LUCOEX
(Contract Number: 269905)

DELIVERABLE (D1.8)

Author: Christer Svemar

Date of issue of this report: 12/06/12

Start date of project: 01/01/11

Duration: 48 Months

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

<table>
<thead>
<tr>
<th>Dissemination Level</th>
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<tr>
<td>PU</td>
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<tr>
<td>Public</td>
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<tr>
<td>RE</td>
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<tr>
<td>Restricted to a group specified by the partners of the [acronym] project</td>
</tr>
<tr>
<td>CO</td>
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<tr>
<td>Confidential, only for partners of the [acronym] project</td>
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[LUCOEX]
Minutes of Project Progress Meeting – PPM 02

Time: 14 March, 2012
Location: Olkiluoto, Finland
Participants: Erik Thurner, SKB
Fredrik Johansson, SKB (Chair of meeting)
Magnus Kronberg, SKB
Christer Svemar, SKB (Secretary of meeting)
Jacques Morel, Andra
Frédéric Bumbieler, Andra
Tim Vietor, Nagra
Hanspeter Weber, Nagra
Sven Köhler, Nagra
Timo Äikäs, Posiva
Jukka-Pekka Salo, Posiva
Keijo Haapala, Posiva
Christophe Davies, European Commission

Distribution: Participants, LUCOEX Steering Committee, European Commission
(Deliverable D1.8)

1 Welcome and introduction

Timo Äikäs welcomed the participants to Olkiluoto. He informed of the latest Olkiluoto news (presentation enclosed as Appendix 1), among other things:

- The third reactor OL3 is scheduled to start production in late 2013, while the initial plan had 2009 as starting year.
- The OL4 project started late December 2011.
- Posiva will submit its construction licence application late this year to Government.
- Yesterday (March 14th) the Minister of Labour and Economy urged Posiva’s owners to create a working group together with Fennovoima with the objective to analyse the possibility to host
also Fennovoima’s estimated volumes of spent nuclear fuel in the planned repository at Olkiluoto. The working group is expected to present its findings by the end of 2012.

2 Chair of PPM 02

Fredrik Johansson chaired the meeting.
Christer Svemar provides minutes of the meeting.

3 Agenda

The draft agenda was accepted as distributed prior to the meeting - Appendix 2.

4 European Commission presentation

Christophe Davies presented general information from the European Union on Euratom FP 7 and the future FP8 (2014-2020). The latter programme is launched under the name “HORIZON 2020”.

The presentation is enclosed as Appendices 3a and 3b.

Christophe Davies specially mentioned:

- Three projects have been funded from the last call on “Management of radioactive waste – geological disposal”: BELBAR on bentonite erosion, FIRST-NUCLIDES on instant release from high burn-up spent fuel, and SITEX on networking among regulatory bodies. In addition a cross-cutting activity - NEWLANCER – was supported with the objective to enhance the number of different NMS taking part in future Euratom FPs.
- In total 20 projects and activities have up till now (5 calls) been funded in FP7 “Geological disposal” and “Cross-cutting projects”. The EC contribution amounts to approximately MEUR 44.3.
- A last call with deadline March 27 2012 is expecting two proposals: Plugs and Seals (one Collaborative project) and Secretariat of IGD-TP (one Coordination and Support Action). The budget of this call is MEUR 9 ± 10%.
- For the FP8 the Euratom budget is presently set to MEUR1788 (of which MEUR 355 is for fission, MEUR 710 for fusion and MEUR 724 for JRC – Joint Research Centre.)
- Number of supported projects is expected to decrease – from 40 to 30 – by shifting strategy from supporting specified projects to also support programmes or funding management of programmes. Joint programming is in this context judged to become prioritized.
- First call of FP8 will be launched early January 2014.
- Discussion is on-going on how to proceed in extending possibilities of supporting whole programmes in addition to supporting projects.

Christophe Davies also pointed out that two major events will take place in Luxemburg:
- International symposium and workshop on “Gas migration and generation” (FORGE project) on 5 to 7 February 2013.
- International conference and workshop on “Monitoring in geological disposal and radioactive waste” (MODERN project) on 19 to 21 March 2013.
5 Progress and plans - WP 1 and WP 6 (Coordinator)

Fredrik Johansson presented the status of WP 1 and WP6. The presentation is enclosed as Appendix 4. He especially mentioned:

- Time schedule
  - Nagra: A draft WP 2 Project plan has been distributed for comments. It is intended to be adjusted according to comments and to be finished before March 31.
  - Nagra: The Tunnelling Report is delayed, and construction work starts first next week. The work is judged to be completed with no further delay and end in July.
  - Andra: The tunnel excavation work is a few months late. It will be carried through in September-October instead of earlier intended February-March.
- Periodic report
  - Fredrik Johansson distributes instructions for the up-coming 18-month periodic reporting (due in June).
- Staff secondment
  - Andra and Nagra will issue their announcements soon.
- Website and Projectplace
  - Both have been established and are in operation.
- Scholarships
  - A wide distribution has been made but with discouraging result; no applicants have announced interest for the first event, the Olkiluoto workshop (tomorrow). All participants were asked to investigate ways of improving the response to the coming events.
- Risk list
  - Up-dates have been received from SKB and Andra. Posiva and Nagra will provide their inputs soon.
- Added Value
  - Five organizations – ONDRAF/NIRAS (Belgium), BfS (Germany), Javys (Slovakia), SERAW (Bulgaria) and Ministry of Economy (Poland) – have announced interest and an Activity Plan for dissemination activities with these organizations will be made. It will focus on a pre-judgment of added value to the organisations’ respective RD&D programme, dissemination activities, and evaluation of the outcome.
  - Christer Svemar raised the question on confidentiality. He proposed Terms of Reference in compliance with the Grant Agreement and the Consortium Agreement. He will distribute a draft for participants’ review.

6 Progress and plans - WP 2 (Nagra)

Hanspeter Weber presented the status of WP 2. The presentation is enclosed as Appendix 5. He specially mentioned:

- The activities are carried through in accordance to the time plan with one exception. The excavation of the tunnel is delayed 9 months and starts first next week.
- Construction and installation are part of LUCOEX. Instrumentation is not and will consequently not be reported in EC Deliverables.
- Design lifetime is 20 years. Consequent redundancy of instrumentation will be considered.
- Aitemin designs and manufactures the heaters
- 50 m long tunnel excavation will soon start.
- The tunnel will host 3 “heaters” with dimensions simulating full-scale canisters, see drawing in Appendix 4. Each heater will get a thermal load of 1500 W from start.
• The buffer components will consist of bentonite blocks and bentonite pellets. The aim is to achieve a dry density of 1.4 Mg/m³ in the saturated buffer.
• Fibre optics instruments will be used for measurement of temperature and extension.
• The emplacement activities will take a few months.

7 Progress and plans - WP 3 (Andra)
Frédéric Bumbieler presented objectives, activities and considerations of WP 3. The presentation is enclosed as Appendix 6. He specially mentioned:
• The activities are carried through in accordance to the time plan for each activity, but critical activities have been delayed and the emplacement of the cell will be completed in November-December this year compared to May-June in the original plan.
• Aitemin designs and manufactures the heaters.
• They will be in operation during several years in the test.
• Strain gauges will be used for measurement of strain in the liner. Temperature, total pressure on the liner and clearance reduction between the liner and the cell wall will also be measured.

