LUCOEX - end of project overview

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Presentation

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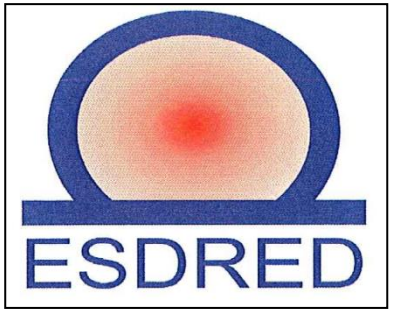
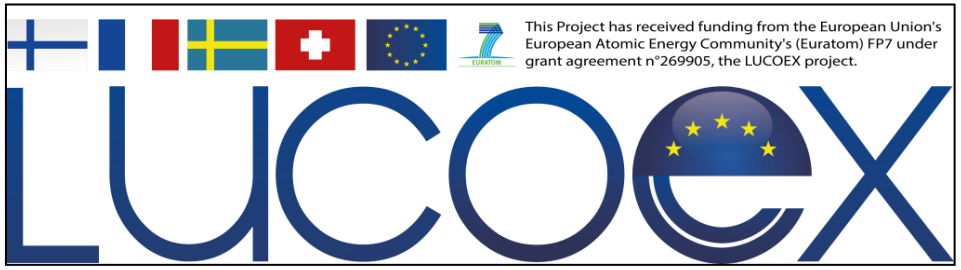




Background

Stepwise approach

Technical development

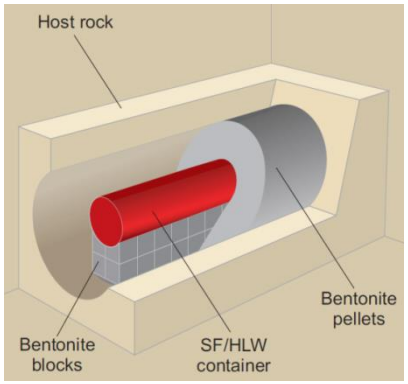
- Design work
  - Small scale tests
  - Large/full-scale tests in surface facilities
  - Full-scale tests in repository like conditions
    - Sub system (e.g. backfill installation)
    - Integrated System (e.g. Prototype Repository at Äspö)
  - Important to solve and confirm design, logistics and personal safety aspects

State-of-the-art around 2009

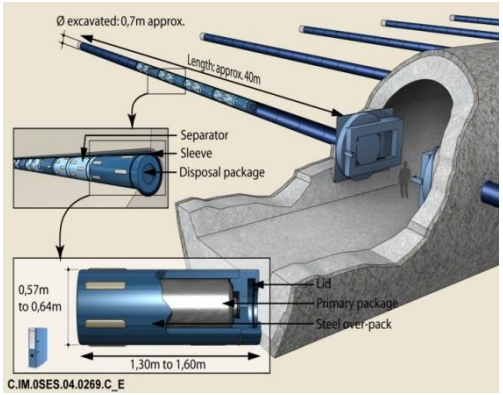
National programme specific Repository Designs

Clay formations

- Nagra

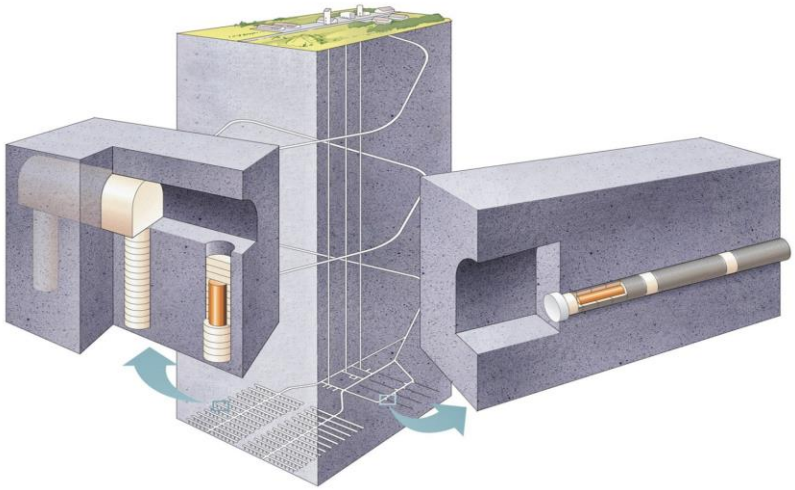


- Andra



Crystalline rock

- SKB
- Posiva



State-of-the-art around 2009

ESDRED - Engineering Studies and Demonstrations of REpository Designs (2004-2008)

Cofunded by the European Commission (EC) as part of the 6th EURATOM Research and Training Framework Programme (FP6) on nuclear energy (2002-2006)

State-of-the-art around 2009

ESDRED - Objectives

The FIRST objective was to demonstrate, **at an industrial scale**, the technical feasibility of some **very specific activities** related to the construction, operation and closure of a deep geological repository for high level radioactive waste and spent nuclear fuel.

