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DELIVERABLE (D-N°:D1:07B) EXPERT GROUP REPORT #1

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PU	Public	PU
RE	Restricted to a group specified by the partners of the	
CO	Confidential, only for partners of the LUCOEX project	

[LUCOEX]



1 Introduction and overall Expert Group objectives

The LUCOEX Project was launched in May 2011. Its overall objective is to demonstrate the technical feasibility *in situ*, in European underground research laboratories (URLs), of key technical activities for safe and reliable construction, manufacturing, waste emplacement and sealing of repositories for long-lived, high-level radioactive waste.

The LUCOEX Project consists of several large-scale demonstration activities developed to the present state-of-the-art in national programmes. The activities take place in four different URLs in Europe, which have been constructed for the specific purpose of developing repository technology under repository-like conditions. The key technical areas to address are drift construction, manufacturing and emplacement of buffer material around waste canisters, emplacement of waste packages, and backfilling and sealing of drifts.

The four (4) addressed repository concepts are:

- Horizontal disposal of waste packages in Opalinus clay formation (Mont Terri, Switzerland), by Nagra;
- Horizontal disposal of waste packages in Callovo-Oxfordian clay formation (Bure, France), by Andra;
- Horizontal disposal of waste packages in crystalline hard rock (Äspö, Sweden), by SKB;
- Vertical disposal of waste packages in crystalline hard rock (Onkalo, Finland), by Posiva.

1.1 LUCOEX Project organisation

The LUCOEX Project consists of six Work Packages (WPs) that are lead respectively by the organisation indicated in brackets:

- Work Package 1 (WP1) - Coordination and integration (SKB),
- Work Package 2 (WP2) - Full Scale Emplacement Experiment (FE) Mont Terri (NAGRA),
- Work Package 3 (WP3) - Full Scale Emplacement Experiment (ALC) at Bure (ANDRA),
- Work package 4 (WP4) - KBS-3H Multi-purpose Test (MPT) at Äspö (SKB),
- Work Package 5 (WP5) - KBS-3V Emplacement tests in Onkalo (POSIVA),
- Work Package 6 (WP6) - Management and dissemination (SKB).

The Project is managed by a Steering Committee consisting of representatives of all involved institutions and chaired by SKB, which is also acting as the Project Coordinator.

To support the Project implementation, an Expert Group (EG) has been appointed; consisting of four (4) individual representatives of involved institutions (those representatives are not directly engaged in the implementation of the LUCOEX Project), and four (4) external independent experts.

The scheme of the LUCOEX Project organisation is shown in Figure 1.

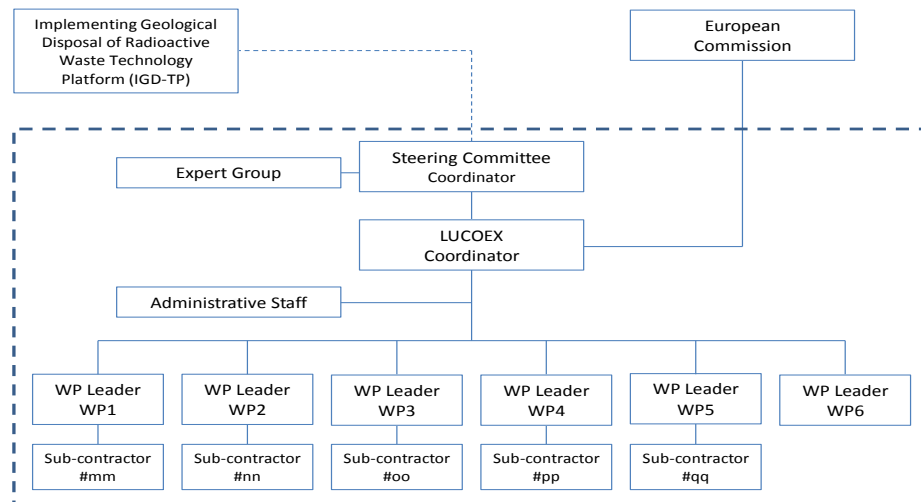


Figure 1: LUCOEX Project organisation

1.2 Expert Group Work Organization

1.2.1 Organization

The Expert Group reports to the LUCOEX Steering Committee, and consists of the following eight (8) members:

- Jean-Michel Bosgiraud (Andra - Chair),
- Thomas Fries (Nagra),
- Stig Pettersson (SKB),
- Hannu Pihlainen (Posiva),
- Wilhelm Bollingerfehr (DBE-TECHNOLOGY),
- Alan Hooper (Consultant, UK),
- Lumir Nachmilner (Consultant, Czech Republic),
- Jan Verstricht (SCK/CEN), replacing Geert Volckaert on 25 March 2013.

1.2.2 Meetings

As per the Experts' Letter of Mission, the Expert Group meets at the request of its Chair or of the Steering Committee, and as a minimum meets to discuss findings and to formulate recommendations and advice on the three (3) occasions when Expert Group Reports are required to be prepared.

1.2.3 Responsibilities

The Expert Group serves the Project with reviews, cross-Work Package (WP) examinations and recommendations and advice related to technical plans, achievements and dissemination activities. In particular, it considers:

- The added value generated through the technical and scientific integration in LUCOEX during progress of the project;
- The soundness and relevance of the technical approach;
- The scientific and engineering standard of the work carried out; and
- The progress of the technical/scientific work reached at the end of the Project and the fulfilment of the posted objectives.