8 Progress and plans - WP 4 (SKB)
Magnus Kronberg presented the status of WP 4. The presentation is enclosed as Appendix 7. He especially mentioned:
• Preparations are carried through with an overall delay of a couple of months. Installation will be delayed with 5-6 months, and made early next year.
• Studies have recommended Ti instead of Fe as material for the Supercontainer shell, plugs and other supporting structures, but Fe will still be used in the MPT demonstration set-up as originally intended.
• The “Supercontainer” weighs 46 tonnes. It will be handled by the existing, specially constructed “Multipurpose vehicle” at Åspö, which has a payload capacity of 100 tonnes.
• The reference design – DAWE (Drainage Artificial Watering and air Evacuation) will be used in the MPT.
• A 400-day long test period will be carried out after installation.
• The natural rate of water inflow into the demonstration tunnel is approximately equivalent to the bentonite’s sorption capacity.
• Wireless system for transmitting signals from instruments will be used in parallel with conventional wire bound transmission.
• The mould for compacting buffer blocks will be delivered in April as planned.
• One scholarship student is planned for autumn 2012, the task being to test-drive the deposition machine to try to identify problems generally avoided by the experienced operator.

9 Progress and plans - WP 5 (Posiva)
Keijo Haapala presented the status of WP 5. The presentation is enclosed as Appendix 8. He especially mentioned:
• Activities are carried through according to the time plan, except LOT 1 which has a time delay of 3 months now. This time delay will, however, not affect LUCOEX’s overall time plan.
• A comprehensive study of methods for supplying buffer blocks to the installation position and for installation of them in the deposition hole has resulted in the selection of a two vehicle method instead of the earlier applied one vehicle method.
10  **Mid-term Workshop**

Fredrik Johansson informed of the planning status. A discussion and possible decision on the agenda was forwarded to the Steering Committee Meeting scheduled for tomorrow afternoon.

11  **Next Project Progress Meeting - PPM 03**

The next meeting will be held at Bure during the second part of Sept 2013. Andra will decide upon exact date after consultation with the other participants.

12  **Decision making forwarded to Steering Committee Meeting**

The following issues were forwarded to SC-03 for formal decisions:

- Confidentiality with respect to scholarships and organizations to be engaged in dissemination activities.
- Current delays and judgment of how they may affect the completion of planned activities within eh LUCOEX’s 48 months.
- Guidance for compilation of 18 month periodic report.
- Staff secondment announcements.
- Meeting schedule for PPM 03.
- Scholarship announcements.
- Risk lists.
- Mid-term Workshop agenda.

13  **Onkalo visit.**

Johanna Hansen and Paula Kosunen presented status and investigations of the Onkalo URCF (Underground Rock Characterisation Facility), see PowerPoint series in Appendix 9.

Visits were made to the drill core storage facility and the Onkalo underground parts.
Implementation of spent fuel disposal

Teollisuuden Voima Oyj

Fortum Power and Heat Oy

Posiva Oy

Final disposal repository for spent nuclear fuel

Date of issue of this report: 12/06/12
Plan for Disposal Facility for 2020
Disposal facility above and underground
Appendix 2

LUCOEX Project Progress Meeting 02

13.1

13.2

13.3  **Time:** Wednesday March 14, 2012

13.4  **Place:** Posiva, Olkiluoto

**Draft Programme**

**09.00 – 15.00 PPM 02 including lunch and coffee breaks**

- 9.00–9.15  Welcome – introduction, with Coffee  Timo Äikäs
- 9.15-9.45  EU news  Christophe Davies
- 9.45-10.30 Progress and plans WP1 and WP6  Fredrik Johansson
- 10.30–10.50  Coffee
- 10.50-11.20 Progress and plans WP2  Hans-Peter Weber
- 11.20-11.50 Progress and plans WP3  Frédéric Bumbieler
- 12.00-13.00 Lunch
- 13.00-13.30 Progress and plans WP4  Magnus Kronberg
- 13.30-14.00 Progress and plans WP5  Keijo Haapala
- 14.00-14.30 Summary and miscellaneous
- 14.30–15.00 Safety instructions for ONKALO visit
- 15.00-17.30 Onkalo visit

- Group 1: ONKALO visit, Topias Siren, Kimmo Kemppainen
Euratom research on radioactive waste management & Disposal

DG RTD (Research and Innovation)
Unit K4 – Nuclear Fusion
Christophe Devys

OVERVIEW

- Euratom FP7 status in geological disposal
### Funded projects in call FP7 - 2011

#### Management of radioactive waste – Geological Disposal

<table>
<thead>
<tr>
<th>Project acronym and title</th>
<th>Key activities</th>
<th>Coordinator / no. partners</th>
<th>Start date &amp; duration</th>
<th>Total cost / EU funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELEBAR – Energetic Borehole Effects on the Long-term Performance of the Engineered Barrier and Adjacencies Transport</td>
<td>To increase the knowledge of processes that control clay colloidal stability, generation and ability to transport radionuclides.</td>
<td>EUR (DE)</td>
<td>March 2013 44 months</td>
<td>€6.6M / €2.8M R&amp;D</td>
</tr>
<tr>
<td>FIRST-NUCLIDES – Fast Instant Release of Safety Relevant Radionuclides from Spent Nuclear Fuel</td>
<td>To improve understanding of fast instantaneous radionuclide releases from spent fuel to environment</td>
<td>KIT (DE)</td>
<td>Jan. 2012 36 months</td>
<td>€4.7M / €2.5M R&amp;D</td>
</tr>
<tr>
<td>BTEX – Sustainable network of independent technical expertise for radioactive waste disposal (Support for regulatory functions)</td>
<td>Network regulatory bodies &amp; TSOs for common understanding of the key safety elements to be presented in the safety case in discussion with waste management organizations</td>
<td>RSU (FI)</td>
<td>Jan. 2012 24 months</td>
<td>€1.04M / €0.5M Coordination</td>
</tr>
</tbody>
</table>

#### Support actions – Cross-cutting

| NEWLACER – New MS Linking for an Advanced Cohesion in Euratom Research | To enhance NMS involvement in future Euratom FP and strengthen NMS R&D potential and cohesion. | NR (RC) | Nov. 2011 24 months | €0.54M / €0.9M Coordination |

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**FP7 Geological disposal & cross-cutting projects (Status Oct. 2011)**

- Implementer TP & Regulation network
- Implementer: oriented key issue
- Cross-cutting topics
- Support to safety: codes & rules applications
- Governance & Training

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[D.1.8] – Minutes of Project Progress Meeting – PPM02
Dissemination level PU
Date of issue of this report: 12/06/12
FP7 Geological disposal & cross-cutting projects (Status Oct. 2011)

Euronan FP7 - Statistics after 5 calls (2007-2011)