- Module 1: Buffer Construction Technologies for Horizontal Disposal Concepts
- Module 2 : Transfer and Emplacement of Waste Canisters
- Module 3: Heavy load emplacement technology
- Module 4: Temporary Sealing using low pH cement Technology

The SECOND objective was to promote a shared European vision in the field of radioactive waste disposal technology.

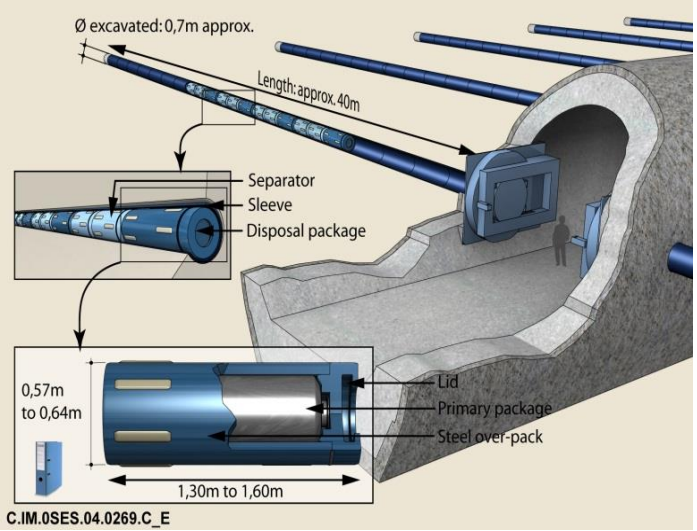
The THIRD objective focused on training and communication.

