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Safe radioactive waste disposal: from vision to practice

Barbara Pastina
Saanio & Riekkola Oy

Spent fuel management organisation

AUTHORISATIONS

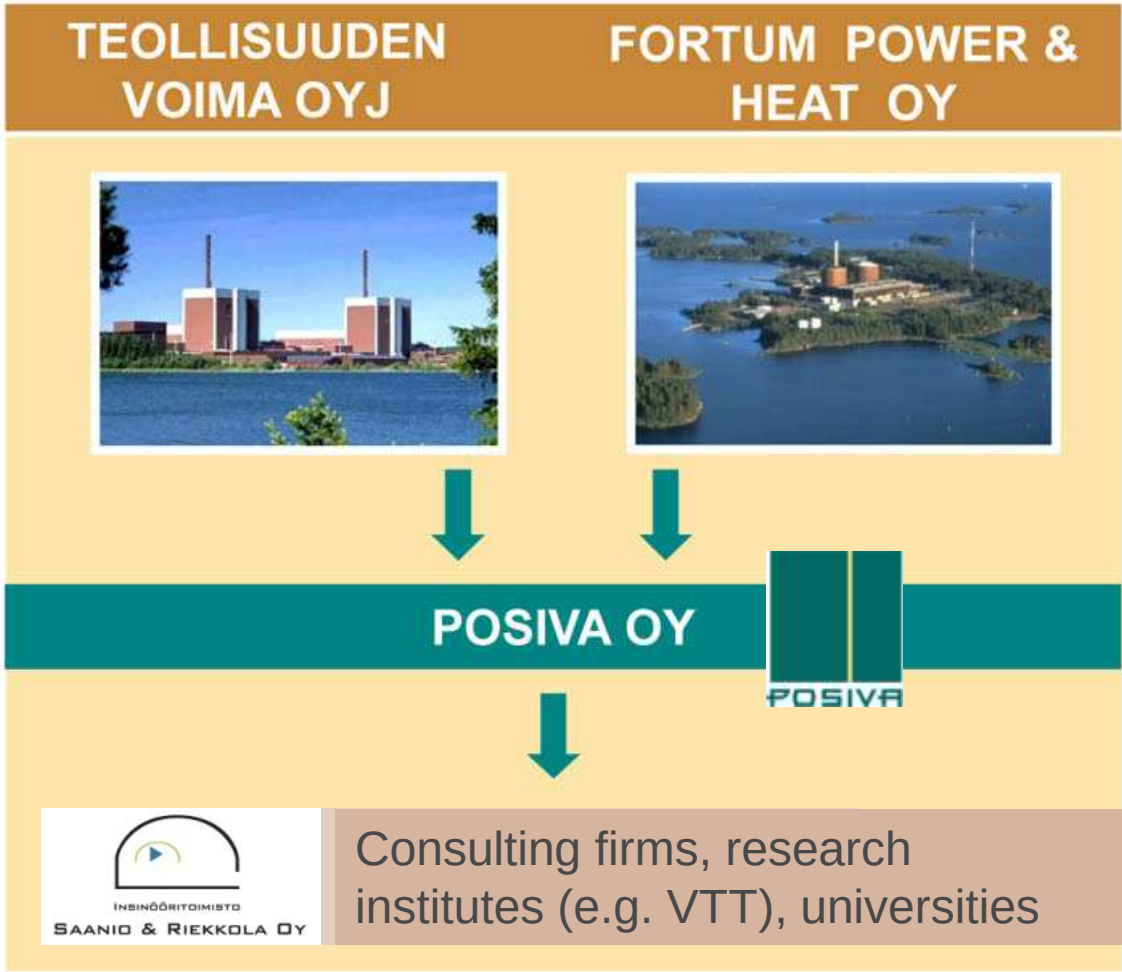
Ministry of Employement and Economy (TEM)

OVERSIGHT

Säteilyturvakeskus (STUK)