<table>
<thead>
<tr>
<th>Area</th>
<th># projects</th>
<th>total cost (€)</th>
<th>EC contribution (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geological disposal</td>
<td>20</td>
<td>ca. 86 M€</td>
<td>ca. 44.3 M€</td>
</tr>
</tbody>
</table>

International Symposium and workshop on

Gas generation and migration:
“Implications for the performance of geological repositories for radioactive waste disposal”
6 to 7 February 2013 - Luxembourg

International conference & workshop

Monitoring in Geological disposal of radioactive waste
Luxembourg, 19-21 March 2013


[LUCOEX] 13

(D1.8) – Minutes of Project Progress Meeting – PPM02
Dissemination level PU
Date of issue of this report: 12/06/12
Two Topics:

- **Plugs and seals - full-scale demonstration & long-term performance** Maximum one Collaborative Project.
- **Secretariat of IGD-TP** Maximum one Coordination and Support Action

Budget EUR 9 million +/-10% of total (ca. €53 million)

http://ec.europa.eu/research/participants/portal/page/fp7_sals
Commission proposal for a 80 billion euro research and innovation funding programme (2014-2020)

A core part of Europe 2020, Innovation Union & European Research Area:

- **Responding to the economic crisis** to invest in future jobs and growth
- **Addressing people’s concerns** about their livelihoods, safety and environment
- **Strengthening the EU’s global position** in research, innovation and technology
Priorities

1. Excellent science (EUR 24418 million)
   European Research Council, Future and Emerging Technologies, Marie Curie actions & Res. Infrastructures

2. Industrial leadership (EUR 17938 million)
   Industrial technologies (ICT, nanotechnologies, materials, biotechnology, manufacturing, space), risk finance for R&E & SMES

3. Societal challenges (EUR 31748 million)
   Health, demographic change and well-being; Food security, agriculture, marine res. & bioeconomy; Energy (non-Euratom) EUR 5782 million; Transport; Climate, resources & raw materials and Society

+ European Institute Technology (EIT) (EUR 2.8 billion)
+ Joint Research Centre (JRC) (EUR 1962 million)
+ Euratom (€1788 million), ITER (other proposal €2573 million)

Euratom 2014–2018

Budget: TOTAL: € 1788 million, including Fission €355 million; Fusion € 710 million; JRC € 724 million.

General objective:
- Improve nuclear safety, security & radiation protection
- Contribute to the long-term decarbonisation of the energy system, in a safe, efficient and secure way

Specific objectives for indirect actions (fission):
- support safe operation of nuclear systems;
- contribute to development of solutions for the management of ultimate waste;
- support development and sustainability of nuclear competences;
- foster radiation protection;
- promote innovation and industrial competitiveness
- ensure availability and use of research infrastructures
Specific instrument envisaged by the Rules for Participation

Programme co-fund action – for supplementing calls or programmes funded by entities other than EU bodies managing research and innovation programmes

Support for indirect actions instruments provided for by the New Financial Regulation

... Also complementary use of Structural Funds (relation with national Operational Programmes)

Work Programmes

• The essential element for implementing the actions
• Detailed objectives, associated funding
• Multi-annual approach & strategic orientations for the following years of implementation
• Links with the platforms’ SRAs?
• Input from the symposium “Benefits and limitations of nuclear fission research for a low carbon economy fission research” to be organised in 2013

WP 2014 expected in summer 2013
Next steps

Ongoing: Parliament and Council negotiations on the basis of the Commission proposals


Mid 2012: Final calls under 7th Framework Programme for research to bridge gap towards Horizon 2020

Mid 2013: Adoption of legislative acts by Parliament and Council on Horizon 2020

1/1/2014: Horizon 2020 starts, launch of first calls

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**EURATOM WP 2013**

The EURATOM programme for 2013 is meant to support a Preparatory Phase of 2014-2018

Expected Call publication: Summer 2012?

Target call deadline: Fourth quarter 2012

Evaluation of proposals: early 2013

Contracts signed and payments made in 2012

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[D1.8] – Minutes of Project Progress Meeting – PPM02
Dissemination level PU
Date of issue of this report: 12/06/12
Preparatory Phase (PP)

WP2013 to provide catalytic and leveraging support for the PP
Possible setting up of legal entities of pan-European interest
aiming at optimal coordination, cross-border operation and
possible integration of national efforts
PP would include strategic, governance, management, financial,
legal and technical work
Successful PP would lead to Public-Public and Public-Private
Partnerships implementing joint research programmes being
attractive at world level
Summary of activities 2011

• Handling of deliveries and meetings (4 SCM).
• Documents and reports
  – Project plan,
  – Project risk list
  – Communication plan
  – Staff secondment plan
  – Scholarship plan,
  – Scholarship terms of reference
  – Expert group terms of reference.
• Internal and external website
Expert group formed

- Internal Experts
  - Chair: Jean Michel Bosgiraud (Andra)
  - Thomas Fries (Nagra)
  - Stig Pettersson (SKB)
  - Jere Lahdenperä (Posiva)

- Start-up meeting in March.

External experts
- Alan Hooper
- Wilhelm Bollingerfehr (DBE)
- Geert Volckaert (SCK-CEN)
- Lumir Nachmilner

European added value

- Poland, Ministry of Economy
- Bulgaria, State enterprise radioactive waste
- Slovakia, Javyz
- Belgium, Ondraf Niras
- German, Federal office for radiation protection
Nextcoming deliveries

- Workplan
  - Nagra 01/06/2011
- Report on construction of the emplacement tunnel
  - Nagra 01/03/2012
- Report of the digging and emplacement of the cell
  - Andra 01/06/2012
- Report on manufacturing of distance blocks
  - SKB 01/04/2012
- Periodic report to be submitted to the Commission
  - SKB 01/06/2012

Staff Secondment

<table>
<thead>
<tr>
<th>Activity</th>
<th>Preliminary estimate</th>
<th>Duration</th>
<th>Detailed agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation and Dissemination of document</td>
<td>September 2012</td>
<td>1-2 weeks</td>
<td>May 2012</td>
</tr>
<tr>
<td>1.1 Andra Activity</td>
<td>Preliminary estimate</td>
<td>Duration</td>
<td>Detailed agreement</td>
</tr>
<tr>
<td>Full scale excavation of emplacement vault</td>
<td>February 2012</td>
<td>1-2 weeks</td>
<td>October 2012</td>
</tr>
<tr>
<td>1.3 Nagra Activity</td>
<td>Preliminary estimate</td>
<td>Duration</td>
<td>Detailed agreement</td>
</tr>
<tr>
<td>Tunnel excavation and installation</td>
<td>Early 2012</td>
<td>1-2 weeks</td>
<td>October 2011</td>
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<tr>
<td>1.2 Passive Activity</td>
<td>Preliminary estimate</td>
<td>Duration</td>
<td>Detailed agreement</td>
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<td>Dissemination and verification of excavation quality control</td>
<td>December 2012</td>
<td>1 month</td>
<td>January 2013</td>
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<tr>
<td>Dissemination and verification of excavation quality control</td>
<td>January 2013</td>
<td>1 month</td>
<td>January 2013</td>
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Date of issue of this report: 12/06/12
Meeting schedule

From: SCM02

- The meeting schedule for PPM and SCM is:
  - PPM 02: March 2012 at Olkiluoto, Finland. Theme: Tunnel and disposal cell excavation.
  - PPM 03: September 2012 at Buro, France. Theme: Instruments and instrumentation.
  - PPM 04: June 2013 at Mont Terri, Switzerland. Theme: Bentonite block and pellets production and emplacement.
  - PPM 05: April 2014 at Åspö, Sweden.
- Mid-term and Large Workshops are scheduled for:
  - Mid-term one-day WS: October 25-26, 2012 in Montpellier.
  - Large two-day WS: April 2014 at Åspö in conjunction with PPM and SCM.