NAGRA activities in Module 1

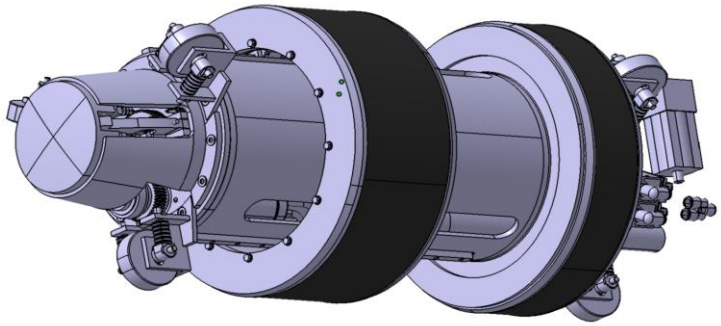
Experimental setup of auger system

Emplacement of bentonite granulate

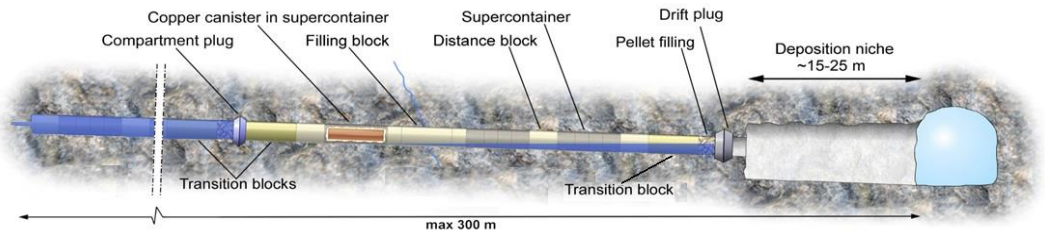
ANDRA activities in Module 2



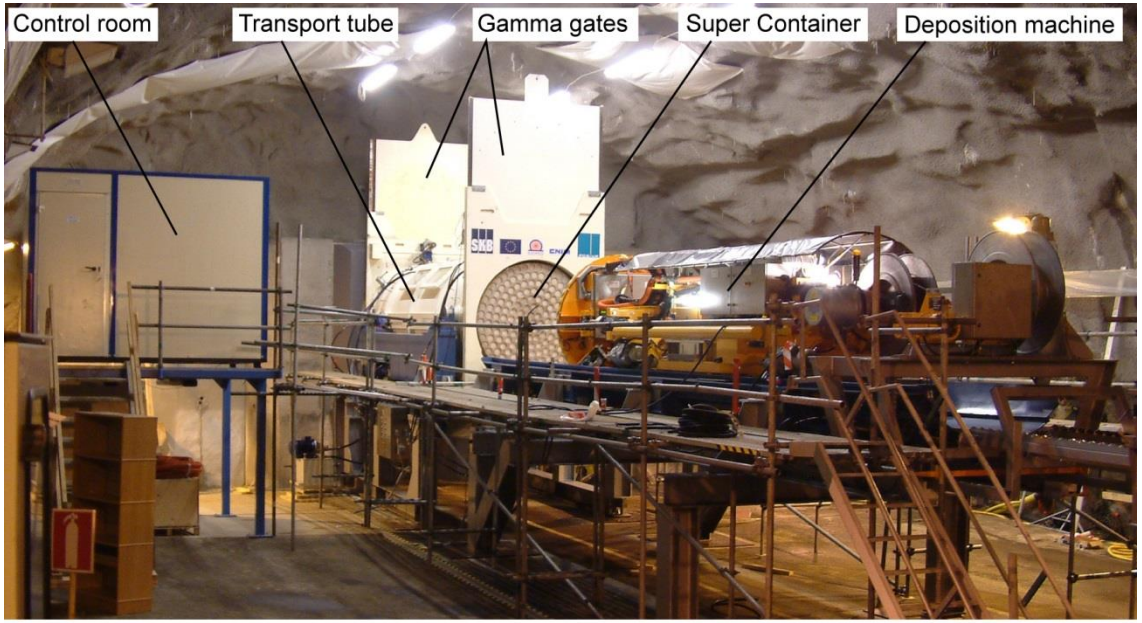
Layout of ANDRA deposition tunnels for vitrified waste and the pushing robot developed



SKB/Posiva activities in Module 3

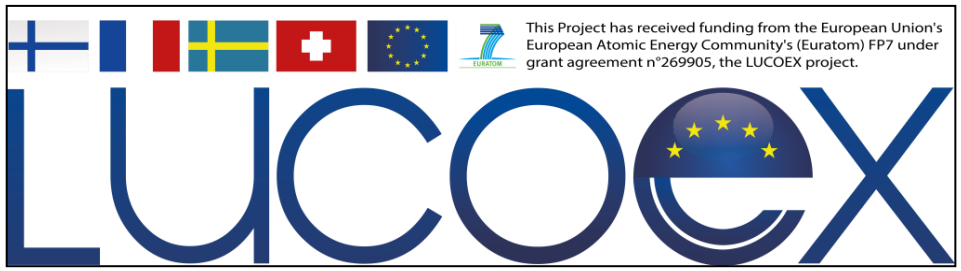


Development of the KBS-3H deposition machine from sketches to prototype equipment.



LUCOEX

Large Underground Concept Experiments



Project co-funded by the European Commission under the Seventh Euratom Framework Programme for Nuclear Research &Training Activities (2007-2011)

Objectives

Four advanced waste management programmes in Europe have as part of their stepwise development of repository concepts for long-lived radioactive waste come together in the LUCOEX project with the common objective to demonstrate the technical feasibility ***of certain vital deposition sequences*** *for a safe and reliable disposal of radioactive waste in geological formations.*

LUCOEX

The four addressed repository concepts are:

- Horizontal disposal of waste packages in Opalinus clay formation (Nagra)
  (Experiment at Mont Terri)
- Horizontal disposal of waste packages in crystalline rock (SKB)
  (Experiment at Äspö HRL)
- Horizontal disposal of waste packages in Callovo-Oxfordian clay formation (Andra)
  (Experiment at Bure)
- Vertical disposal of waste packages in crystalline rock (Posiva)
  (Demonstration at Onkalo)

NAGRA Full scale Experiment at Mont Terri (FE)

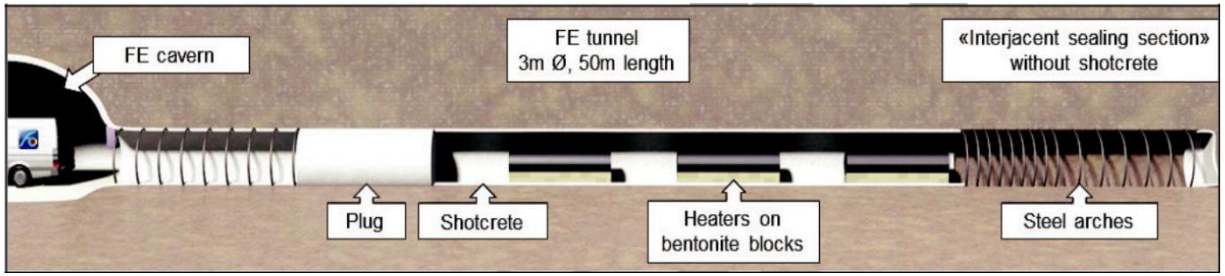
The main aim of this experiment is to investigate repository-induced thermo-hydro-mechanical (THM) coupled effects on the host rock and to validate existing coupled THM models.

