed from early on, KBS-3H project initiated in 2002, a joint project SKB-Posiva
- First KBS-3H safety assessment for the Olkiluoto site in Finland 2003–2007*
- In Posiva's construction licence application for a spent fuel repository at Olkiluoto (2012), KBS-3H design variant was described as a potential alternative
- Ongoing: KBS-3H safety evaluation for Olkiluoto 2014–2016

* SMITH, P. et al., Safety Assessment for a KBS-3H Spent Nuclear Fuel Repository at Olkiluoto - Summary Report, POSIVA 2007-06, Posiva Oy, Olkiluoto (2007)

# Components of KBS-3H deposition drift

Figure: Saanio & Riekkola Oy




Supercontainer assembly. Courtesy of SKB. Based on Figure 4-4 of SKB Technical Report 2012-01/POSIVA 2013-03.

# Posiva's VAHA system

- Posiva's requirement management system VAHA* launched in 2007 (for KBS-3V)
- Five levels of requirements:

  Level 1: Stakeholder requirements
  Level 2: System requirements (including safety functions)
  Level 3: Performance targets and target properties
  Level 4: Design requirements
  Level 5: Design specifications

* VAHA = "Vaatimusten Hallinta", i.e. "Requirements Management" in Finnish

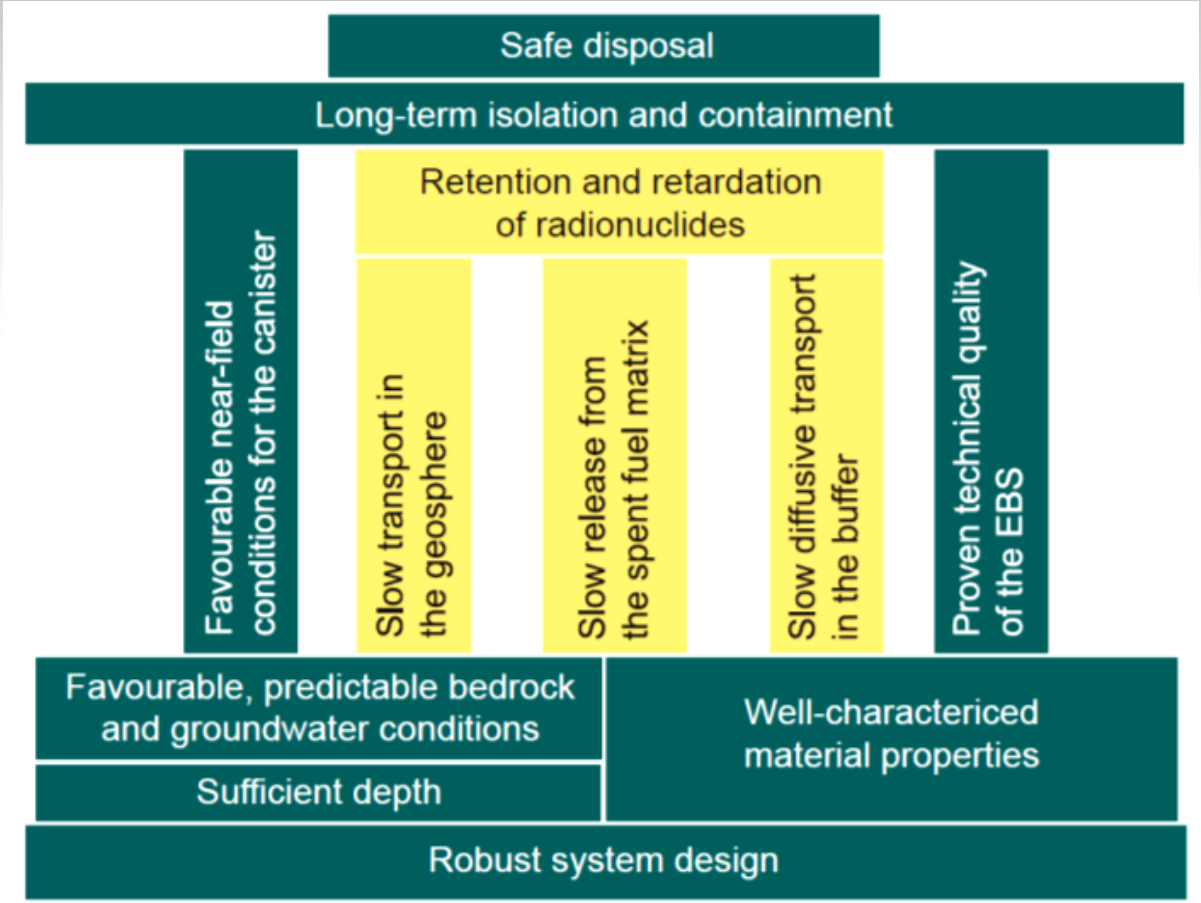
# Level 1/Stakeholder requirements

- Level 1 requirements are legal and stakeholder requirements that arise from laws, decrees, decisions-in-principle etc.
- Identical for both KBS-3V and KBS-3H
- **Example:** “The geological characteristics of the disposal site shall, as a whole, be favourable to the isolation of the radioactive substances from the environment.” (L1-STH-26) – based on Government Decree on the safety of disposal of nuclear waste 12 §