For this purpose, the Expert Group has the responsibility to:

- Perform a critical cross-WP examination of technical plans existing at the time of the Expert Group Reports scheduled during the project, i.e. after approximately 1.5 years and 3 years,
- Perform a cross-WP examination and analysis of technical achievements on three occasions during implementation of the LUCOEX project: after approximately 1.5 years, 3 years and on the completion of project activities,
- Carry out a technical review of the Final Project Technical Reports, including an assessment of the added-value reached in terms of scientific and technical integration, soundness and relevance of the technical choices made and the adequacy of the scientific and engineering standard of the work carried out.
- Advise on the technical relevance of the other reports intended for publication on the LUCOEX website with respect to objectives and obtained technical facts,
- Produce three EG reports (Deliverables) to document its findings on three occasions: around Month 18, Month 36 and Month 46, and
- Make relevant suggestions, based on the review findings, related to the LUCOEX Project work, either as a group or as individual members.

1.2.4 Deliverables

The Expert Group delivers to the LUCOEX Steering Group three (3) Expert Group reports to be posted on the public website of the LUCOEX project as Project Deliverables (D1.7, D1.11 and D1.14). These 3 reports have a “Public” (PU) Dissemination level.

In this document, the Expert Group Report (D1.7) provides an extended version (B) of the first of these 3 Deliverables (Version A was released on 15.03.2013).

2 Expert Group activities linked to the present report

The independent Expert Group for cross-examination and critical review of plans and results was established in spring 2012: it consists of eight (8) members of whom four (4) have been appointed by the LUCOEX beneficiaries and four (4) selected from organisations outside the LUCOEX consortium.

The Group has held so far two (2) meetings: the aim of the opening one was to establish a common view on tasks to be performed and to plan its work in accordance with the EG Terms of Reference, while the second one focused on assessment of the Project progress after some 18 months of implementation.

2.1 Opening Expert Group meeting and first recommendations

This first meeting was held in Andra headquarters (Châtenay-Malabry) on 28 March 2012. The meeting consisted of presentation related to WP3 activities (Andra heating experiment, called hereafter ALC) followed by a round-table discussion regarding the Expert Group work.

The ALC experiment is related to the disposal cell concept in the French Deep Geological Repository (DGR, also referred to as Cigéo) for the vitrified waste (high-level, long-lived waste) storage containers. A horizontal micro-tunnel, about 700 mm in diameter, is lined with steel casings (called hereafter liner and insert) with the following geometrical characteristics:

- ✓ Usable part (“body” part), at least 30 m long, used for disposal of containers,
- ✓ Head part, 10 m long, used for cell sealing,
- ✓ End steel plug (base plate) and shield steel plug.

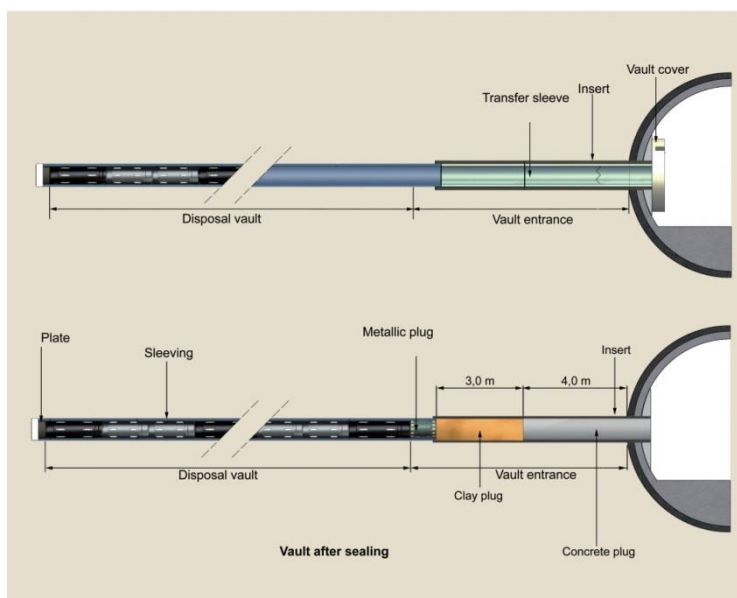


Figure 2: Schematic of horizontal disposal cell for vitrified waste containers (during filling operations & after closure)

The ALC program is planned at the Bure Underground Laboratory (URL) to test the feasibility of horizontal cell construction and the thermo-hydro-mechanical (THM) behaviour of such a type of disposal cell.

The main objectives of this full-scale demonstrator are to:

- Test the making up of the cell (head & usable part) and of different equipment into the cell (base plate and shield plug),
- Verify the suitable working of the cell head insert to absorb the thermal dilation of the liner in the cell body part,
- Provide data on the liner behaviour under thermal loading (vitrified wastes have a significant thermal output, which has an impact on the individual cell design and on the lay-out of panels of cells and hence on the prospective Cigéo footprint),
- Verify the design of the cell head to limit thermal gradients on the drift wall,
- Study the THM behaviour of the interface between rock and sleeve, and of the surrounding rock (this part is not included in LUCOEX).