Further aims are

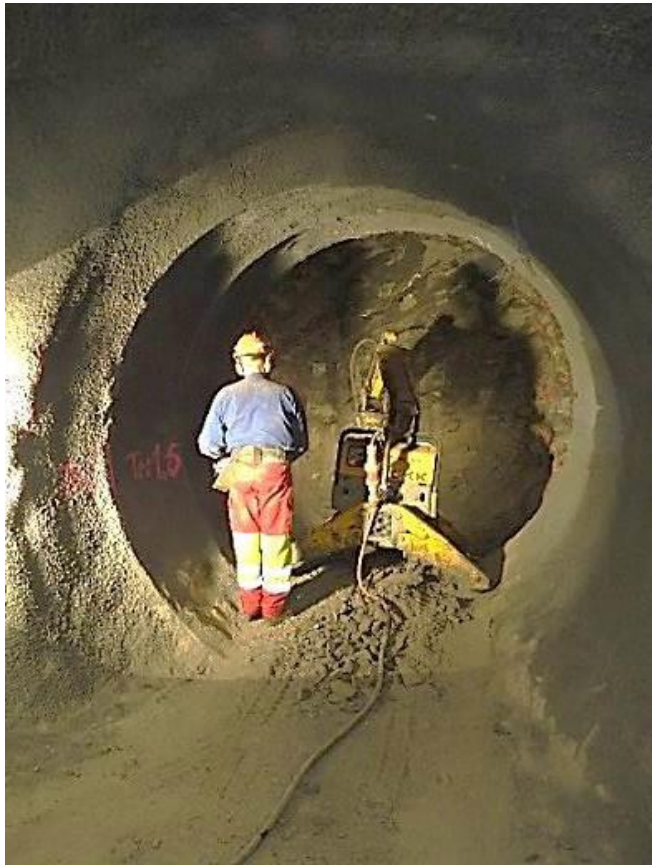
a) the verification of the technical feasibility of constructing a repository tunnel

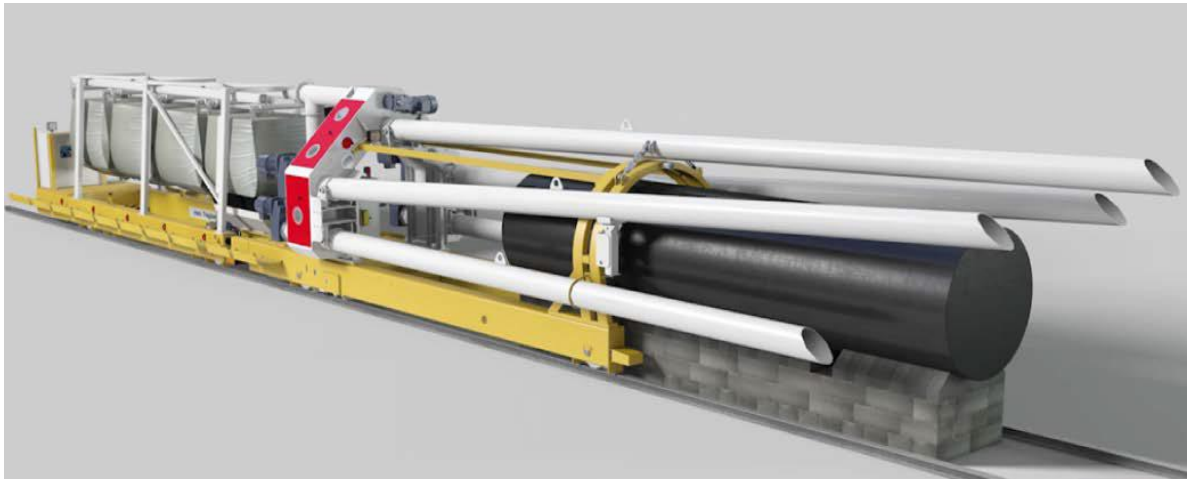
b) the optimisation of the bentonite buffer material production