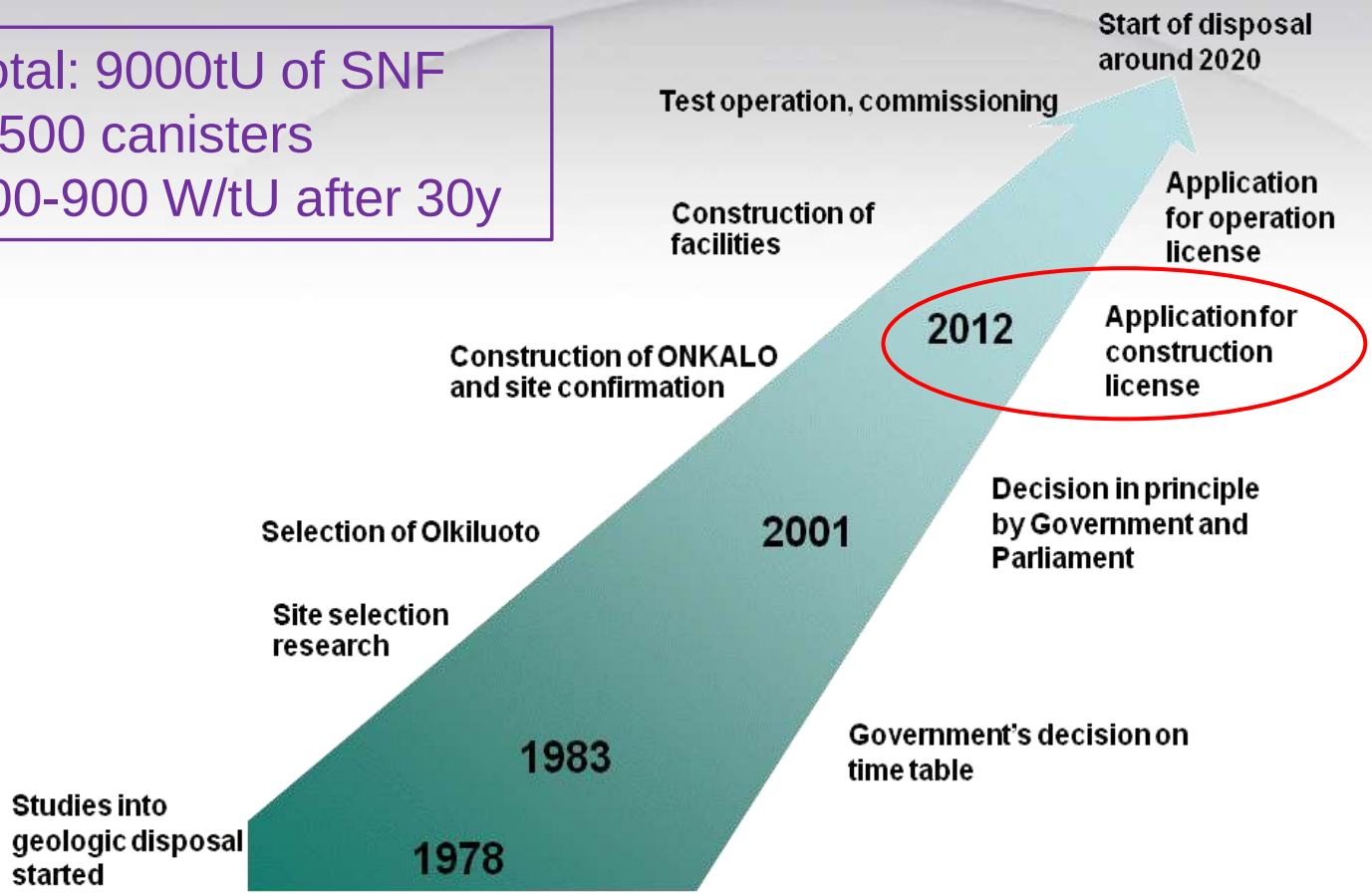
RAD WASTE MANAGEMENT FUNDING

Nuclear waste fund managed by TEM

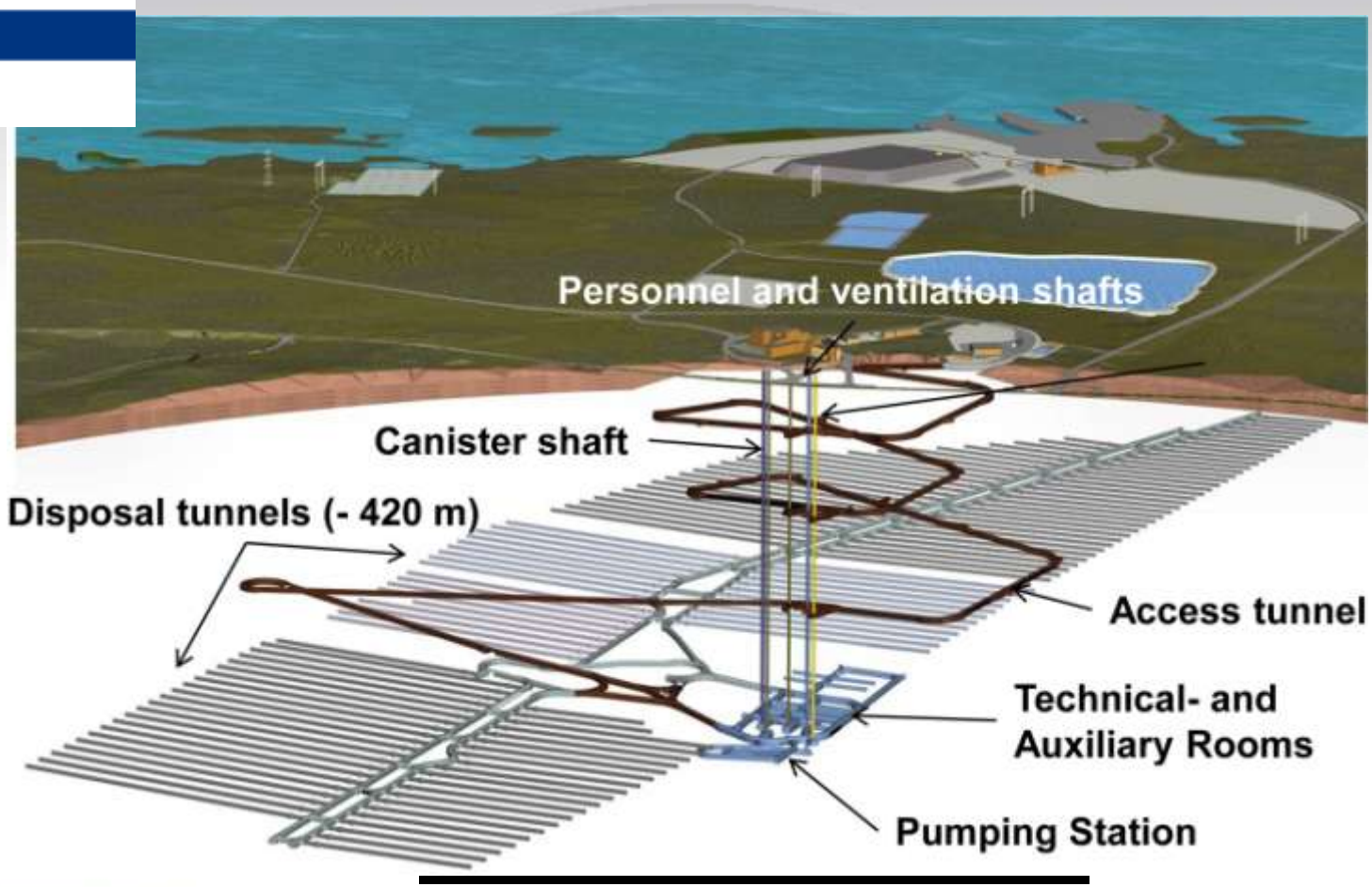


Status of spent nuclear fuel management in Finland

Total: 9000tU of SNF
4 500 canisters
800-900 W/tU after 30y

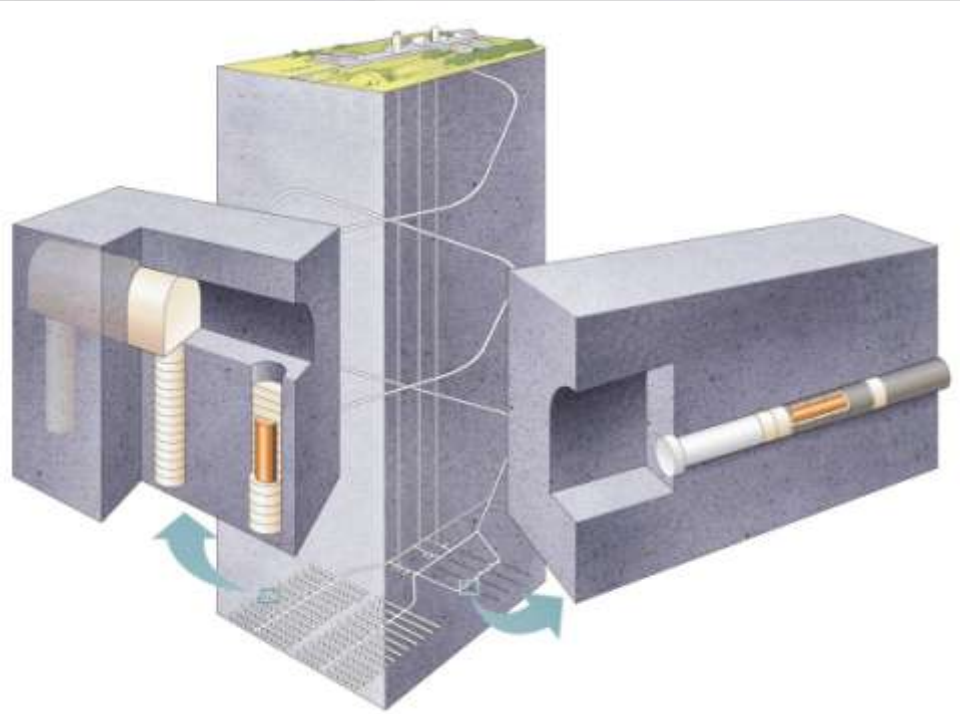


Olkiluoto spent nuclear fuel repository



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

Disposal method

Design & technical development

Safety case

Next stage

Safety assessment

Site characterisation, design & technical development

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”

Safety case portfolio TURVA-2012

TURVA-2012	
Synthesis	
Site Description	Biosphere Description
Design Basis	
Production Lines	
Description of the Disposal System	
Features, Events and Processes	
Performance Assessment	
Formulation of Radionuclide Release Scenarios	
Models and Data for the Repository System	Biosphere Assessment Data Basis
Biosphere Assessment: Modelling reports	
Assessment of Radionuclide Release Scenarios for the Repository System	Biosphere Assessment
Complementary Considerations	