The experimental set-up is presented below in Figure 3:

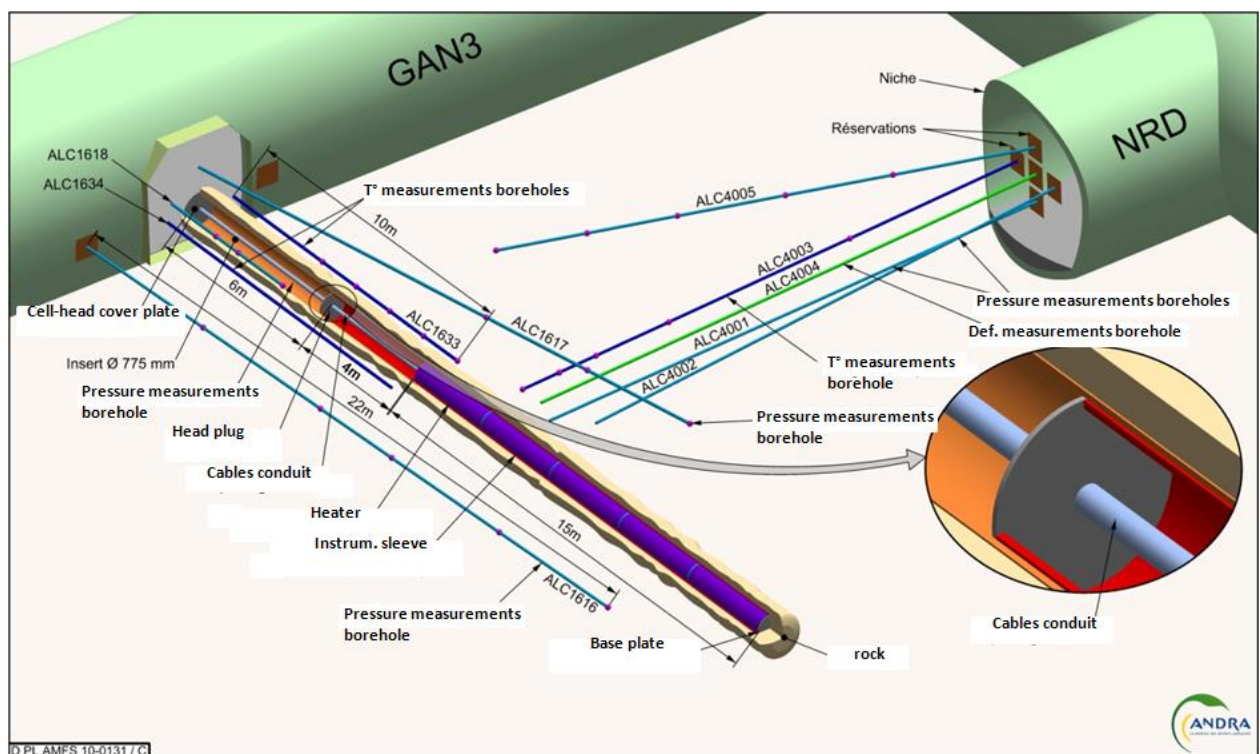


Figure 3: Schematic of ALC instrumentation and monitoring set-up

Previously, a 40 m long horizontal cell was drilled in a Bure URL drift in October 2011. Its sleeve was equipped with several sensors to monitor the mechanical load of the rock, but no thermal load had been applied. The new horizontal borehole (disposal cell) will enable the monitoring of the thermal effect on the near field.

The ALC experiment status and schedule as presented to the EG are summarized hereafter:

- 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 in May 2012 in Toledo (Spain),
 - ✓ Machining and instrumentation of the sleeve and insert elements from July to September 2012,
 - ✓ Excavation of the cell in October 2012,
 - ✓ Finalisation of the instrumentation of the liner and insert in October/November 2012,
 - ✓ Installation of heaters in November/December 2012,
 - ✓ Issue of a Deliverable (Installation Report) in January 2013.

The presentation on the ALC experiment was delivered by Jacques Morel (Andra); it dealt with the general objectives, but also with the current status of the work progress, including a realistic list of technical and scientific risks identified by Andra's scientists.

Technical comments at this stage of the ALC experiment are elaborated in Chapter 3.

Besides, the main items of the round table discussion on Expert Group activities included the following managerial points:

a) Content of Expert Group work:

Following a free exchange of ideas, the Expert Group summarized its views concerning its assessment work on the LUCOEX Project as follows:

- Evaluation of the LUCOEX work programme and achievements cannot be based on technical deliverables alone; a specific presentation by the WP manager or scientific expert of the objectives and of the results obtained in each technical work package (supported by a general discussion with the presenter) is necessary, throughout the project life, for a thorough understanding of the pending technical/scientific issues,
- Most of the Expert Group's contribution will be in providing recommendations on how to bring added value to the Project,
- Added value lies in particular in integration actions, public communication, confidence building in repository concepts and designs, clarification of safety case rationale, and risk evaluation,
- Since each of the four (4) technical WPs is devoted to a specific demonstration activity in support of the respective national programme, integration of project results has been deemed by the Experts as a real challenge.

b) Expert Group Opinion about the information lodged in IGD-TP/LUCOEX website:

All the experts agreed on the fact that “Projectplace” is a great web tool to work with: it is fast, powerful and safe, easy to customize, nice for conviviality... but at the time, with the current configuration of the LUCOEX Project on Projectplace, information is hard to find.

