EUROPEAN COMMISSION

Community research

LUCOEX

(Contract Number: 269905)

DELIVERABLE (D-N°:6.4)

Summary of progress of work

Author(s): SKB, Andra, Nagra and Posiva

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Dissemination Level		
PU	Public	X
RE	Restricted to a group specified by the partners of the [acronym] project	
CO	Confidential, only for partners of the [acronym] project	

1. Introduction to the LUCOEX project

1.1 Project partners

Partner number	**Partner full name**	**Short name**	**Country code** (2-letter ISO code)
1	Swedish Nuclear Fuel and Waste Management Company	SKB	SE
2	National Agency for Radioactive Waste Management	ANDRA	FR
3	National Cooperative for the Disposal of Radioactive Waste	Nagra	CH
4	Posiva Oy	Posiva	FI

1.2 Scope of work

The project consists of several large scale demonstration activities on vital technical parts of four different concepts, which have been developed to the present state-of-the-art in national programmes. The demonstration activities take place in four different underground research laboratories (URL) in Europe, which have been constructed for the specific purpose of developing repository technology under repository-like conditions. All four URLs have access available for domestic and foreign decision makers and the general public interested in getting information at actual sites of demonstration.

The four addressed repository concepts are:

- Horizontal disposal of waste packages in Opalinus Clay formation
- Horizontal disposal of waste packages in Callovo-Oxfordian clay formation
- Horizontal disposal of waste packages in crystalline hard rock
- Vertical disposal of waste packages in crystalline hard rock

In order to establish confidence in the technical feasibility of constructing and operating the four repository concepts the following key technical issues are addressed in LUCOEX:

- Gallery construction
- Manufacturing and emplacement of buffer around waste canisters
- Emplacement of waste packages
- Backfilling and sealing of galleries

The quality and use of obtained technical achievements are enhanced by engaging many more persons in the addressed issues than the ones taking part in the actual demonstration activities. This is done by specific activities on:

- Networks among engineers and scientists representing Member States and associated countries

The further demonstration work beyond the LUCOEX project calls for broad distribution of findings and remaining tasks to consider. In line with this ambition specific activities address:

- Training and dissemination of project outcomes

2. Project objectives

2.1 Overall objectives

The overall objective of the four year LUCOEX project is to demonstrate the technical feasibility *in situ* in European URLs of the key technical activities for safe and reliable construction, manufacturing, disposal and sealing of repositories for long-lived high-level nuclear waste.

In more detail the objectives are:

2.2 Detailed objectives for "Coordination and integration" (WP1)

The objectives are to continuously integrate the results in the different demonstration activities and to disseminate obtained knowledge in European Union Member States and Switzerland by means of:

- Providing a broad base for integrated planning, evaluation and reporting of the LUCOEX outcome.
- Communicating technical findings and conclusions drawn during progress in one activity, which primarily may have an interest to the continuation in the other activities.
- Networking among scientists and engineers in countries of the European Union and Switzerland with focus on creating forums for presenting and discussing the LUCOEX project.
- Providing training opportunities on the proposed demonstration projects to organisations engaged in radioactive waste management within countries of the European Union and Switzerland.

More detailed objectives are:

- Host training activities e.g. at respective URL carrying through demonstration activities.
- Provide programme for exchange of staff between participating organisations for information transfer on performed demonstration activities.
- Invite representatives in European Union Member States and Switzerland, working with concepts not studied in LUCOEX, to discussions on LUCOEX outcomes.
- Invite and support travel and lodging of students from European Member States and Switzerland to training and workshop events.

- Publish results in technical magazines and at specific seminars/conferences.

2.3 Detailed objectives for "FE Mont Terri" (WP2)

This experiment has the following objectives:

- Provide a confirmation of the suitability of the repository design basis or give clear insights regarding how it should be modified.
- Construct an emplacement tunnel using modified standard equipment (e.g. modified road header) and adequate support measures (anchors, concrete lining or steel ribs).
- Demonstrate the production of high quality bentonite granulate mixtures (pellets) and compacted bentonite blocks under relevant conditions.
- Design, manufacture, test and install (in situ) the emplacement equipment suitable for the emplacement of steel canisters (heaters), pedestal bentonite blocks and bentonite granulate buffer under relevant conditions.
- Demonstrate the suitability of the overall horizontal emplacement concept for SF/HLW repositories in shales (Opalinus Claystone).

2.4 Detailed objectives for "ALC experiment at Bure" (WP3)

This experiment has the following objectives:

- Test the making up of the cell (head & usable part) and of different equipments into the cell (end steel plug and shield steel plug).
- Verify the suitable working of the head insert to absorb the thermal dilation of the casing. Provide data on the casing behaviour under actual thermal loading.
- Verify the design of the cell head to limit thermal gradients on the drift wall.