TURVA -2012

3238 pages not including the supporting reports

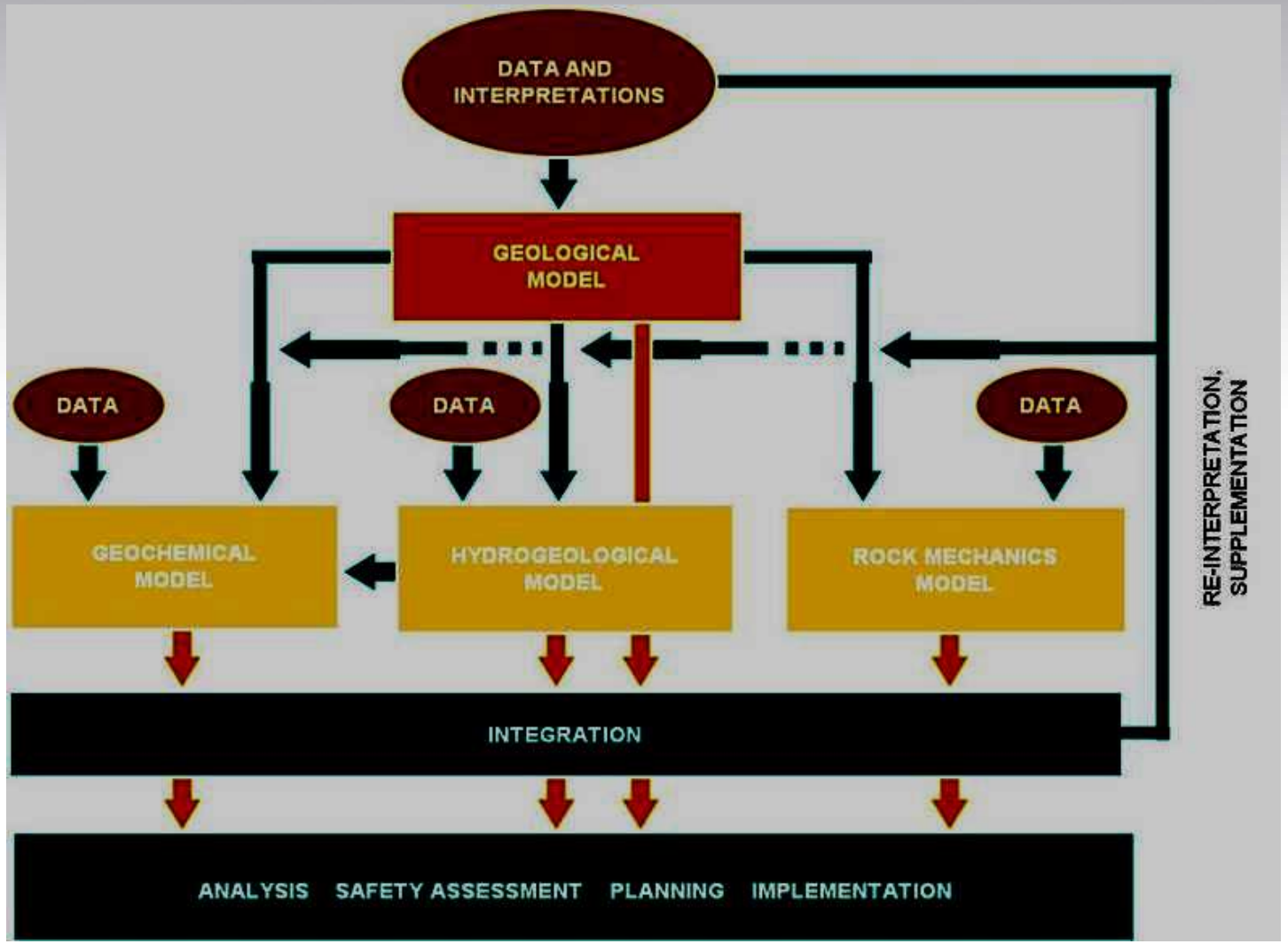
Safety case portfolio reports