# Level 2/Safety functions of KBS-3H barriers

- The development of long-term safety requirements for KBS-3H starts by defining the release barriers of the system:
  - Canister
  - Buffer (in the supercontainers and in the distance blocks)
  - Filling components
  - Compartment plugs and drift plugs
  - Closure
  - Host rock

# Level 2/Posiva's safety concept



# Level 3/Performance targets

- Performance targets (PT) are derived from the safety functions and the expected loads during the long-term evolution
- PT is a quantitative criterion indicating the fulfilment of a barrier safety function,
  - e.g. mechanical strength of the canister
- The verification (i.e. the fulfilment of the PT) is assessed (via modelling) in the performance assessment
- A performance target is not a requirement, i.e. it does not need to be fullfilled at all times
- The performance targets drive the design requirements

# Performance targets – Example (preliminary):

## Host rock (ROC)
## Level 3 (L3)

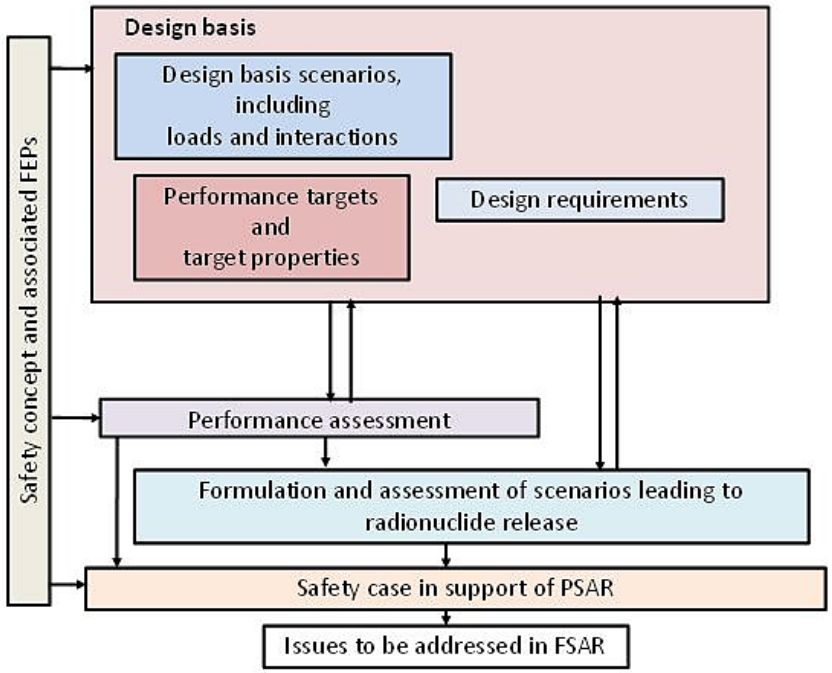
| ID | Level 3 - Subsystem Requirements - Host Rock (KBS-3H) | Reference | Section in this report |
|---|---|---|---|
| L3-ROC-15**H** | Groundwater at the repository level shall have limited salinity so that the buffer and **filling components** will maintain a high enough swelling pressure.<br><br>Therefore, in the future expected conditions the groundwater salinity (TDS, total dissolved solids) at the repository level shall be less than 35 g/l TDS. During the initial transient caused by the construction activities salinities up to 70 g/l TDS can be accepted. | cf. Posiva 2012, L3-ROC-15 | 6.3.2 |

# Levels 4 and 5/Design requirements and specifications for KBS-3H

- Design requirements and design specifications apply to the initial state; requirements must be verifiable during manufacturing and installation
- Level 5 is the most detailed level → more differences between KBS-3V and -3H than at higher levels
- Supercontainer shell is not a barrier and has no long-term performance targets, but some design requirements and specifications can be derived from the performance targets of (mainly) the buffer

# Challenges in the KBS-3H requirement development process (1/2)

- Significant iteration needed



# Challenges in the KBS-3H requirement development process (2/2)

- The regulatory requirements are themselves evolving along the development of the repository programme; requirement development work is thus “shooting at a moving target”
- Close co-operation is needed (i) between long-term safety, design and implementation, (ii) among barrier-specific experts, and (iii) with the regulator
- Requirements are a communication tool between various parties involved in the work

# Thank you for your attention!

## More information:

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Published KBS-3H reports:
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