Web site

- Projectplace
  - All project documents
  - Possibilities to communicate
- www.lucoex.eu
  - General information
  - Application for scholarship
  - Deliveries (public)
- News
Scholarships

- How do we get applicants?

Risk list 2011

<table>
<thead>
<tr>
<th>ID</th>
<th>Risk analysis</th>
<th>Risk description of the risk and its potential consequence</th>
<th>Preventive action</th>
<th>Responsible person (with LUCOEX)</th>
<th>Deadline for preventive action</th>
<th>Status (will be entered in status in danger area if deadline missed)</th>
<th>Date for entry of risk and latest update</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>F  C  R</td>
<td>Original time schedule for WP 2 too optimistic</td>
<td>Plan correct preventive action which is planned to diminish the probability of the risk or mitigate its consequences.</td>
<td>WP2, WP3, and WP4</td>
<td>2011-07-01</td>
<td></td>
<td>2011-06-01</td>
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<tr>
<td>2</td>
<td>F  C  R</td>
<td>Change in requirements or data basis in a late stage of WP 2 (LWAK) is indicated</td>
<td>Technical challenges in developing technologies needed; solutions not identified or no ability to realize them</td>
<td>WP2 leader</td>
<td></td>
<td></td>
<td>2011-06-01</td>
</tr>
<tr>
<td>3</td>
<td>F  C  R</td>
<td>Technical challenges in developing technologies needed; solutions not identified or no ability to realize them</td>
<td></td>
<td>WP2 leader</td>
<td></td>
<td></td>
<td>2011-06-01</td>
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[LUCEOX]

(D1.8) – Minutes of Project Progress Meeting – PPM02
Dissemination level PU
Date of issue of this report: 12/06/12
FE: Full-Scale Emplacement Experiment at Mont Terri
Status and Outlook

Hanspeter Weber et al.
14th of March 2012

Content of this Presentation

- Organisation – involved Nagra staff
- Experimental aims
- Location, plans / (3D) Sketches
- Scoping calculations, modeling-
- Observation boreholes
- (Excavation 50 m long Test Tunnel) → see Pres. Sven Köhler
- Granular Bentonite - production and emplacement
- Pedestal Bentonite Blocks - production
- Time plan
Introduction Project FE / Lucoex

- FE = Full-scale Emplacement Experiment at Mont Terri
  - Principle Investigator: Henwig Müller (NAGRA)
  - Partners in Phase 17:
    - ANDRA
    - CHEVRON

- Lucoex = Large Underground Concept Experiments
  - EC funded project (EURATOM, 7th Framework Programme)
  - Partners:
    - SKB
    - ANDRA
    - POSIVA
    - NAGRA

Nagra’s Project Team

Date of issue of this report: 12/06/12
Experimental Aims

- **LUCEOX aim:**
  The demonstration of emplacement techniques under repository conditions.
  For NAGRA: Simulation of horizontal canister and buffer emplacement.

- **FE aim:**
  The investigation of repository induced, thermo-hydro-mechanical (THM) coupled effects on the host rock.

  - The experiment will be:
    - Full-scale
    - Heated up to 130°C
    - Not artificially saturated
    - Long-term (approx. 20 years)

Experiment Location at Mont Terri

- Plan view
  - FE-A niche (finished in 2011)
  - FE tunnel (planned for 2012)
FE-Experiment, Scoping calculations

Example from TH-modeling with the multiphase flow simulator TOUGH2
- Temperature after 20 years (longitudinal section)

Niche Construction

- FE-A (start) niche
- height: approx. 5m, length: approx. 8m, width: approx. 10m)

- finished in June 2011
- needed for instrumentation, tunneling and emplacement
Experimental Design

MB tunnel | FE-A niche

Plug | Heaters

Boreholes for Instrumentation – Phase 1

<table>
<thead>
<tr>
<th>What do we want to measure?</th>
<th>Instrumentation</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rock</td>
<td>Buffer</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Saturation</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pressures</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Deformation</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

**Bohrung** | **Länge (m)** | **Durch.messer (mm)** | **Kn. durchmess (mm)** | **Ach. (%)** | **Hoehung (aufwärts verschieb) (%)**
---|---|---|---|---|---
BFE.A8 15.13 | 76 | 61 | 242.10 | -0.08 |  
BFE.A9 13.10 | 76 | 61 | 242.10 | 0.08 |  
BFE.A10 46.43 | 131 | 117 | 242.10 | 0.38 |  
BFE.A11 46.45 | 131 | 117 | 242.10 | 0.38 |  

**Instrumentation Phase 1:**
- approx. no. of sensors
- 8 climate
- 6 packer systems
- 38 temperature
- 35 pore pressure
- 36 packer (bar) press.
- 2 horizontal inclinometers
- 40 temperature
- 30 deformation points
FE-Experiment, Instrumentation (Phase 1)

- Instrumentation of the host rock (far-field)
  - Hydraulic (multi) packer systems (pressures + Temp.) [in blue]
  - Horizontal inclinometers (deformation + Temp.) [in orange]
  - Explorational borehole extension [in green]
  - Distributed fiber optical sensing [Temp.]

Dissemination level PU

Date of issue of this report: 12/06/12
Excavation: See Presentation  Sven Köhler

Granular Bentonite Emplacement

- Emplacement experiment with granular bentonite and twin augersystem

ESDRED (EC co-funded) 2006

Date of issue of this report: 12/06/12
Fine Granular
Industrial Sodium Bentonite

MX 80

General Description
Fine granular Sodium Bentonite with an average particle size ranging between 16 and 200 mesh.

Functional Use
Multi-purpose product noted for rapid dispersal in water. Employed in a wide variety of industrial applications.

Purity
Hydrous aluminum silicate comprised primarily of the clay mineral Montmorillonite. Montmorillonite content is minimum. Contains small portions of feldspar, feldspathoids, etc.

Chemical Composition
Typical Analysis (moisture free):

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>32.0%</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>21.9%</td>
</tr>
<tr>
<td>CaO</td>
<td>3.15%</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.33%</td>
</tr>
<tr>
<td>MgO</td>
<td>1.67%</td>
</tr>
<tr>
<td>Na₂O</td>
<td>2.57%</td>
</tr>
<tr>
<td>H₂O</td>
<td>5.64%</td>
</tr>
<tr>
<td>Trace</td>
<td>0.77%</td>
</tr>
</tbody>
</table>

Chemical Formula
A thixotropic expanding mineral structure of approximately:

\( (Al₂Si₄O₁₀(OH)₂)·Na⁺·Ca⁺·H₂O \)

Moisture Content
Maximum 12% as supplied.