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

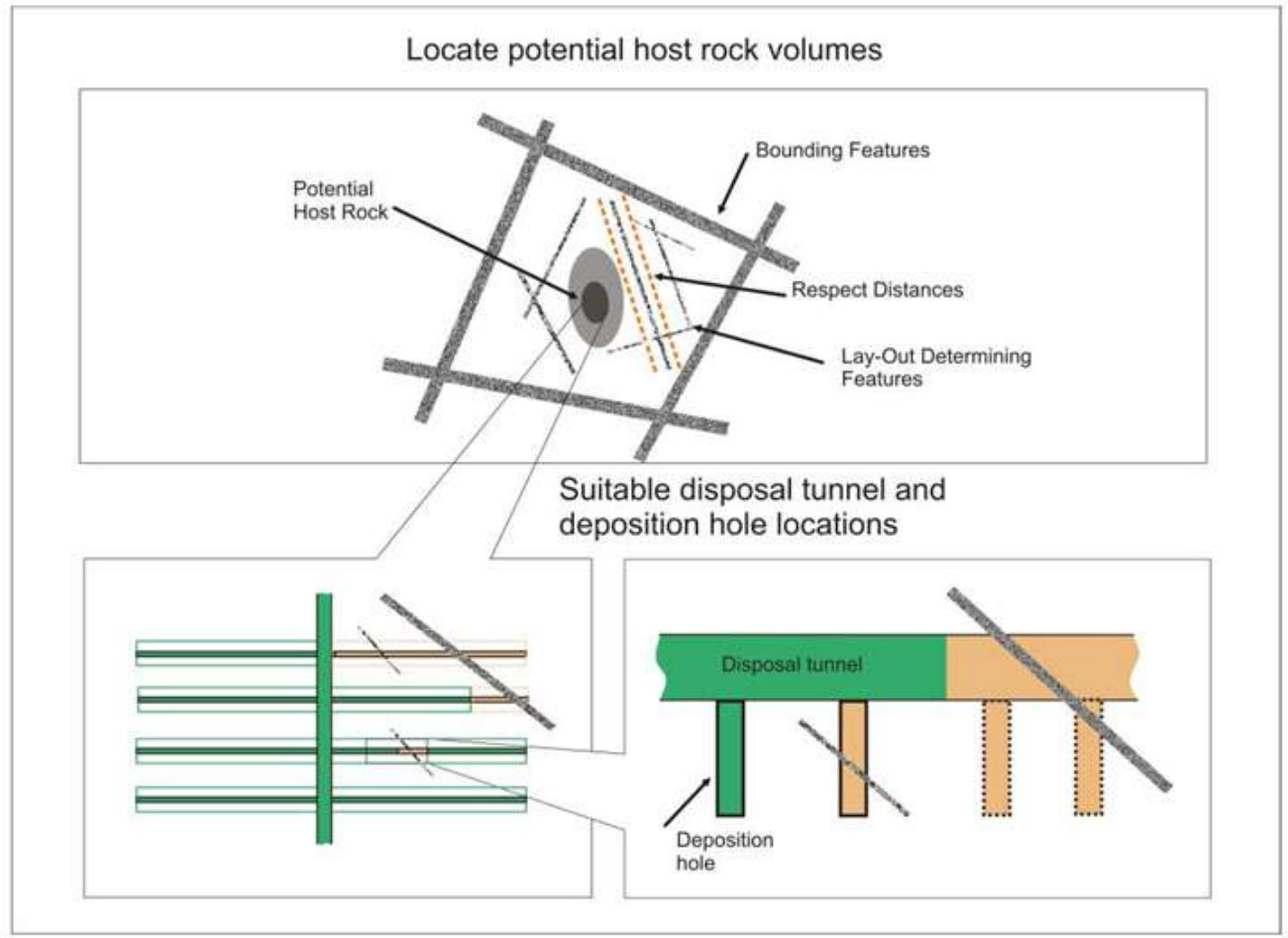
Incorporating site data into the safety case