Then, the Expert Group made its first recommendation:

- ***Recommendation 1/1***

The LUCOEX website lodged on Projectplace should be organized in a user-friendly way (coming with a user’s guide) for quick access to documents in their final status. If possible, all the draft documents should be lodged in “Work folders” and the old documents in “Archive folders”.

A similar disposition should be made available to upload/download the Expert Group outcomes (“Expert Group Folder”).

A technical arborescence of the website should accordingly be arranged for that purpose (e.g. as for SKB’s SIERG Project).

c) Expert Group Opinion about the information lodged in the LUCOEX Public Portal

By contrast with what is stated above, all the experts agreed on the fact that the www.lucoex.eu Website was a user-friendly and convenient place to browse, even if the amount of information available is somewhat limited (a fact which makes sense at this early progress stage of the project).

d) Expert Group Opinion about Appendix 1 & Work plans

Appendix 1 to the Contract executed by the LUCOEX participants contains a general Description of the Work (DoW), of the existing state of knowledge/state of the art and of the programme objectives (what is at stake), hence the need for specific information (cf. Item (a) above).

Apart from Appendix 1 to the contract, no reading had been made at date of first meeting by the Experts, concerning the Work Plans content (cf. Item (b) above).

2.2 18 month progress meeting

This second meeting was held in Mont Terri, Switzerland, on 24/25 September 2012. The meeting consisted of presentations of all technical WP activities apart from WP3 (which was presented at the first meeting in Paris), a round-table discussion regarding the progress of the Project, and concluded by a site visit to Mont Terri Underground Research Laboratory, specifically to the site where the LUCOEX Full-Scale Emplacement (FE) Experiment has been initiated.

2.2.1 Summary of presentations

a) WP2 – Nagra – Full Scale Emplacement Experiment at Mont Terri:

The FE Experiment carried out by Nagra at the Mont Terri URL is reproducing the progressive spent fuel (SF)/high-level waste (HLW) disposal canister emplacement and bentonite buffer backfilling sequence of operations, including emplacement tunnel construction (at 1:1 scale as dimensioned in Nagra's DGR concept). It has the following objectives:

- Investigation of THM response of Opalinus clay and bentonite buffer to heating and natural saturation over a period of 12 to 15 years (this is not a part of LUCOEX),
- Investigation of 1:1 scale emplacement operations including:
 - Emplacement tunnel construction,
 - Canister emplacement operation,
 - Stability of bentonite block pedestal (supporting the canister),
 - Granular bentonite backfilling operation (with target emplacement of a dry density of around 1.45 g/cm³ and homogeneous dry density distribution).

The Figure 4 below illustrates the conceptual approach of the various tests to be carried out in the FE Experiment at Mont-Terri:

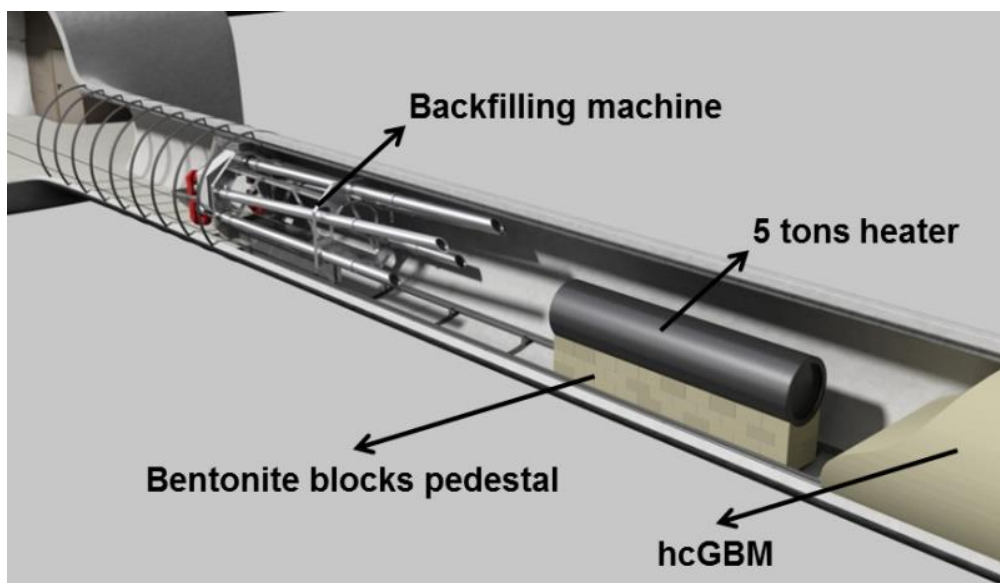


Figure 4: Schematic of canister disposal in drift followed by buffer backfill

Herwig Müller & Tim Vietor presented the rationale and objectives of the heater part of the FE Experiment (full scale, not artificially saturated, supported by a long-term data collection over 12 to 15 years). The experts noticed some commonality with Andra's ALC Experiment (long term, same maximum temperature at contact with the host formation) and Andra's repository concept (type of rock, thickness of host formation, and importance of geological containment).