Dry Particle Size
Maximum 13% retained on 18 mesh (850 microns).

pH
5% solids dispersion 8.0 to 10.5

Viscosity
1 part bentonite to 1 part deionized water (5.2% solids) dispersed on high-speed mixer. Funnic mixer. 5ppg minimum.

Packaging
Multi – 50 kg paper bags, 10 kg bags or bulk.

Grain sizes granulates-bimodal distribution

Martin Holl
Rettenmaier & Söhne
Holzmühle 1 73494 Rosenberg Germany
Grain size distribution bentonite granulate

Emplacement with 1-Auger-System (EB); 2002

(D1.8) – Minutes of Project Progress Meeting – PPM02
Dissemination level PU
Date of issue of this report: 12/06/12
Emplacement with 2-Auger-System (ESDRED)

2006

Emplacement with 5-Auger-System (LUCOEX)

2014

Date of issue of this report: 12/06/12
LAVIOSA MPC
Zone Portuaire
62, Route du
Hazay
78520 Limay
FRANCE
Serge Resnikow

Bony S.A.
St. Etienne (F)

Bentonite Block Production 2011

Alpha
Ceramics
Aachen (D)
FE/LUCOEX-Experiment, Time Frame

Instrumentation will be realized in 3 phases
- Phase 1: Instrumentation of host rock (far-field)
- Phase 2: Instrumentation of host rock (near-field)
- Phase 3: Instrumentation of buffer / canisters

The duration of heating resp. monitoring depends on the “speed” of saturation and hence will last approx. 15 to 20 years

Acknowledgment:
- Experimental Partners: ANDRA, CHEVRON, SKB, ROSIVA
- Mont Terre Consortium: P. Bossart, Ch. Nussbaum, D. Jäggi, Th. Theurillat, etc.
- Contractors: Swisstopo, CTSM, GGT, Flotron, Schütze, Geotest, Solvays, Solvay, etc.
- Modeling Teams: UPC, Intera, Föyry, GRS, LBNL, BGR

thank you for your attention
WP3 - Full scale emplacement experiment (ALC Phase 3 experimentation)

LUCEOX Progress meeting 2
Olkiluoto

Objectives of the Phase 3 HLW cell experiment

1. Test the technical feasibility of a cell construction, including useful & head part and different equipments into the cell (end steel plate and shield steel plug).
2. Verify the suitable working of the head insert to absorb the thermal dilation of the casing,
3. Provide data on the casing behaviour under thermal loading,
4. Verify the design of the cell head to limit thermal gradients on the drift wall,
5. Study the THM behaviour of the interface between rock and casing and of the surrounding rock (not included in LUCEOX).
Preliminary test of the head part feasibility (1)

Objective: demonstrate the feasibility of driving in a metal cell-head insert over a length of 10 m with a reduced initial annular space.

The test has been performed in the CAN drift from 14 to 16 June 2011.

The drilling machine (Ø excitation = 791 mm)

Characteristics of each sleeve section

<table>
<thead>
<tr>
<th>material</th>
<th>Non alloy steel S235</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside diameter</td>
<td>775 mm (annular space = 8 mm)</td>
</tr>
<tr>
<td>thickness</td>
<td>35 mm</td>
</tr>
<tr>
<td>Useful length</td>
<td>2 m</td>
</tr>
</tbody>
</table>

Preliminary test of the head part feasibility (2)

The drilling has been stopped after 7.5 m (4 sleeve sections) due to the jamming of the insert in the rock.

Thrust limit of the drilling bench

Date of issue of this report: 12/06/12
Preliminary test of the head part feasibility (3)

Geometry of HAT1601 insert (BD scan performed 3 weeks after the excavation)

Incline of the cell = +0.63°, overall horizontal deviation < 10 cm

Impact of this preliminary test on the design of the cell that will be excavated in the Phase 3 of the “HLW cells” program:

Overview of the experimental set-up for phase 3 of the “HLW cells” Program Unit

Date of issue of this report: 12/06/12
Definition of the thermal load

- To be representative of the waste packages, a constant rated power has to be applied from the beginning of the heating
- The thermal peak has to be reached in a reasonable time (< 1 or 2 years)

For comparison, the mean thermal power of HAIR waste packages at the moment of their storage (2025) will be approximately 100 W/m - thermal peak after 25 years.

Design of the heaters (performed by Aitemin)

3 heating elements of 3 m long each
\[ \text{Diameter } = 103 \text{ mm} \]

- External cylinder to protect the heating system from water
- Location of the heaters cables
- Location of the electric resistances

Heater prototype
Design of the casing instrumentation
Sensors technology

- Local strain measurements: strain gauges stuck on a metallic foil, itself welded on the sleeve
- Total pressure measurements
- RH measurements
- Temperature measurements: PT100
- Convergence measurements: classical potentiometric displacement sensor
- Annular space evolution: not defined yet

Examples of similar measurement results

Within the framework of Phase 2 « HLW Cells » Program Unit, a 40 m long cell has been drilled in the CAN drift in October 2011. The sleeve has been equipped with several sensors to estimate the mechanical load of the rock. No thermal load has been applied.
Examples of similar measurement results

RH evolution in the annular space

Convergence evolution

Examples of similar measurement results

Evolution of external circumferential strain at 35 m from the drift

Mechanical signature to be related to mechanical radial load
Current status of the project

- Design of the experimentation
  - Design of the heaters → end of March 2012,
  - Design of the sleeve instrumentation → end of March 2012,

- Qualification phase
  - Qualification of the heaters → June 2012,
  - Thermo-mechanical qualification of the sleeve instrumentation: from April to July 2012 in Seyssins (France)
  - Qualification of the electromagnetic compatibility between heaters and sensors: May 2012 in Toledo (Spain)

- Machining and instrumentation of the sleeve and insert elements: from July to September 2012
- Excavation of the cell: October 2012
- Finalisation of the instrumentation of the sleeve and insert: October/November 2012
- Heaters installation: November/December 2012

- Deliverables: Installation report in January 2013
LucoeX Work Package 4, Multi Purpose Test
LUCOEX Project Progress Meeting 02
March 14th - 15th, 2012
Magnus Kronberg

Contents

- MPT, short recap
  - Background
  - Objectives
- Status and plans
  - Established organisation
    - Steering documents
  - Status and plans
    - Instrumentation and preparation
    - Buffer and filling components
    - Machine development work
- Time schedule

Appendix 7

(D1.8) – Minutes of Project Progress Meeting – PPM02
Dissemination level PU
Date of issue of this report: 12/06/12
Contents

- MPT, short recap
  - Background
  - Objectives

- Status and plans
  - Established organisation
    - Steering documents
  - Status and plans
    - Instrumentation and preparation
    - Buffer and filling components
    - Machine development work

- Time schedule

KBS-3H key components in the design

The development and demonstration of the deposition machine was included in ESDRED.
KBS-3H reference design: DAWE (Drainage, Artificial Watering and air Evacuation)

Schematic illustration of DAWE, in the repository case the sections will be ~150 m long with multiple canisters and distance blocks.

