Safe radioactive waste disposal: from vision to practice

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Spent fuel management organisation

**AUTHORISATIONS**
Ministry of Employment and Economy (TEM)

**OVERSIGHT**
Säteilyturvakeskus (STUK)

**RAD WASTE MANAGEMENT FUNDING**
Nuclear waste fund managed by TEM

Consulting firms, research institutes (e.g. VTT), universities
Status of spent nuclear fuel management in Finland

Total: 9000tU of SNF
4500 canisters
800-900 W/tU after 30y
Olkiluoto spent nuclear fuel repository
The KBS-3 method

- Sites: Olkiluoto (Finland), Forsmark (Sweden)
- Granitic host rock
- Depth 400-500 m
- Reducing conditions

KBS-3V    KBS-3H
System understanding
• Site
• Waste streams
• FEPs

Legal requirements & other constraints

Site characterisation, design & technical development

Disposal method

Design & technical development

Safety case

Next stage

Safety assessment
Finnish safety case

- Safety case for KBS-3V design (main)
  - Safety case for KBS-3H design (alternative) joint project with SKB
- Both developed according to the Nuclear Energy Agency and IAEA guidelines
- Structured as a report "portfolio"
### Complementary Considerations

#### Assessment of Radionuclide Release Scenarios for the Repository System

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3238 pages not including the supporting reports

- Safety case portfolio reports
- Main supporting reports
Lessons learned in geologic disposal of SNF

- Integrate site characterisation data (above and below ground) iteratively in repository layout and in safety case
- Apply a step-wise approach for the R&D programme
- Establish & manage the requirements early on
- Communicate effectively among site characterisation, repository design and long-term safety
Incorporating site data into the safety case
Lessons learned from the site selection process

• The site selection process approach should be stepwise and systematic in the early phases.
• Stepwise means that the results of the earlier phases are used to guide the investigations in the next steps.
• Focus on more site-specific features for the last sites.
• The suitability of the final site must be confirmed by underground investigations.
  – Ideally using an underground characterisation facility, as in Finland (ONKALO).
From site characterisation to Host Rock Classification
Lessons learned on management and cost estimates

- Understanding the interaction between design, costs and safety is essential
- Cost estimates should begin in the very early phase
- Cost estimates should be always in real-time
- Cost estimates show where to concentrate resources from the cost point of view
- Cost estimates are one of the tools for a successful project management
Case of Russian Federation geologic disposal programme

- Vitrified HLW (decay heat <1MWt/m$^3$)
- HLW (low decay heat) and ILW
- Example of a multi-purpose repository
- Conceptual repository layout shown as example in the next slide…
- **80 m**: Decommissioning Waste Repository (Large Scale Components)

- **195 m**: Low & Intermediate Level Waste (LILW) Repository

- **315 m**: Underground Research Laboratory (URL) and Demonstration Tunnels

- **470 m**: Vitrified HLW (class 1)

Saanio & Riekkola, 16.9.2013
Saanio & Riekkola know-how related to the disposal of radioactive waste

Repository Technology
- Technical design of nuclear waste repositories
- Layout adaptation to site specific conditions
- Description of operation
- Management of technical requirements
- Backfilling technology
- Environmental impact analysis
- Cost estimates of the repositories

Design
- Main design
- Layout design
- HVAC design
- Project development
- Structural design
Saanio & Riekkola know-how related to the disposal of radioactive waste

**Long-Term Safety**

- Management of safety requirements
- Integration of site and engineered barrier system into long-term safety assessment
- Features, events and processes
- Performance assessment
- Formulation of radionuclide release scenarios
- Complementary considerations (e.g. natural analogues)
- Planning and management of safety case
Saanio & Riekkola know-how related to the disposal of radioactive waste

Rock Engineering Department
- Rock mechanical analyses
- Risk analyses
- Time schedules and cost estimates
- Life cycle analyses of rock caverns
- Geological modeling
- Rock engineering mapping
- Groundwater flow modeling
- Groundwater analysis
- Inflow analysis
- Estimations for sealing requirement
- Planning and management of monitoring measurements
Saanio & Riekkola know-how related to the disposal of radioactive waste

Bentonite laboratory (B+Tech Oy)

- Research and development on clay-based engineered barriers for spent nuclear fuel disposal.
- Specialised clay laboratory and experimental facilities
- Modeling capabilities to study clay-based barriers
- Detailed information is provided at www.btech.fi.
Major Clients and References – Nuclear Waste

• Posiva (Finland), URL (Onkalo) and HLW disposal facility
• TVO (Finland), LILW disposal facility
• SKB (Sweden), HLW disposal facility
• KEPCO E&C/KRMC (Korea), LILW disposal facility
• KAERI (Korea), URL and HLW disposal facility
Thank you!

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Repository design and site characterisation reports

- WR 2012-50 Repository design 2012
- POSIVA 2012-19 Design, Production and Initial state of the Underground Disposal Facility Closure
- WR 2011-32 Foreign Materials in the Repository - Update of Estimated Quantities
- WR 2010-17 Drilling and Associated Drillhole Measurements of the Investigation Holes in the EDZ Tunnel at Chainage 3620
- WR 2008-83 Assessment of the Potential for Rock Spalling at the Olkiluoto Site

www.posiva.fi
KBS-3V Safety Case Reports

- POSIVA 2012-12 Synthesis report
- POSIVA 2011-02 Olkiluoto Site Description 2011
- POSIVA 2012-04 Performance Assessment 2012
- POSIVA 2012-05 Description of the Disposal System 2012
- POSIVA 2012-06 Olkiluoto Biosphere Description 2012
- POSIVA 2012-07 Features, Events and Processes 2012
- POSIVA 2012-08 Formulation of Radionuclide Release Scenarios 2012
- POSIVA 2012-10 Biosphere Assessment BSA-2012
- POSIVA 2012-11 Complementary Considerations 2012
- POSIVA 2013-01 Models and Data for the Repository System 2012

www.posiva.fi
KBS-3H related reports

- POSIVA 2008-01 KBS-3H Design Description 2007
- POSIVA 2007-09 KBS-3H Process report,
- POSIVA 2007-08 KBS-3H Evolution report,
- POSIVA 2007-07 KBS-3H Radionuclide Release and Transport reports
- POSIVA 2007-10 Safety assessment for a KBS-3H spent nuclear fuel repository at Olkiluoto - Complementary evaluations of safety report
- SKB TR 12-01 KBS-3H Complementary studies 2008-2010.

www.posiva.fi
Saanio & Riekkola Oy

• Founded 1962
• Main office in Helsinki, Finland
• Branch office in Seoul, South Korea
• ISO 9001:2008 quality management system
Forsmark HLW
South Korea HLW

Total SF: 36,000 Mt HM
- CANDU: 45%
- PWR: 55%
AREA: approx. 4 km² (2 km x 2 km)
- PWR:CANDU = 19:2 (approx. 10:1)
Wolsong LILW
Service Business Areas of Saanio & Riekkola Oy

- Underground Facilities
- Nuclear Waste Management
- Mining

Technical Consultation Services