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

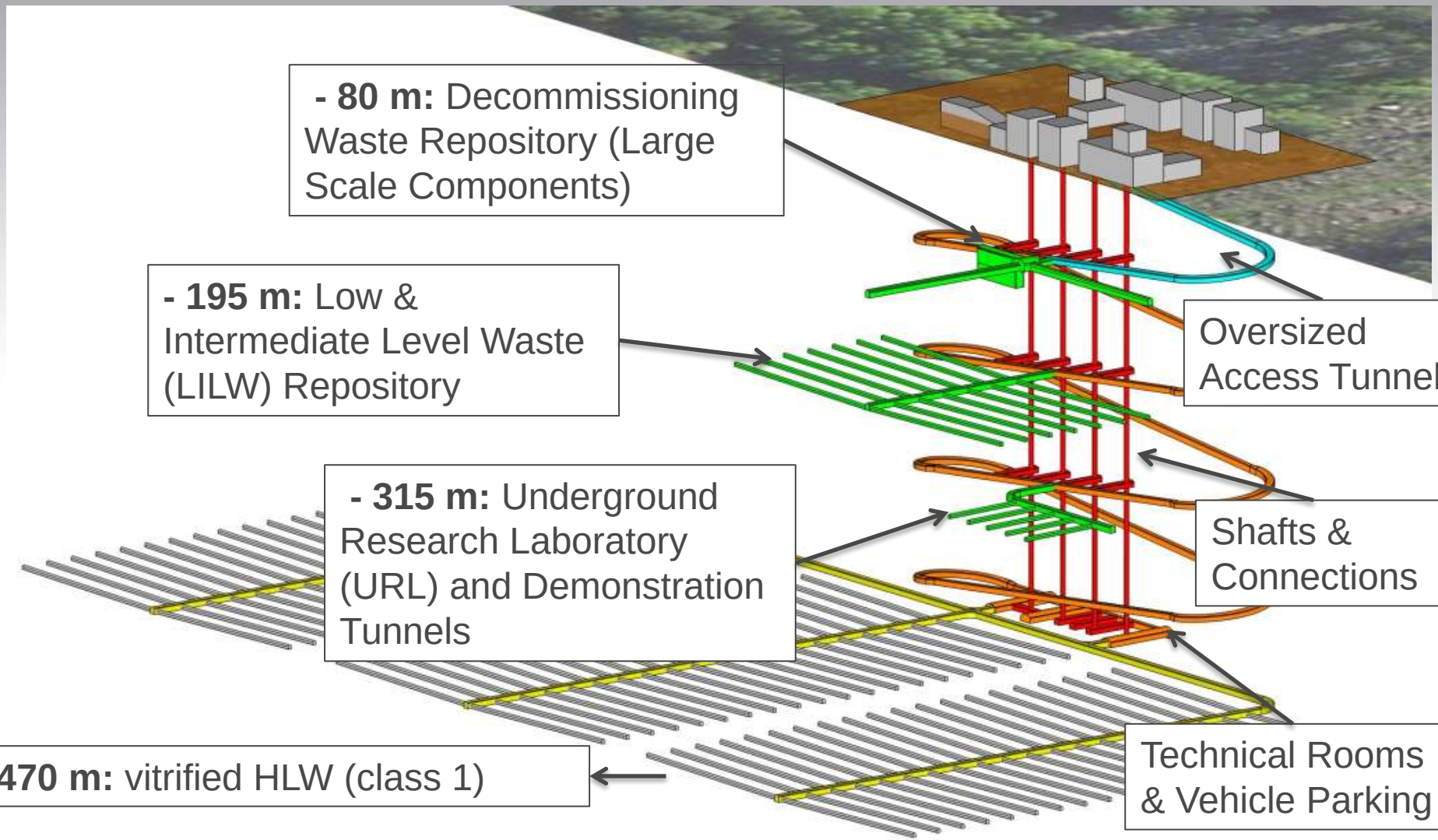


Lessons learned on management and cost estimates

- 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…



Saanio & Riekkola, 16.9.2013

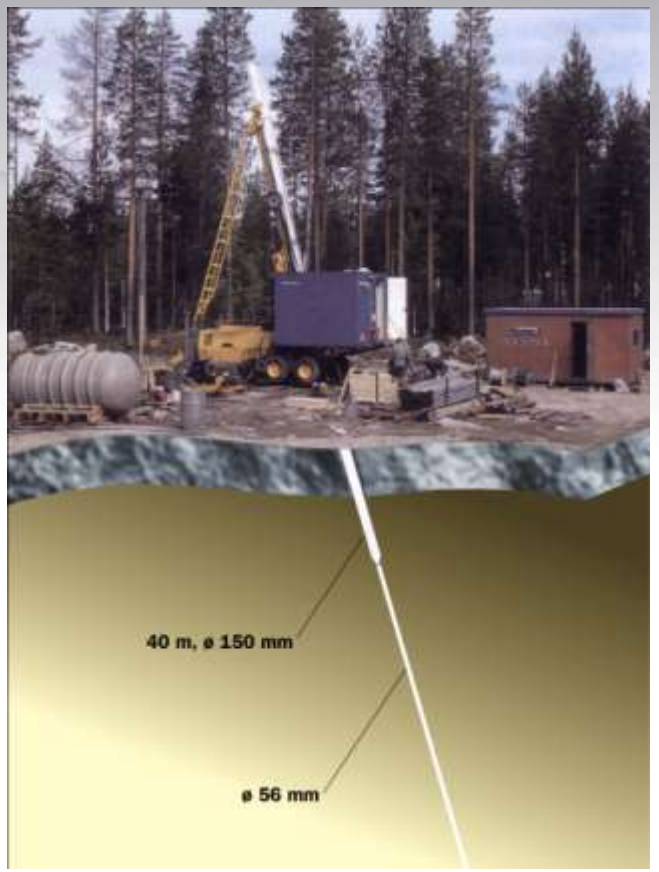
Saanio & Riekkola know-how related to the disposal of radioactive waste