Multi Purpose Test, background

- Åspö HRL, KBS-3H test site at the -220 m level
  - Deposition drift DA1619A02, 95 m long
  - Deposition equipment is located at the site
Multi Purpose Test, objectives

- Test the system components in full scale and in combination with each other to obtain an initial verification of design implementation and component function
- This includes the ability to manufacture full scale components, carry out installation (according to DAWE) and monitor the initial system state of the MPT and its subsequent evolution

Contents

- MPT, short recap
  - Background
  - Objectives
- Status and plans
  - Established organisation
    - Steering documents
  - Status and plans
    - Instrumentation and preparation
    - Buffer and filling components
    - Machine development work
- Time schedule
Multi Purpose Test, established organisation

Multi Purpose Test, steering documents

- KBS-3H Multi Purpose Test, LucoeX WP4, Work Plan
  SKB:doc ID 1289269
  - Sub Work Plan MPT Instrumentation and Preparation,
    SKB:doc ID 1319412
  - Sub Work Plan MPT Buffer and filling components
    SKB:doc ID 1319470
  - Sub Work Plan for the KBS-3H Machine development
    SKB:doc ID 1294077

- Documents and WP4 folders will be copied to the project place during March (April)
Scoping calculations indicate that the inflow is about the same as what the buffer can absorb. Given the large quantity of water which is artificially added into the system following the installation (according to DAWE) further wetting is not assessed as being beneficial and the test will be left to saturate naturally during the test period.

An Instrumentation plan has been developed

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP</td>
<td>S1: 17.8</td>
</tr>
<tr>
<td>PP</td>
<td>S2: 16.3</td>
</tr>
<tr>
<td>WC</td>
<td>S3: 13.95</td>
</tr>
<tr>
<td>WP</td>
<td>S4: 11.55</td>
</tr>
<tr>
<td>WF</td>
<td>S5: 9.05</td>
</tr>
<tr>
<td>DS</td>
<td>S6: 6.8</td>
</tr>
<tr>
<td>DB</td>
<td>S7: 3.3</td>
</tr>
<tr>
<td>IS</td>
<td>S8: 1.3</td>
</tr>
<tr>
<td>IB</td>
<td>S9: 0</td>
</tr>
<tr>
<td>Gas pressure</td>
<td>S10:</td>
</tr>
<tr>
<td>Strain gauge</td>
<td></td>
</tr>
<tr>
<td>Flow meter</td>
<td></td>
</tr>
<tr>
<td>Displacementcollar</td>
<td></td>
</tr>
</tbody>
</table>

[S1: 1 pore pressure will be installed at the pilot hole.
S9: 3 pore pressure transducers will be installed in each core]
MPT, Instrumentation plan, detailed example

S4

Sensors
- TP Total pressure
- PP Pore pressure
- WC Water content capacitive
- WP Water content psychrometric
- WF Water content volumetric
- DS Displacement supercontainer
- DB Displacement bentonite
- IS Incinerometer supercontainer
- IB Incinerometer bentonite
- GP Gas pressure

MPT, Instrumentation and Preparation

Status
- The Instrumentation Plan review and update process is currently being finalized and an updated cost assessment has been initiated.
- Tenders for manufacturing of the plug have been obtained and evaluated, the purchase is currently in its final stage.
- Contractor for the sawing of the plug and cable notches have been selected.

Plans
- Production of drawings for the measurement system will start when the number of sensors and contractor have been decided, followed by purchasing of measurement system, sensors, data loggers, computers etc.
- Scanning and an updated geological mapping is being planned.
MPT, Buffer and filling components

- **Status**
  - A Buffer Mould has been ordered from Herrströms Mekaniska, expected delivery is April 30, 2012.
  - Bentonite (MX-80) has been ordered and delivered

MPT, Buffer and filling components

- **Planned work**
  - Acceptance test of the bentonite
  - Compaction test to establish the correct process parameters for the specific material.
  - Mixing of the bentonite with water to attain the required moisture content, prior to pressing of the blocks.
  - A few test blocks will be cut and samples extracted to check the quality of the blocks.
  - Machining of the blocks is planned to be carried out in Finland
MPT, KBS-3H Machine development work

• Status
  – Flaws in the software structure have been surveyed
  – Bus loads, sensor interfaces and control interfaces have been examined.
  – Software corrections programmed
  – Wear in the sliding plate noted. Likely reason for the jamming problems noted when driving the palette underneath the Supercontainer.
  – New cushions and new sensors systems will be mounted in the palette.

MPT, KBS-3H Machine development work

• Planned work
  – When the mechanical updates are ready the control system testing will continue (structural corrections and development of new control methods).
  – Upon sufficiently stable control the machine performance will be evaluated in repetitive tests (Supercontainer and Distance block dummies followed by bentonite distance blocks).
  – 2-week training possibility for Post-doc/student planned for autumn 2012, operating the deposition machine with the objective to identify difficulties generally avoided by the regular operator due to experience of specific situations.
MPT, KBS-3H Machine development work

- Planned work
  - Transport of the Supercontainer dummy to ground surface will provide knowledge of the overall transportation process with SKBs new MPV (Multi Purpose Vehicle)
  - Detailed planning of Supercontainer and Distance Block assembly with sensors will be initiated as soon as the instrumentation design is locked
  - Detailed planning of MPT installation and control procedure will be initiated before summer.

Contents

- MPT, short recap
  - Background
  - Objectives
- Status and plans
  - Established organisation
    - Steering documents
  - Status and plans
    - Instrumentation and preparation
    - Buffer and filling components
    - Machine development work
- Time schedule
Multi Purpose Test, time schedule, delays

- Work with the deposition machine is delayed due to key recourses (control system expertise) required within a prioritized SKB project.

- There is an ongoing expansion of Åspo HRL and the blast cycle affects the KBS-3H test site from 14:00 most days throughout 2012.

As a result installation will not be possible during 2012 but will rather be carried out in the beginning of 2013. The consequences for the KBS-3H and Lucoex project is currently being evaluated and will be addressed asap.