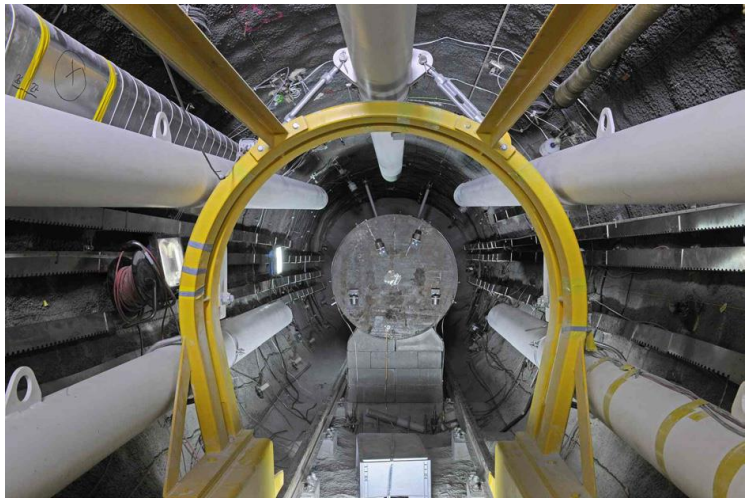
c) the investigation of emplacement procedures under underground conditions.



NAGRA Full scale Experiment at Mont Terri (FE)



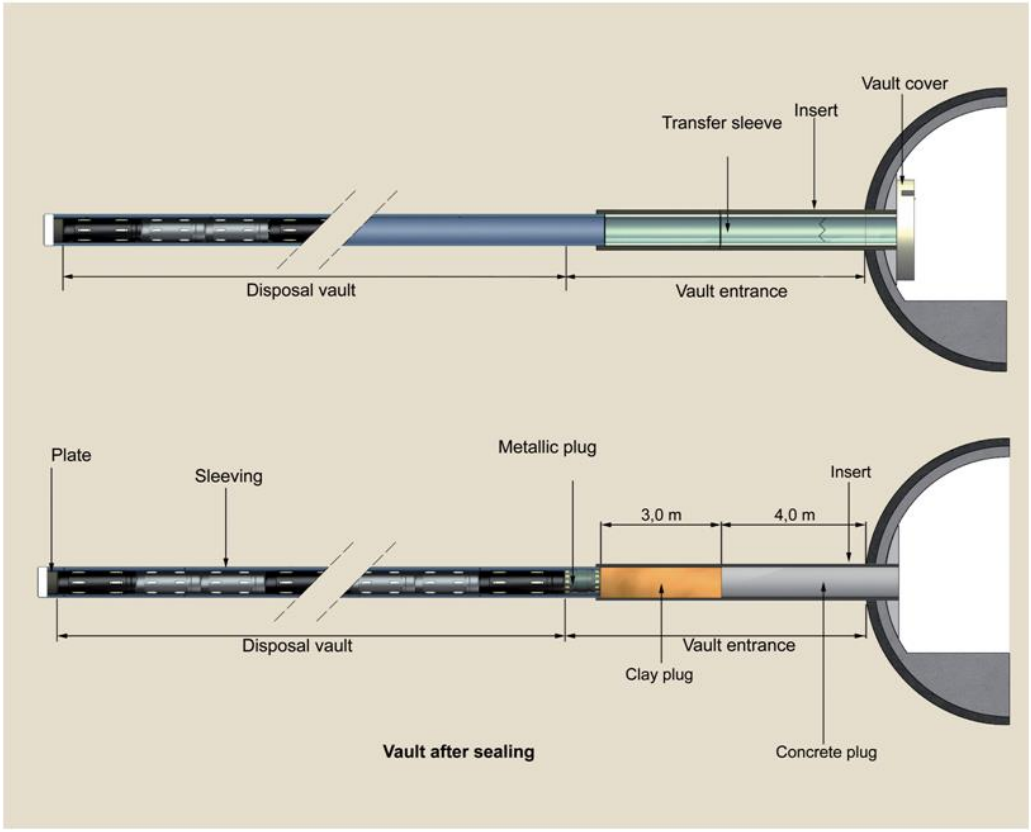




Excavation of a D3m and 50 m long gallery

Andra ALC full-scale emplacement experiment

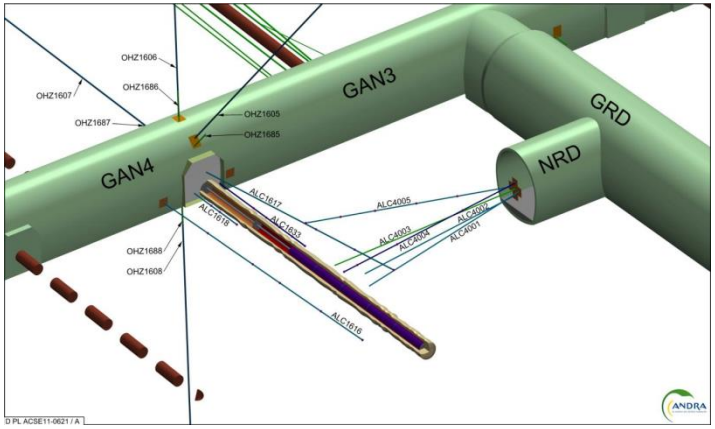
ANDRA - Schematic diagram of a HLW cell according to the French concept 2009



The HLW cell is a micro-tunnel which is approximately 40 m long and 0.7 m in diameter.