2.5 Detailed objectives for "KBS-3H" (WP4)

This experiment has the following objectives, which have been slightly revised from the text in the Grant Agreement:

- 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 – Drainage, Artificial Watering and air Evacuation) and monitor the initial system state of the MPT (Multi Purpose Test) and its subsequent evolution.

2.6 Detailed objectives for "KBS-3V Emplacement tests in ONKALO" (WP5)

This experiment has the following objectives:

- Develop and demonstrate emplacement of full scale bentonite buffer in deposition holes.
- Develop quality assurance.
- Develop problem handling during installation.

2.7 Detailed objectives for "Management and dissemination" (WP6)

The main objectives for LUCOEX Coordination Work Package are:

- Set up the needed infrastructure both physically and virtually, to coordinate LUCOEX

activities and to support the LUCOEX work in the different Work Packages.
- Help organize and balance the LUCOEX work and activities, and to facilitate and support the organization and management of the different Work Packages in LUCOEX.
- Supervise the production of necessary documentation for the LUCOEX, to provide means of quality controlling them and to publish them, including open access.

- Disseminate results to the scientific and engineering communities and to the public.
- Act as an information and communication centre about the activities of the LUCOEX.

3. Work progress and achievements during the period

LUCOEX has submitted 17 out of 22 Deliverables being due during the project's first 18 months and achieved 24 out of 29 Milestones. The remaining Deliverables and Milestones will be late due to miscellaneous delays in the project's work progress.

Some of the project's total set of objectives have been achieved during the first 18 months as planned. Many of the others have been addressed and project work progressed in accordance with technical plans. In some cases the work has been delayed but is predicted to be completed in the course of the project in such a way that the project's objectives are achieved with planned quality before the end of the project. In one case, however, this is not judged possible; Work Package 4 (WP4) has experienced such a delay that the final objective, the WP's final report, will not be achieved until May 2015, i.e. 5 months after LUCOEX´ end date.

The project work has in its technical and manageable parts resulted in important progress, in particular:

3.1 WP 1 Coordination and integration

Project Progress Meetings (PPM) have been planned to take place at regular intervals - approximately one each 9 months. The first two meetings have been held during the project's first 18 months, and the meeting minutes have been submitted to the Commission as Deliverables. The first meeting was devoted to integrated planning and the second to technical progress. The second meeting provided the opportunity to visit the ONKALO Underground Rock Characterisation Facility and the site for the LUCOEX demonstration activities. The meeting was also followed by an internal workshop on "Tunnel and disposal cell excavation" and "Buffer components design and manufacturing".

A technical Expert Group, which shall advice the Project Management in an independent mode, has been established with members representing the beneficiaries and members from other European organisations.

Technical and management plans have been developed in accordance with plan. A quality document in the form of a Project Plan has been compiled in order to document Terms of Reference, important rules and general guidance for the activities to take place. The Risk Assessment Plan outlines the specific issues, which shall be assessed in the course of the

project, by whom and at what intervals. A Communication Plan outlines how external communication to the scientific community and general public as well as internal communication between WPs will take place. A Scholarship and Training plan describes how 20 different scholars may be involved in the LUCOEX' work, be trained and in general learn about LUCOEX' results. A plan on Added Value describes how European Member States may take part in LUCOEX' dissemination process. All these plans have been submitted to the Commission as Deliverables.

The Scholarship applications have been a disappointment and the two first ones attracted no applicant and the second two only two. Decision has been taken to intensify announcement by using LUCOEX network for making person-to-person contacts.

A second disappointment is that only five European organisations have announced interest in

taking part in the process of disseminating results.

3.2 WP2 FE Mont Terri

The detailed planning has been completed and documented in a work plan, which was submitted to the Commission as a Deliverable. Due to time delay in acquiring information on when the tunnelling work would start, this delivery was made late.

The 50 metres long tunnel with a diameter of 2.5 metres was successfully excavated from April to July 2012 within the planned time for the work. The support was made in accordance with the plan and consisted of steel ribs and/or concrete. The concrete was applied in layers with and without reinforcement. The advance rate was on average 1.0 up to 1.5 metres per day, the lower rate when steel ribs were used.

Development of manufacturing methods for bentonite blocks and pellets have advanced to laboratory and full size mock-up testing in accordance with plan.

The design of the emplacement machine has started with a conceptual study and planning of pre-tests.

Technical topics on excavation of galleries in shale have been subject to intense discussions between Nagra and Andra, while manufacturing methods have been discussed in a wider forum between all LUCOEX' beneficiaries.

3.3 WP3 ALC experiment at Bure

The test of the ALC cell head experimental design casing digging was successfully performed in June 2011 as reported in the submitted Deliverable on the work. The result indicated two technical issues that need modification in the design of the ALC experiment. One is the cell head length that is suggested to be 6 metres instead of 10 metres. The other is the gap between the cell wall and the insert that is suggested to be increased from 8 millimetres to 12 millimetres.