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

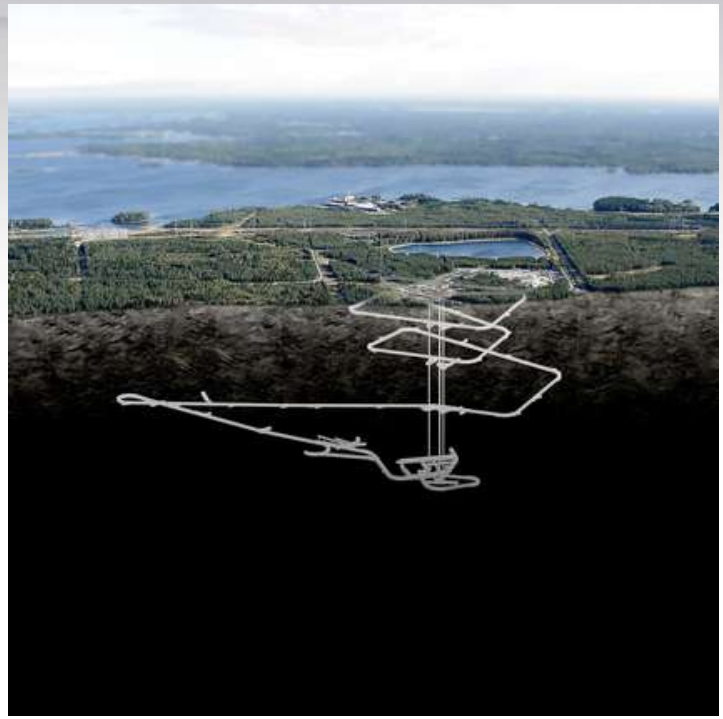
Long-Term Safety

- 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 facilitïes
- 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!

Insinööritoimisto
Saanio & Riekkola Oy

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Repository design and site characterisation reports

- WR 2012-50 Repository design 2012
- WR 2012-24 Rock Suitability classification – RSC 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
- WR 2008-66 EDZ Programme, EDZ Studies in ONKALO 2007-2008
- WR 2008-45 R20 Programme: Development of Rock Grouting Design, Techniques and Procedures for ONKALO

www.posiva.fi

KBS-3V Safety Case Reports

www.posiva.fi

- 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

KBS-3H related reports

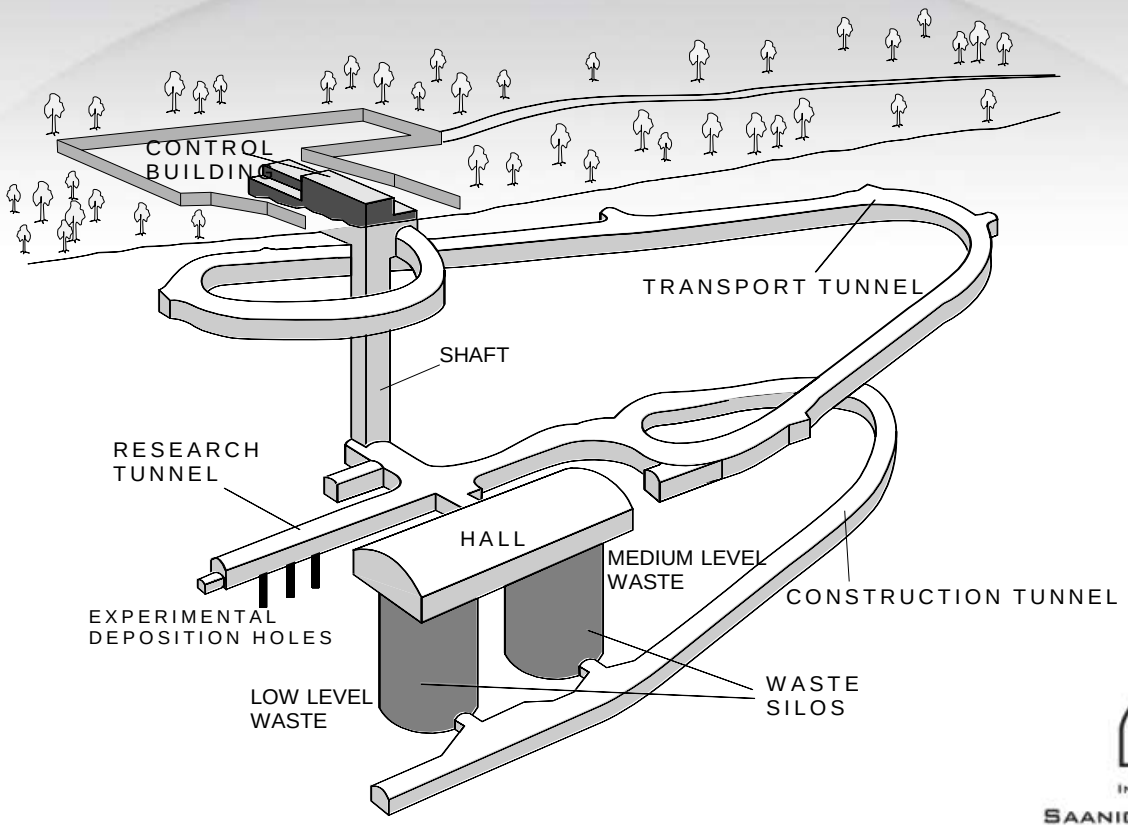
- POSIVA 2008-01 KBS-3H Design Description 2007
- POSIVA 2007-09 KBS-3H Process report,
- POSIVA 2007-08 KBS-3H Evolution report,
- POSIVA 2007-07 KBS-3H Radionuclide Release and Transport reports
- POSIVA 2007-10 Safety assessment for a KBS-3H spent nuclear fuel repository at Olkiluoto - Complementary evaluations of safety report
- POSIVA 2008-03 Horizontal Deposition of Canisters for Spent Nuclear Fuel. Summary of the KBS-3H Project 2004-2007
- 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