Sven Köhler presented the characteristics of the excavated drift and the various designs and materials of wall supports considered: low pH shotcrete (dry mix application), fibreglass rock

bolts and steel arches. The excavation-induced damage observed on the drift floor (slab) were commented on (the main reason proposed was the host formation dip and the associated orientation of the main stresses).

Tobias Vogt detailed the THM monitoring strategy over the experiment life cycle, while Hanspeter Weber elaborated the fabrication and installation of the pedestal blocks (supporting the canisters) and of bentonite admixture (pellets made of MX80 from Wyoming) emplaced at time of backfilling. An exchange of questions and answers followed, mainly focused on the block handling and positioning (alignment) issues at time of real application (i.e. industrial operations). Aspects of the hygroscopic behaviour of the blocks were also discussed.

Nagra reminded the Expert Group that retrievability of canisters (following emplacement) is not a part of the design criteria selected for the repository concept. This presentation was complemented by being followed by a site visit inside the Mont Terri URL to observe the FE experimental drift undergoing excavation works.

Technical comments on the FE Experiment are elaborated in Chapter 3.

b) WP4 – SKB – KBS-3H Multipurpose Test at Aspö:

The WP4 Multi-Purpose Test (MPT) carried-out by SKB is dealing with the buffer emplacement and plugging of a horizontal disposal drift as per the KBS-3H concept. Its main objectives are as follows:

- Test the system components in full scale and in combination with each other to obtain an initial verification of design implementation and component function; and, intrinsic to this,
- Test the ability to manufacture full-scale components, carry out their installation and monitor the initial system state of the MPT and its subsequent evolution.

The sketches below show the various components comprising the MPT.

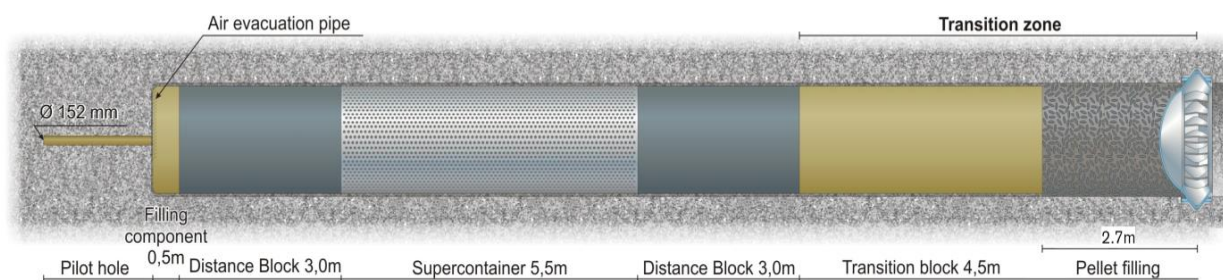




Figure 5: Schematic of MPT experimental set-up

This complex experiment comes as a complement to the initial development of the water-cushion, heavy-load emplacement machine, which was mostly carried out within the frame of the EC co-funded ESDRED Project (www.esdred.info), a few years ago. It takes place inside a 95m long, 1.85m internal diameter drift drilled with a horizontal reamer, thus providing a circular, regular and smooth surface.

Magnus Kronberg delivered a general presentation and focused on the key experiment objective: making possible a thorough comparison with the KBS-3V emplacement concept. This comparison has already been achieved for the issues related to mechanical handling of copper canisters in both horizontal and vertical disposal concepts, but not yet reached for horizontal disposal drift buffer material backfilling and plugging/sealing issues.

The main technical challenges were identified, these being: a tight schedule, the future fabrication of bentonite blocks (needing a 30 000 t press) and their machining, the wireless monitoring over a 40+ month period and the adaptation of the KBS-3H water-cushion emplacement machine (initially designed for the transfer of the “super-container”).

The Expert Group requested to receive in the near future a sketch of the lifting tool considered for the manipulation of blocks at time of construction (assembly) of the super-container (made of copper canister + bentonite blocks + steel perforated envelope).

Technical comments on the MPT Experiment are elaborated in Chapter 3.

c) WP5 – Posiva – Development of Buffer Block Installation Concept at ONKALO:

The KBS-3V Emplacement Test in Onkalo has 3 main objectives:

- Development of bentonite buffer rings or blocks respectively surrounding or below/above the copper canister; and pellet installation between the rings and blocks and the rock wall,
- Achievement of required quality of installation (involving demonstration that the buffer installation is in compliance with pre-defined standards),

- Development of problem-handling tools: design, build and test adequate equipment to solve critical situations such as breakage of bentonite blocks before or after copper canister installation.

The KBS-3V concept is illustrated below (the buffer installation process (2), covered by WP5, occurs inside the vertical excavated hole (4) in which the canisters (3) are emplaced).