The objective of the ALC experiment was to demonstrate the construction feasibility of the french concept and to determine the impact of a thermal loading on the overall behaviour of the cell.

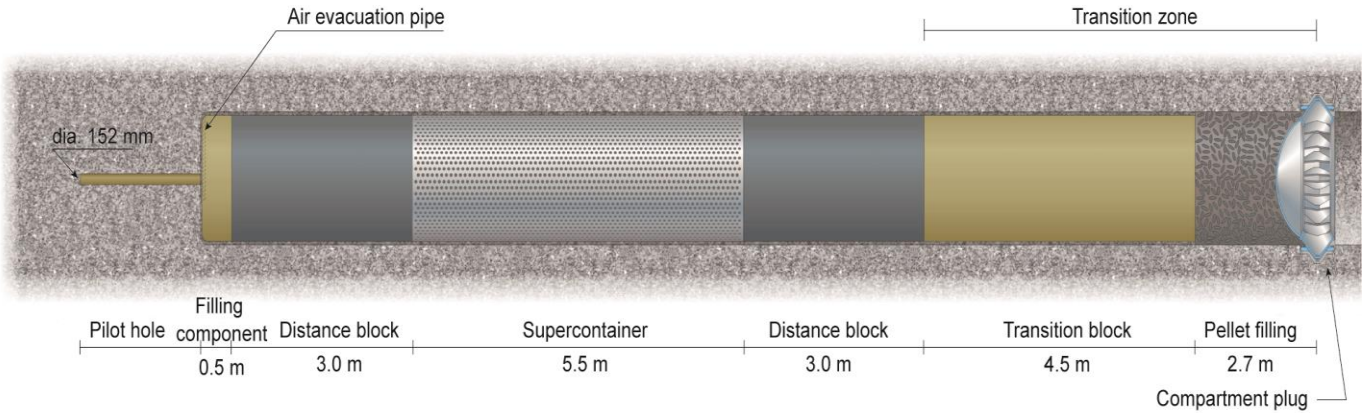
Andra ALC full-scale emplacement experiment



Drilling of a 25 m long cell.

Photo of the heater element used

SKB Multi purpose test (MPT)