Preparation for the ALC experiment has started with development of the instrumentation design. The first sleeve section for instrumentation has been completed. It will be used for

pre-tests of instrumentation and heater installation before start of cell excavation. This start has primarily been delayed by six months due to unforeseen technical problems.

Interactive discussions have taken place within the LUCOEX project on excavation in shale as well as in crystalline rock. Instrumentation questions have been raised during technical meetings in other WPs besides the PPMs and Steering Committee Meetings (SCM).

3.4 WP4 KBS-3H

When the detailed plan was made it was concluded that the objectives of the WP's activities should be slightly modified, by adding the word "initial" in one place, due to the fact that the test period will be only 400 days. The objectives now read: "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 the Drainage, Artificial Watering and air Evacuation – DAWE - design) and monitor the initial system state of the Multi Purpose Test

(MPT) and its subsequent evolution"

A new mould for pressing buffer blocks has been successfully manufactured and is ready for testing. The bentonite has been purchased and verified to comply with the quality requirements. The pressing of the blocks has been postponed for six months due to the delay in the up-grading of the deposition machine.
The machine has during the period been significantly up-graded, primarily through installation of new sensors, which provide better data on lifting heights and position. The time schedule, however, has suffered from a 5 months delay due to lack of software resources. This delay has in turn consequences for all future WP activities and suggests that decommissioning and reporting after 400 days of testing will not be completed until May 2015. Corrective actions to take will be raised at the next SCM in September 2012.

Important progress has been made in preparation of the MPT, among them instrumentation plan, compartment plug purchase and a slightly modified test geometry with a 2.7 metres long pellets section – increased from 1.3 metres - and a consequent 19.2 metres long total test section.

Interaction with other WPs has been by participation in project meetings in addition to PPMs and discussions of different experiences from excavation in shale and crystalline rock, manufacturing of buffer components and use of different types of sensors.

3.5 WP5 KBS-3V emplacement tests in ONKALO

A new concept for transportation and installation of bentonite buffer blocks has been developed. The concept protects the blocks against air humidity and mechanical damage inside a container during transport.

The filling of the gap between the buffer blocks and the rock will be carried out in parallel with the installation of the blocks. The pre-measured amount of pellets will be transported and installed with the same installation equipment as the buffer blocks.

In interaction with the other WPs in project meetings, reviews of work plans and discussion on common issues and experiences, new ideas for the installation of the WP5 test have developed and have been implemented.

3.6 WP6 Management and dissemination

The LUCOEX project management has been organised and a Steering Committee (SC)

established. The SC has held 5 meetings during the first 18 months.

The web site portal (www.lucoex.eu) has been designed and put into operation. Its purpose is to publish all public LUCOEX information and results. A two-way internal LUCOEX internet portal has in addition been established, where all LUCOEX documents are made available to the invited members.

4. Contact details

WP1 Leader
Christer Svemar
SVENSK KARNBRANSLEHANTERING AB (SKB)
Technology
Box 250
1101 24 Stockholm
SWEDEN
E-mail: christer.svemar@skb.se

WP2 Leader
Hanspeter Weber
NATIONALE GENOSSENSCHAFT FUER DIE LAGERUNG RADIOAKTIVER ABFAELLE (Nagra)
Engineering and Field Investigations
Hardstrasse 73
5430 Wettingen
SWITZERLAND
E-mail: hanspeter.weber@nagra.ch

WP3 Leader
Gilles Armand
AGENCE NATIONALE POUR LA GESTION DES DÉCHETS RADIOACTIFS (ANDRA)
Direction scientifique
Service mécanique des fluides et des solides
Centre de Meuse / Haute-Marne - Route départementale 960 - BP 9 - 55290 Bure
FRANCE
E-Mail: gilles.armand@andra.fr

WP4 Leader
Magnus Kronberg
SVENSK KARNBRANSLEHANTERING AB (SKB)
Technology
Äspö Hard Rock Laboratory
Box 929
572 29 Oskarshamn
SWEDEN
E-mail: magnus.kronberg@skb.se

WP5 Leader
Keijo Haapala
POSIVA OY (POSIVA)
Engineering Development
Olkiluoto
FI-27160 Eurajoki
FINLAND
E-mail: keijo.haapala@posiva.fi

WP6 Leader
Christer Svemar
SKB
Technology
Box 250
1101 24 Stockholm
SWEDEN
E-mail: christer.svemar@skb.se

Coordinator
Fredrik Johansson
SKB
Technology
Box 250
1101 24 Stockholm
SWEDEN
E-mail: fredrik.johansson@skb.se

Proxy
Christer Svemar
SKB
Technology
Box 250
1101 24 Stockholm
SWEDEN
E-mail: christer.svemar@skb.se

EC project officer:
Christophe Davies
European Commission
Directorate-General for Research
Directorate Energy (Euratom)
Unit J.2 – Fission
Office: CDMA 1/61
BE-1049 Brussels
BELGIUM
Email:
christophe.davies@ec.europa.eu

5. Project information

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