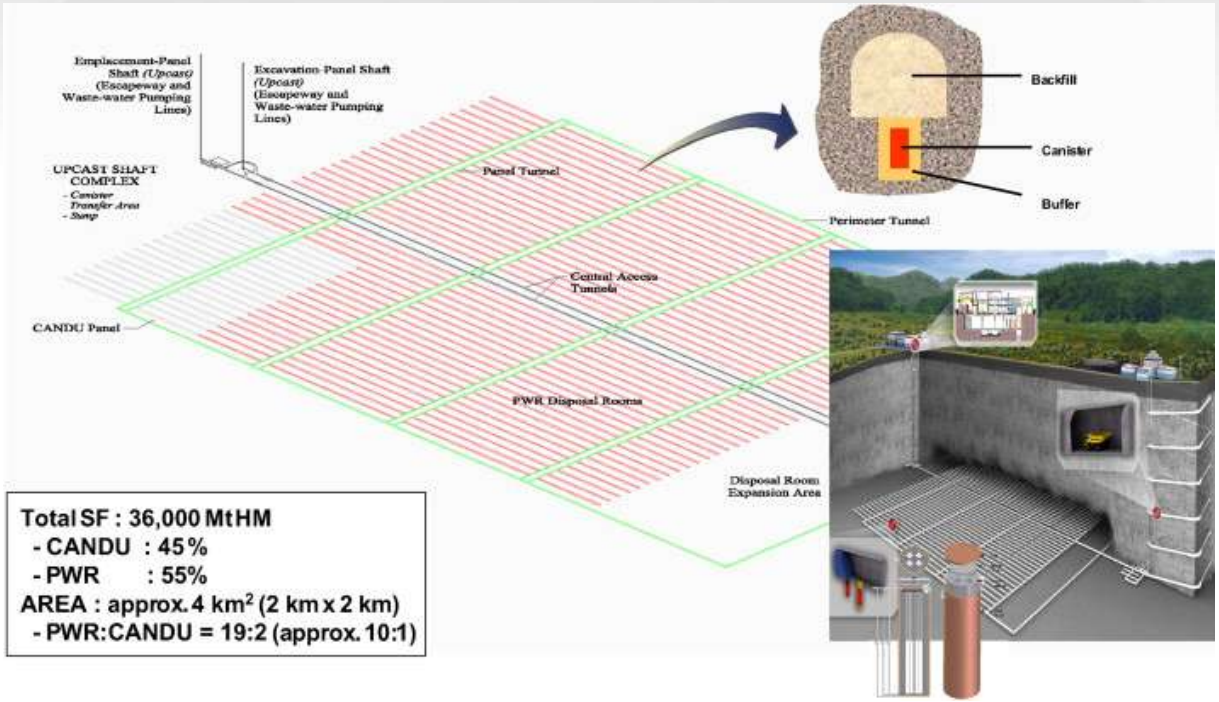
Olkiluoto LILW



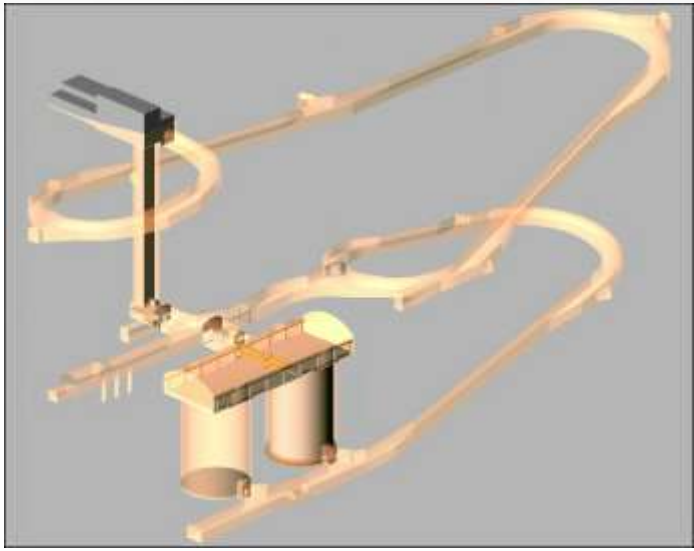
INSINÖÖRITOIMISTO
SAANIO & RIEKKOLA OY

Forsmark HLW

South Korea HLW



Wolsong LILW



Service Business Areas of Saanio & Riekkola Oy