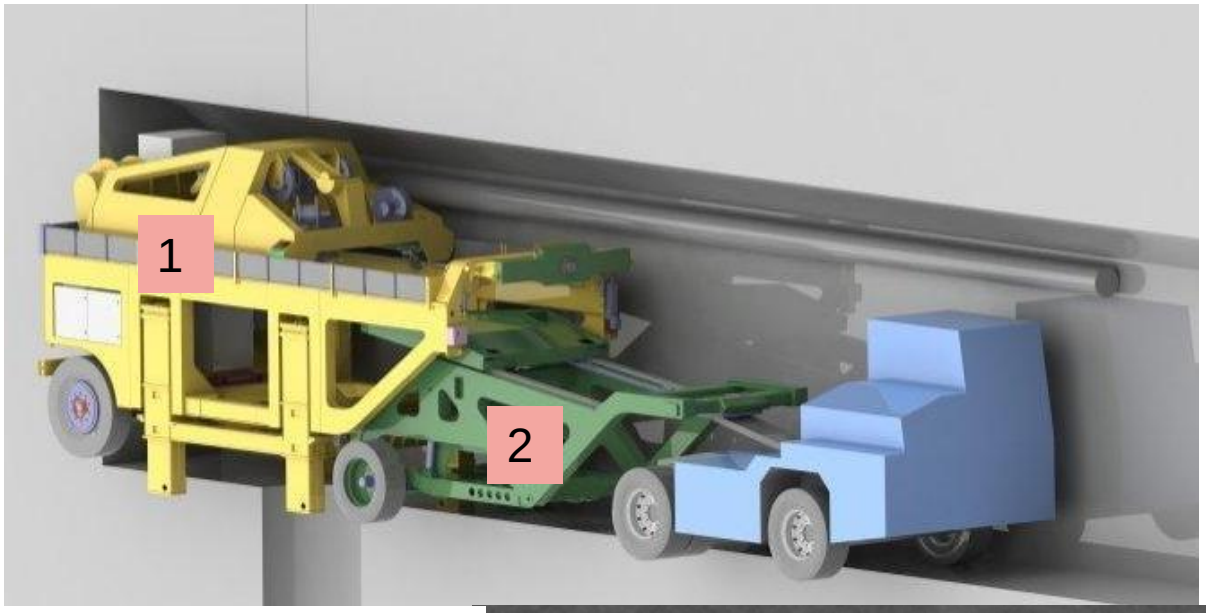


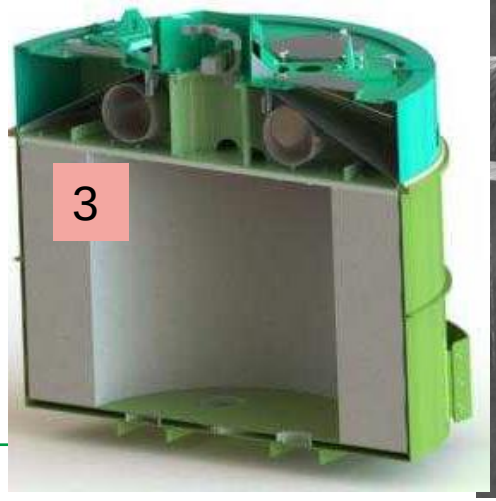
Manufacturing of buffer blocks

Distance and transition blocks for the MPT

SKB Multi purpose test (MPT)

Posiva – Deposition of buffer blocks and pellets





1. Buffer Installation Machine (BIM)
2. Buffer block transfer vehicle
3. Bentonite container for transportation and handling of blocks and pellet.
4. General overview of deposition tunnel.

Posiva – Buffer Installation Machine (BIM)

Lowering of buffer blocks into the deposition hole with a vacuum lifting tool.

Photo of the BIM in the test hall. The machine is moved with help of a truck.

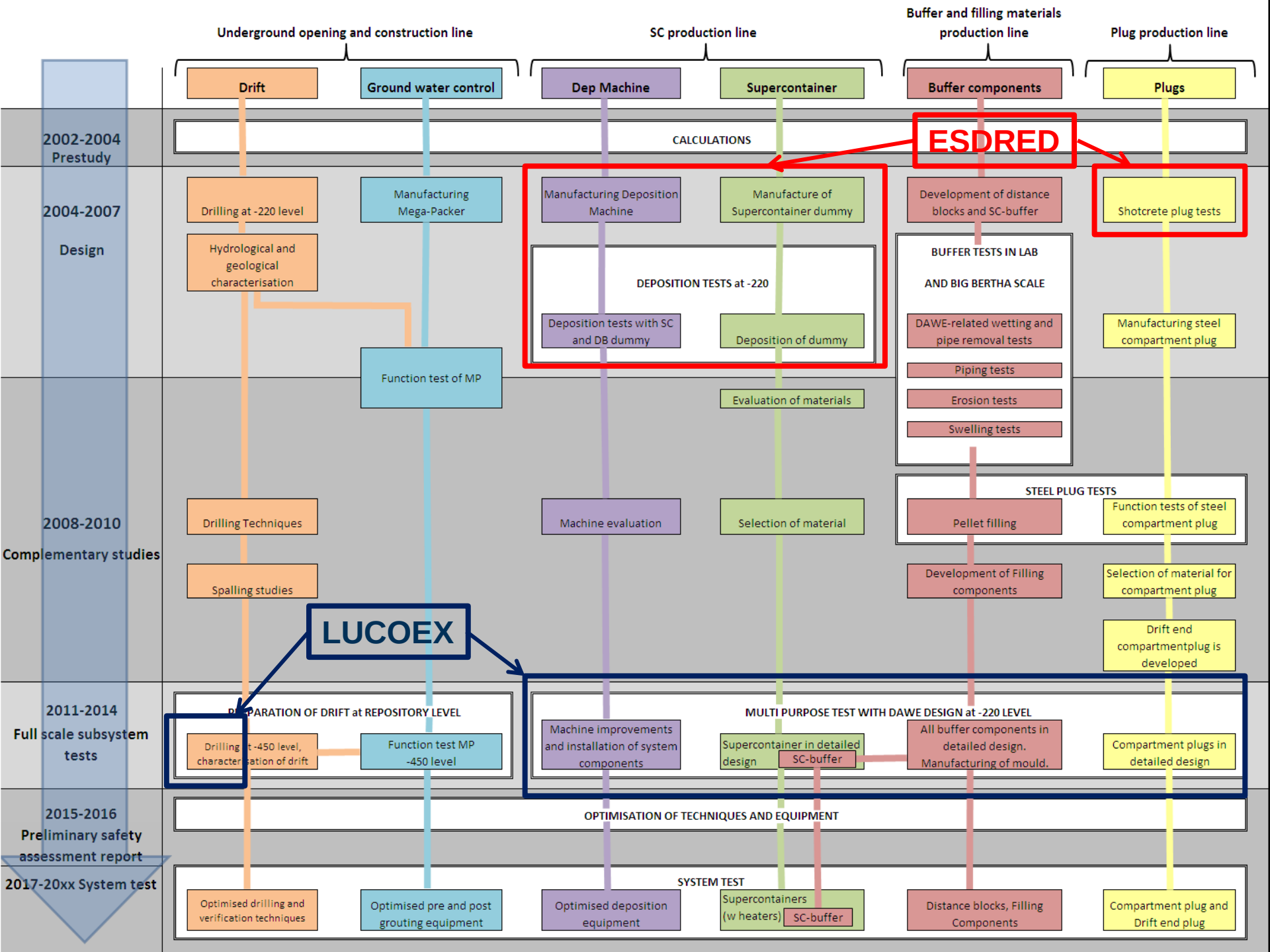
Photo of the Buffer Installation Machine in ONKALO demonstration tunnel 1.