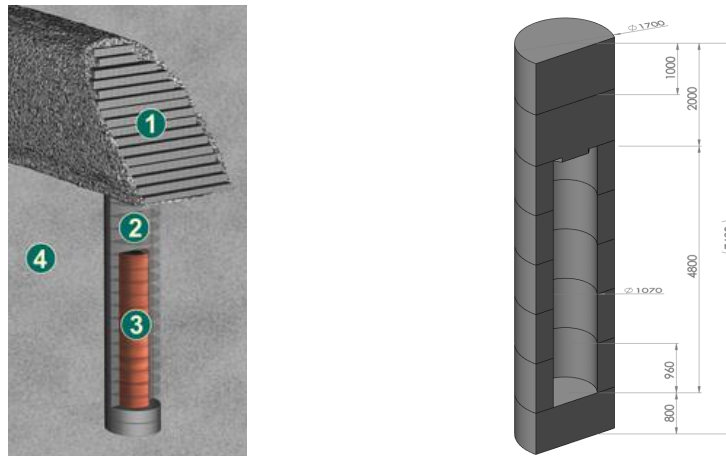


Figure 6: Buffer installation in KBS-3V concept

The two main pieces of handling equipment conceived for the purpose are respectively called:

- Buffer Installation Machine (BIM) for buffer block emplacement,
- Buffer Transfer Device (BTD) for transferring of buffer blocks from service tunnel (1) to BIM.

The sketches below show their design principles:

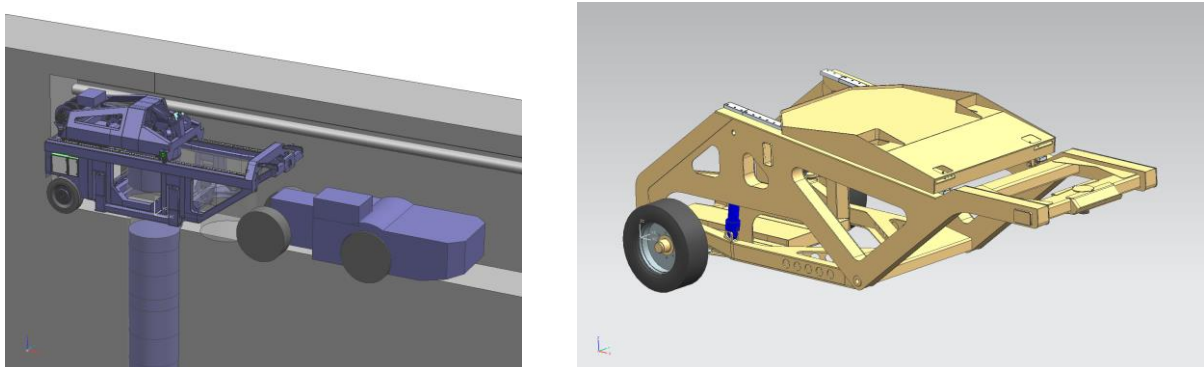


Figure 7: BIM (left) and BTD (right)

Keijo Haapala presented more details on the development status of the Buffer Block (ring) Installation Concept. The system also includes a vacuum type (suction cups) lifting device (see sketch below).



Figure 8: Bentonite blocks lifting device

This last machine also emplaces the pellets which are introduced at the conclusion of buffer block emplacement to backfill the residual voids (annular gaps) in the deposition hole. It was noted that the mechanical tolerances are very strict and represent a challenge of their own.

The testing campaign was scheduled to take place in ONKALO between April 2013 (with dummy concrete blocks) and August 2013 (with real bentonite blocks).

Questioned about the general schedule and operational safety aspects, Keijo Haapala indicated that the 5t block (ring) fabrication and the lifting equipment fabrication are long lead items, on the critical path and that the system at the end will be operated by remote control.

Technical comments on the KBS-3V Emplacement Test are elaborated in Chapter 3.

d) Risk management plans (Nagra, SKB, Posiva):

The second focus was related to the participants' risk management plans. Nagra, Posiva and SKB successively presented their respective experiment risk management plan. Each of these plans is regularly updated (at least twice a year) by the technical WP experiment team members.

For Nagra, the main risks are technical and listed below:

- Tunnel stability and long term convergence,
- Life duration of sensors (need of redundancy),
- Heater failure (redundancy),
- Emplacement-instrumentation interaction,
- Block pedestal installation.

For SKB, the main risks identified are as follows:

- Lack of human resources, organization to be perfected,
- Deformation of deposition pallet on emplacement machine,
- Emplacement machine software,
- Supercontainer assembly,
- Sensor failure after installation,
- Spacer feet (made of bentonite and screwed on spacer bentonite rings),

- Operational safety under remote controlled conditions.

For Posiva, the main risks identified are:

- General organization,
- Long lead items (see Item 3.).

The Expert Group praised the participants for their transparency in describing the risks, although noting the divergent approaches to risk identification ranging from technical evaluation to rather routine procedural aspects. They identified a few additional risks which are dealt with in the recommendations presented in the following section (Chapter 3).

3 Expert Group recommendations at the end of the second meeting

Based on its preliminary findings, the Expert Group recommendations have been sorted in two categories:

- General recommendations which are more related to Management and Dissemination issues,
- Recommendations which are specific to a given technical WP (WP2 to WP5).

3.1 General recommendations:

a) *Recommendation 1/2: Conviviality of Project-Place Site*

Even though the LUCOEX Project structure in “Project-Place” has improved since the delivery of the first Expert Group recommendations (in April 2012), there is room for further improvement.

The Expert Group in particular (the reader in general) should be informed when final (only) documents or deliveries are downloaded to make their work easier. This information should come with the access route clearly identified.

The names of the files must be improved and should be built up in a standardised way and show the expected content of the document (in short a self-explanatory title would help).