Multi Purpose Test, time schedule

<table>
<thead>
<tr>
<th>Activity</th>
<th>Variant</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPT Work Plan</td>
<td>195 Aug</td>
<td>01.06.27</td>
<td>01.12.23</td>
</tr>
<tr>
<td>MPT test design</td>
<td>235 Aug</td>
<td>01.06.27</td>
<td>01.06.18</td>
</tr>
<tr>
<td>Pre characterization DA1515A02</td>
<td>259 Aug</td>
<td>01.09.19</td>
<td>01.08.28</td>
</tr>
<tr>
<td>Deposition machine upgrade and tests</td>
<td>407 Aug</td>
<td>01.06.06</td>
<td>01.02.20</td>
</tr>
<tr>
<td>Planning for the MPT installation</td>
<td>130 Aug</td>
<td>01.04.02</td>
<td>01.09.28</td>
</tr>
<tr>
<td>Production of buffer mould</td>
<td>295 Aug</td>
<td>01.01.19</td>
<td>01.01.30</td>
</tr>
<tr>
<td>Production of buffer and filling components</td>
<td>374 Aug</td>
<td>01.05.04</td>
<td>01.03.08</td>
</tr>
<tr>
<td>Pipes for DAWE</td>
<td>128 Aug</td>
<td>01.02.15</td>
<td>01.06.19</td>
</tr>
<tr>
<td>Production of CP</td>
<td>238 Aug</td>
<td>01.10.27</td>
<td>01.12.19</td>
</tr>
<tr>
<td>Sensors</td>
<td>130 Aug</td>
<td>01.05.21</td>
<td>01.12.16</td>
</tr>
<tr>
<td>Drift preparation</td>
<td>195 Aug</td>
<td>01.07.36</td>
<td>01.04.12</td>
</tr>
<tr>
<td>Supercontainer assembly</td>
<td>209 Aug</td>
<td>01.05.09</td>
<td>01.04.20</td>
</tr>
<tr>
<td>MPT installation</td>
<td>57 Aug</td>
<td>01.02.18</td>
<td>01.05.07</td>
</tr>
<tr>
<td>MPT DAWE procedure and test start</td>
<td>V Aug</td>
<td>01.03.02</td>
<td>01.03.15</td>
</tr>
<tr>
<td>Operational phase</td>
<td>148 Aug</td>
<td>01.03.13</td>
<td>01.04.17</td>
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<tr>
<td>Excavation</td>
<td>150 Aug</td>
<td>01.04.10</td>
<td>01.11.15</td>
</tr>
<tr>
<td>Reporting</td>
<td>573 Aug</td>
<td>01.03.21</td>
<td>01.04.02</td>
</tr>
</tbody>
</table>
WP 5, GENERAL

- LUUCOX tasks:
  - 5.1. Detailed WP planning
  - 5.2. Demonstration of buffer components emplacement
  - 5.3. Quality assurance and problem handling
  - 5.4. Final reporting of WP5
  - 5.5. Integration

- Tasks 5.2 and 5.3 has devided in 3 LOTs:
  - LOT 1: Bentonite block emplacement and gap filling
  - LOT 2: Equipments for quality control
  - LOT 3: Problem handling equipment
WP 5, PROGRESS

- LOT1, Bentonite block emplacement and gap filling
  - Feasibility study ready in August 2011
  - Design phase from autumn 2011 to March 2012
  - Manufacturing of installation machine, steel construction
    - Invitation for tenders has sent at 12th February
    - Order until the end of April
    - Machine ready until October

14 March 2012

WP 5, PROGRESS

- LOT2, Equipments for quality control
  - Feasibility study ready in November 2011
  - Design phase from November 2011 to May 2012
  - Manufacturing of equipments; from summer to autumn 2012

14 March 2012
WP 5, PROGRESS

- LOT3, Problem handling equipments
  - Work will be started in June 2012
  - Currently we are waiting new ideas

LOT 1, STARTING POINT

- One vehicle with full bentonite set and lifter, "Full Set Combined Vehicle"
- Plain bentonite blocks brought to the tunnel
LOT 1, EXAMINED VEHICLE CONCEPTS

- One logistic selection
  - Many blocks at the same time to the deposition hole or
  - blocks brought during the installation procedure
- Five different vehicle types examined further
  - Full Set Combined Vehicle = FSCV
  - Four different kind of "split vehicles"

LOT 1, CHOSEN CONCEPT

- Two vehicles, installation machine and transfer shuttle
- Transfer shuttle is travelling between driving tunnel and
deposition hole bringing blocks for installation machine.
LOT 1, CHOSEN CONCEPT

- Dimensions of the blocks
  - Diameter 1.65 M
  - Height 0.5 M – 0.96 M
- Transportation of buffer blocks to ONKALO inside the container

LOT 1, CHOSEN CONCEPT

- Installation machine
LOT 1, CHOSEN CONCEPT

- Installation machine

BUFFER INSTALLATION SEQUENCE

1. Positioning
2. Block taken from container
3. Gripper over dep. hole
4. Block and pallet installation
5. Transfer shuttle positioning
6. Empty gripper to the shelf
7. Shelf forwards and lifter over container
8. Block taken from container
LOT2: 3D Coordinate System with a Laser Tracker

1. 3 reference points (equipped with prisms) to connect equipment’s local coordinate system to tunnel’s coordinate system.
2. Laser tracker to locate the reference point with accuracy of 0.1mm.
3. Xy inclinometer to level the frame within ±0.2 degrees.
4. 3 reference points (with prisms) to get the position of the gripper within accuracy of ±1 mm.
5. Precise xy inclinometer to level the gripper within accuracy of 0.01 degrees.

LUCEOEX milestones

LOT1:
M01 Feasibility studies ready 30.06.2011 OK
M02 Design of method and related equipment ready 31.12.2011 Delayed, ready by mid March
M03 Indoor testing ready 21.12.2012 Will be delayed
M04 Testing in Ontario with concrete blocks ready 20.05.2013
M05 Testing in Ontario with bentonite blocks ready 28.09.2013
M07 Final report / LOT1 1-2 ready 25.03.2014

LOT2:
M01 Feasibility studies ready 16.11.2011 OK Delayed, was waiting
M02 Design of method and related equipment ready 15.02.2012 Critical
M03 Indoor testing ready 13.04.2013
M04 Testing in Ontario with concrete blocks ready 07.10.2013
M05 Testing in Ontario with bentonite blocks ready 05.11.2013
M07 Quality assurance method report ready

LOT3:
M01 Feasibility studies ready 03.10.2012
M03 Indoor testing ready 07.10.2013
M04 Testing in Ontario ready 17.01.2014
M05 Problem handling report ready 25.02.2014

Date of issue of this report: 12/06/12
ONKALO URCF
Status and investigations
Johanna Hansen/Paula Kosunen

Achievements and plans

- Test operation and commissioning
- Construction of disposal facility
- Construction of ONKALO and confirming investigations at Olkiluoto
- Site selection
- Site investigations started in 1986
- Government's decision on objectives and timeline schedule
- Government's decision on responsibilities
- Application for construction license
- Application for operation license
- Start disposal of spent fuel

Timeline:
- 1978
- 1983
- 2001
- 2012
- 2018
- 2020

Appendix 9
ONKALO layout and technical information

TECHNICAL INFORMATION
- Excavation volume 365,000 m³
- Access tunnel
  - Length 5 km
  - Inclination 1:10
  - Size 5.5 x 6.3 m
- Total length of tunnels and shafts 9.5 km
- Shafts 3.5, 4.5 & 3.5 m

TIME-TABLE
- Start summer at 2004
- Research depth at 2010
- Excavation complete at 2011