This Project has received funding from the European Union's European Atomic Energy Community's (Euratom) FP7 under grant agreement n°269905, the LUCOEX project.

Future input

- Nagra – FE will be monitored for 10-15 years and will contribute to THM modelling.
- Andra – ALC experiment will contribute to increase the reliability of Andra's HLW cells design, especially in regards to the impact of a thermal loading.
- SKB – MPT will be monitored for 5-8 years. Study the early evolution. Use the deposition machine for retrieval of MPT.
- Posiva – BIM will be used for the upcoming FISST-experiment in Onkalo.

Other organisation will benifit from results achieved from LUCOEX, **but** they have to concider their own site conditions and national legislations


Underground opening and construction line
SC production line
Buffer and filling materials production line
Plug production line
Drift
Ground water control
Dep Machine
Supercontainer
Buffer components
Plugs
2002-2004
Prestudy
CALCULATIONS
ESDRED
2004-2007
Design
Drilling at -220 level
Manufacturing Mega-Packer
Manufacturing Deposition Machine
Manufacture of Supercontainer dummy
Development of distance blocks and SC-buffer
Shotcrete plug tests
Hydrological and geological characterisation
DEPOSITION TESTS at -220
BUFFER TESTS IN LAB
AND BIG BERTHA SCALE
Deposition tests with SC and DB dummy
Deposition of dummy
DAWE-related wetting and pipe removal tests
Manufacturing steel compartment plug
Piping tests
Function test of MP
Evaluation of materials
Erosion tests
Swelling tests
2008-2010
Complementary studies
STEEL PLUG TESTS
Drilling Techniques
Machine evaluation
Selection of material
Pellet filling
Function tests of steel compartment plug
Spalling studies
Development of Filling components
Selection of material for compartment plug
LUCOEX
Drift end compartmentplug is developed
2011-2014
Full scale subsystem tests
PREPARATION OF DRIFT at REPOSITORY LEVEL
MULTI PURPOSE TEST WITH DAWE DESIGN at -220 LEVEL
Drilling at -450 level, characterisation of drift
Function test MP -450 level
Machine improvements and installation of system components
Supercontainer in detailed design
SC-buffer
All buffer components in detailed design. Manufacturing of mould.
Compartment plugs in detailed design
2015-2016
Preliminary safety assessment report
OPTIMISATION OF TECHNIQUES AND EQUIPMENT
2017-20xx System test
SYSTEM TEST
Optimised drilling and verification techniques
Optimised pre and post grouting equipment
Optimised deposition equipment
Supercontainers (w heaters)
SC-buffer
Distance blocks, Filling Components
Compartment plug and Drift end plug

Conclusions

Stepwise approach for technical development is needed.

Despite different conditions and requirements for the various repositories planned, there are many common issues and also experiences that can be shared between organizations.

Development of equipment and systems is normally very time consuming and costly. Sharing experiences in joint projects give us opportunities to find good solutions and to achieve acceptance both on a national and international level.

There is a big difference to carry out tests with system components compared to working with the entire system of equipment at industrial scale.

The environment in the repository are typically also much more difficult than in test environments. Underground laboratories have an important role.

Demonstration at industrial scale is and will be important in order to meet the requirements set by the licensing authorities.

End of presentation

Thank you for your attention!

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