Under folder “working document”, some improvements could be made by adding additional folders, e.g. the different sub-projects or work packages clearly identified to make perusing easier.

Concerning the structure of the “Expert Group” folder, some additional sub-folders could be created: “Programme and agenda”, “Minutes of meeting”, “Presentations” and “Other documents”. In the future it is likely that the number of documents associated with a specific meeting will increase and additional folders would help the Experts to find and file documents.

b) *Recommendation 2/2: Improvement of Work Plans*

Even though the “Work Plans” are not Deliverables per se, as far as they are made available on “Project Place”, they should all come with schematics and drawings and a clear statement of the core objectives and related time frame.

This was more or less respected by the LUCOEX participants (Nagra’s Work Plan was the most in line with this advice). De facto, this recommendation comes late, but could be applied to new European Cooperative Projects, such as DOPAS.

c) *Recommendation 3/2: Formatting of Deliverables*

It would greatly improve the accessibility of the Project to the general interest reader if a standard or at least similar formatting (structure & table of contents, cover page, pagination, validation process, date...) were to be adopted in LUCOEX Deliverables and in particular if an abstract or executive summary were also provided along with an introductory text placing the report's contents in the overall context of the Project.

d) Recommendation 4/2: Integration

The integration between the various Work Packages is, to date, marginal, due to the unique nature of the respective programmes. In these circumstances, the participants should look for (and make explicit) what they can put in common or intrinsically have in common (e.g. KBS-3V and KBS-3H concepts for SKB and Posiva, host rock THM for Andra & Nagra, formulation of bentonite admixtures for blocks and pellets) and specify the likely benefits/inputs to their own programme which are generated by the test outcomes (e.g. critical review of the respective lifting devices used respectively by SKB and Posiva for installing bentonite rings down the vertical deposition holes).

Another possible common issue is how one manages the difficulty and risks of fabricating and emplacing large, heavy bentonite blocks to small tolerances (typically mm), as is the issue of how to protect finished blocks during storage and transport from damage caused by possible fluctuating temperature and humidity or from shocks during transport.

The Expert Group considers that the subject of the management of tolerances could be an element for integration on its own, covering not only the tolerances on the design and specification of bentonite blocks (e.g. size of blocks, water content, density) but also boreholes, drifts, emplacement machinery, any element of the engineered barrier system and how all these have to fit together.

All these aspects of managing tolerances will be encountered in the different LUCOEX WP's and it would be valuable to have a record of how they were dealt with.

e) Recommendation 5/2: Risk management

Even though a risk management plan exists for each technical work package, a common methodology could have been employed to elaborate and formalize all of them.

Similarly, it would have been helpful to have each of them "criticized" (challenged) by an "external eye" (e.g. the LUCOEX Steering Committee). This approach was respected in the DOPAS Project (www.posiva.fi/dopas).

A fault tree analysis could have also helped in the preparation of this type of document.

The LUCOEX Expert Group has noted results of the initial phase of the Project as presented in the 18 month Periodic Report. The Periodic Report indicates certain delays in the implementation of particular tasks having different background, such as various technical problems, missing software, changes in design of handling equipment, optimisation of experiment design, etc. These delays will or may affect gaining complete project results by the planned end of the Project. The Expert Group would appreciate analysis of problems encountered by particular teams while launching their experiments and identification of the

lessons learnt which may be applicable in managing future, large, underground experiments and/or construction of a disposal facility.

The Expert Group positively evaluates cooperative efforts of particular teams, e.g. regarding technical aspects of drift excavation. It has been considered as a good practice to be followed.

f) Recommendation 6/2:

Analysis and assessment of preparatory stages of the project stages may bring useful messages for planning future research and implementation activities. It is recommended to formulate and share lessons learnt from this valuable experience in the final LUCOEX reports.

The Expert Group pointed out the low interest (at this stage) in scholarships and supported an initiative to amplify the announcement of scholarship possibilities by using the LUCOEX network for making person-to-person contacts.

g) Recommendation 7/2:

It might also be helpful to involve the IAEA URF Network to advertise the scholarship possibilities; as well, this network may serve as a channel for disseminating results of the project.

3.2 Technical recommendations:

The technical Work Packages were at their initial stage of implementation. However, thanks to the valuable and open and transparent exchange (mostly focused on work plans and schedules of activities which had just started) with the respective Experiment leaders, it was possible for the EG to issue some preliminary technical recommendations.

3.2.1 WP2 Nagra Full Scale Emplacement Experiment at Mont Terri:

The Expert Group noted the very ambitious work plan covering the FE Experiment at Mont-Terri and the consequent wide array of objectives assigned. The experiment appears well-prepared and justified from the information presented, but the EG considered it would be challenging to thoroughly implement the experiment within the relatively tight schedule of LUCOEX.

Some of the monitoring of the THM behaviour will be initialized at a relatively late stage and little if no results made available within the LUCOEX Project time frame, considering the very slow evolution of the phenomena concerned (requiring some 15 years according to Nagra's presentation). The EG understood that the THM behaviour and the related results are not a part of LUCOEX and therefore not relevant to its deliberations.