Aims and objectives of ONKALO

- Provide an opportunity for Posiva to learn and develop competences
  - Human performance and safety culture
  - Competences required for nuclear facility
  - Methods and means to construct and supervise related activities
- Contribute to the application for Construction License (CLA)
  - Assess that previous conclusions of the site and its properties hold good
  - Enable the acquisition of detailed characterisation information for design and performance assessment
  - Produce evidence that safety critical functions can be managed and controlled during construction
  - Provide assessment that excavation can be executed, managed and quality assured to a sufficient level
- Contribute to the application for Operation License (OLA)
  - Provide a possibility to test and demonstrate repository systems for their intended use (incl. separate licensing)
  - Make possible a full system test to assess "initial state" (prototype)
  - Make possible long-term tests and observations (if needed)
Investigations at ONKALO
Investigations carried out in parallel with excavation

Demonstration tunnel 1 in -420 level ONKALO pilot hole
SURE
Sulphate reduction experiment: investigation plan for the 1st phase

- The aims of the experiment are:
  - to demonstrate microbial reduction of sulphate with ANME
  - to determine case-specific (i.e., variable concentrations) reduction rates
  - to determine renewal rates of energy sources for sulphate reduction

- Two drillholes will be drilled: one for the sulphate rich watertype and the other for methane rich watertype (ONK-PVA6)

- Investigations contain following stages:
  1) Drilling and basin characterization of the investigation drillholes in 2009-2010
  2) Microbiological studies in SO4 and CH4 rich water types in 2010
  3) Influence of flow changes to sulphate reduction rate in 2011
POSE

Posiva’s Okiluoto Spalling Experiment, phase 1

- Objectives:
  - To establish the in situ spalling strength of Okiluoto migmatitic gneiss
  - To establish the state of in situ stress at the -345 m depth level
  - To act as a Prediction-Outcome (P-O) exercise

- The boring of the disposal holes is done in summer 2010
- The experimental work should be ready by the end of 2010

REPRO

Rock Matrix Retention Properties

- Objectives:
  - to investigate rock matrix retention properties (porosity and diffusivity of rock matrix pores) under in situ conditions
  - to demonstrate that the assumptions made in the safety case are in line with the site evidence

- Experiments are focused on the rock mass which presents conditions in the repository near field (ch. 4140), because most of the retention along potential release paths takes place in the vicinity of the deposition holes.

- Three different experiment types are applied:
  - tracer experiments in the water phase,
  - diffusive gas transport in the rock matrix
  - electrical method for logging of the rock matrix pore structure.
HYDCO
Hydraulic characterization of the rock mass and geochemical characterization of poorly conductive fractures

- The primary objective is to investigate groundwater flow pattern in poorly conductive ($T < 10^{-7} \text{ m}^2/\text{s}$) fractures in the rock mass representative to that to be surrounding deposition holes and tunnels.
- The goal is to investigate
  - the geometry, connectivity, geochemical properties, heterogeneity and transport properties in poorly conductive fractures ($T<10^{-7} \text{ m}^2/\text{s}$) (the hydraulic coupling of the transport i.e., the transport resistance)
  - influences of open drillholes to connectivity
  - geochemical characterization of poorly conductive fractures
- Experimental work will be finished by the end of 2010

Underground construction related activities
The main structures in Olkiluoto

Construction cycle for disposal facility
Reinforcement

Grouting with silica in D2
Grouting of personnel and ventilation shafts ongoing

Demonstration tunnel
Making tunnel floor even by mechanical method

Toward the EBS demonstrations
Steps for development and design of KBS-3 system and considered in testing and demonstration at ONKALO.

SAFETY REQUIREMENTS
→ DESIGN BASIS
→ FUNCTIONAL REQUIREMENTS
→ SPECIFICATIONS
→ TECHNICAL SOLUTIONS
→ PERFORMANCE ASSESSMENT
→ SAFETY CASE
→ LICENSE APPLICATION
Buffer bentonite demonstration test

- Objectives:
  - develop instrumentation of a test setup
  - test alternative buffer design
- Location:
  - Demonstration niche TUI (c1470)

Future: preparing for prototype at ONKALO

4-5 canisters will be emplaced in a new tunnel to be excavated at ONKALO and will be sealed and plugged for monitoring
which includes plug too

Prototype at ONKALO – preliminary plans

- Implementation at -420 m, ”demonstration area”
- A new tunnel will be excavated
  - Investigation, design and excavation shall be made based on “final” instructions and method descriptions
- More detailed plan and cost estimation during 2012
  - In conjunction of YJH 2012 -programme
- Tests on equipment in current demonstration tunnels at ONKALO
  - Acquisition of knowledge and experiences for elimination of deficiencies and uncertainties
  - Tunnels will be used also at later date as a place for equipment testing and validation
RSC methodology

Paula Kosunan

RSC

The Rock Suitability Criteria (RSC) programme 2007-2009

- Evaluation of the natural properties of the host rock for the purpose of locating suitable rock volumes for the repository -> avoidance of such features of the host rock that might endanger the proper functioning of the engineered barrier system (canister - buffer - backfill) or the function of the host rock as a natural barrier
- Definition of the target properties of the host rock, related to chemical composition of the groundwater, groundwater flow, groundwater transport properties and thermomechanical stability
- Development and testing of the criteria -> tentative criteria by 2009
- Posiva Working Report 2009-29

The RSC-process (“Rock Suitability Classification”) 2010 ->
- Testing and evaluation of the rock suitability criteria, criteria update
- Application of the criteria -> RSC implementation process
- Integration of RSC into the repository design and construction
- RSC demonstration
Layout determining features of Olkiluoto

9000tU layout
RSC Demonstration

- carried out during the construction of KBS-3V demonstration facilities in ONKALO
- purpose: testing of the RSC-II criteria and their practical application; implementation of the rock suitability assessment procedure with investigations, design and construction

Preliminary RSC suitability assessment

- June 2010: rough, preliminary evaluation of the rock suitability in the demonstration area to estimate the needed length for the demonstration tunnels
- based on the preliminary RSC-I criteria (WP2009-28, Heilä et al.)

Geological model of the Olkiluoto site v 2.0:
- 6 brittle deformation zones (BFZ), no LDFs:
- No hydrological zones
- 2 demonstration tunnels, length 55 m
Demo-area detailed-scale model vs. 1

September 2010, after investigations in the ONKALO access tunnel and in part of the demo area central tunnel.

Demo-area detailed-scale model vs. 2

Model update in November 2010, after drilling of and investigations in pilot holes ONK-PH16 and ONK-PH17.
RSC suitability assessment

- End of December 2010, based on updated RSC-criteria, including a criterion for maximum fracture-specific inflow, effect of the large fractures estimated also by using the FPI-criterion suggested by Murner (2010)

=> Decision on tunnel excavation: DT1 shortened to 52 m, DT2 to be made respectively longer

Demo-area detailed-scale model vs. 3

Model update in July 2011, after investigations in the excavated DT1, also taking into account data from demo-area cross-hole investigations (mise-a-la-masse, hydraulic interference test)
RSC suitability assessment (DT 1)

- Model update in October 2011, after deposition hole pilot hole investigations (DT1), also taking into account data from DT2 (tunnel and probe hole data).

Demo-area detailed-scale model vs.4

- Dissemination level PU
- Date of issue of this report: 12/06/12
Expansion of the detailed scale model

- plans to
  - expand the DSM to cover the technical facilities in ONKALO and, eventually, the first deposition panel
  - include lithology and ductile deformation