The Experts also noted that the bentonite-block pedestals would be assembled manually out of bentonite bricks (blocks approx. 25 kg) at the disposal location and not pre-assembled and transported as a whole as in the original design concept. In addition, the block size used is slightly smaller than for the blocks according to the design concept. The technical choice is well understood (technical and contractual simplification), but the validity of transposing the

test of the handling and emplacing operation is affected with respect to the “pedestal integrity” factor.

Recommendation 8/2:

Monitoring strategy **inside** LUCOEX (technical feasibility of implementation) and **outside** LUCOEX (THM behaviour) should be clarified in terms of expected outcomes.

The FE overall schedule should also be scrutinized to check its compatibility with the LUCOEX general schedule.

3.2.2 WP3 Andra ALC Full Scale Emplacement Experiment at Bure

The Experts took note of the rationale and objectives of the ALC test. The EG comments and questions about the ALC Experiment regarded the following issues:

- i) The sealing performance assigned to the cell head seal (plug) should be more clearly stated (including meeting any associated requirements for hydration and swelling pressure of the bentonite component), even if this part of the programme is out of the scope covered by the LUCOEX Project,
- ii) The validity of the Experiment to represent the full-scale waste emplacement situation (vis-à-vis the thermal effects and the thermal load) could be reconsidered since the interference between horizontal cells cannot be apprehended by this test.

It was recognized by all participants that it would be helpful to the Expert Group’s mission if the strategic objectives of the ALC Experiment could be better understood, e.g. through relevant requirement management information, and it was confirmed that such information could be made available at a later stage.

Recommendation 9/2

Andra should clarify the role of the cell head plug in terms of sealing performance.

Andra should state how the far field is affected by the thermal interference between two horizontal disposal cells and how this phenomenon is taken into account in modelling (as far as this issue is not included in the ALC experiment).

Andra should also specify if a thermal interference test between two thermal cells is planned at a later stage in the Bure URL (and at which scale).

3.2.3 WP4 – SKB – KBS-3H Multipurpose Test at Aspö:

The EG expressed a positive understanding of the technical motivation and noted that most of the components which are assembled within the MPT Experiment were in fact already individually developed before the experiment start-up, thus providing a good degree of technical maturity to the whole test.

The main question raised was linked to the potential risks of bentonite erosion, likely to happen in the real underground conditions (due to a harsher hydraulic situation than anticipated by the test) and how such a phenomenon could affect:

- The successful functioning of the emplacement machine,
- The stability of the engineered barrier formed, and hence its sealing capacity.

Recommendation 10/2

SKB should clarify how the potential buffer erosion phenomenon can be handled or mitigated over a significant time lapse, i.e. the time needed for emplacing the real super-containers and the buffer material over a disposal drift up to 300 metres in length if the environmental conditions are demanding (e.g. will the injection of silica-fume based grout in water-producing fractures be a sufficient solution?).

3.2.4 WP5 – Posiva – Development of Buffer Block Installation Concept at Onkalo:

The EG expressed some concerns concerning the tight work schedule allocated by Posiva to implement the KBS-3V Emplacement Test and wondered about its compatibility with the LUCOEX general schedule. The EG thought that the time necessary for developing positive and realistic answers to the various and relevant technical objectives assigned in the KBS-3V Emplacement Test could exceed the LUCOEX Project duration.

Concerning the production of large bentonite rings with an isotatic press, and considering previous experience developed by SKB or Andra (cf. ESDRED Project) in this field, the Experts mentioned that the availability of the press and the complexity of the mould design / pressing process could be a cause for either some significant delay or technical impasse.

Recommendation 11/2: Pressing of Posiva's bentonite blocks

The use of an isostatic press for such a set of big rings is deemed a major technical and contractual challenge. A “plan B” should be considered (e.g. mobilization of a uniaxial press) for the production of rings, in order not to impair the rest of the WP5 test plan.

The overall KBS-3V Emplacement Test schedule should also be scrutinized to check its compatibility with the LUCOEX general schedule.

4 Expert Group objectives for the next period

The LUCOEX project reached, for most of its technical WPs, the phase of commissioning particular experiments; this is anticipated to be completed during 2013. The Expert Group considers the following issues as appropriate for assessing project performance in this stage:

- Experience gained during bentonite block/ring manufacturing, storage, transport and handling (as a function of time),
- Specifying commissioning/decommissioning criteria for each experiment.

In the longer term, the Expert Group has identified several problems which are deemed as generally valuable for any radioactive waste disposal programme and might be a subject of integration of project results. Even if the results will be obtained during or at the end of performed experiments, their evaluation should be considered in early stages of the experiment initiation to obtain baseline information about the initial status and conditions.

The following non-exhaustive list advises on typical issues in question:

- Observations regarding corrosion or other causes of malfunctioning of the experimental equipment/materials,
- Experience gained regarding lifetime and performance of monitoring instrumentation,
- Comparison of formulated objectives with results obtained, for each WP, and identification of gaps (to advise on initiation of follow-up projects),
- Observation of operational sequences/steps and derived recommendations for future remote-controlled processes.

The Expert Group will focus its activities to adequately follow and interpret the matters listed above and should convene next time with that intent.

The Expert Group also expects that the LUCOEX Experiment leaders will respond to the expressed recommendations (e.g. via discussions in technical Seminars or formal responses), so that the treatment of the relevant issues could be considered in the final EG report.