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LUCOEX

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Project expert review report

Author(s): David Dixon, Golder Associates Limited
Keijo Haapala, Posiva Oy

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

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Publishable Summary

This memorandum provides a summary of the impressions of and observations made by the author in the course of viewing the operation of buffer installation machinery developed as part of the activities of WP5 in the LUCOEX project. Additionally a summary of report review activities associated with development of the documentation of WP5 is provided.

LUCOEX WP5's main goal is to development of prototype machinery for use in demonstrating buffer block emplacement as it could occur in Posiva's KBS-3V geometry. The key parameters investigated in the course of this development activity were developing and demonstrating operation of buffer block and bentonite pellet emplacement equipment and methods. The target set for buffer emplacement in a repository is to place all of the buffer blocks (and pellets) within a 120 minute time period for each borehole. The placement must also attain an accuracy of +/-1 mm to the deposition hole centreline. The 120 minute cycle time excludes the time spent installing the spent fuel canister.

Also of importance to demonstrating the KBS-3V concept is identification and testing of options for removal of buffer materials already placed in a deposition borehole. This is of importance should damage or other unacceptable condition be detected in the buffer, either before spent fuel canister installation or as part of canister recovery. It should be noted that activities associated with installation or recovery of the spent fuel container were beyond the scope of this project.

WP5 was successful in designing, building and demonstrating equipment of the type needed to install both the buffer block and bentonite pellet materials in a KBS-3V geometry. Although not optimised, methods to remove buffer from a borehole were also identified and demonstrated. While the buffer installation technology was demonstrated as being viable, there remain several areas that will require further development and optimisation. In particular, methods need to be identified that will allow for an increased rate of buffer block installation (such that the 120 minute cycle time can be accomplished). If this installation time increase is not achievable, there will need to be a re-evaluation of the allowable time for this and other associated activities within an operating repository. This will not affect the viability of the concept but will have an impact on the scheduling of activities within the repository.

Contents

1 Project Expert Review Report

This memorandum provides a summary of the impressions of and observations made by the author in the course of viewing the operation of buffer installation machinery developed as part of the activities of WP5 in the LUCOEX project (KBS-3V Emplacement tests in ONKALO (EMP)). Additionally a summary of report review activities associated with development of the documentation of WP5 is provided.

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2 General Observations Regarding Field Demonstrations

In order to provide context, it should be noted that the author of this memorandum was not involved in any of the initial design, construction or other development work associated with the LUCOEX. The role of the author was to provide comment, impressions and technical input during the equipment demonstration phases (surface and underground) as well as review of technical documentation generated in the course of WP5 reporting in 2014 and 2015.

2.1.1 Surface and underground demonstrations

The surface demonstration of the completed Buffer Installation Machine (BIM) and Buffer Transfer Device (BTD) were completed at the surface level test and development facility in Posiva's ONKALO facility where lifting, movement and installation trials were completed. Following these trials and completion of any equipment modifications identified as being necessary, both the BIM and BTD as well as a buffer transfer container were tested in Demonstration Test Tunnel 1 at the -420m level at ONKALO.

2.1.2 Summary of observations

As part of the technical review process the operation of the prototype equipment was directly observed by this reviewer at the time of some of the surface trials in late 2014 and general comments were provided to the WP5 project lead. In addition, video records of the equipment operation and subsequent underground demonstrations were provided for review.

The surface trials demonstrated the smooth operation of the BIM once it is properly located above a deposition hole. As noted in the reports for WP5, there were

limitations regarding rate of block installation that can be achieved and in particular, the need for careful movement and positioning of the BTD in the constrained environment of the an underground tunnel. These trials included several iterations as minor limitations of the equipment were identified and corrected. These limitations were largely associated with devices needed to track and confirm block location as it was lowered into the borehole. Although most of this was addressed in the course of LUCOEX, there is still the need for some design optimisation.

The surface trials also included block (and pellet) placement in a full-scale mockup of a deposition hole constructed at the ONKALO. This facility was extremely well laid out, provided an excellent venue for direct observation of buffer installation and physical confirmation of the monitoring devices associated with the BIM. It is possible that this type of facility could also provide a means of demonstrating to the public the technology that would be utilised in the ONKALO without the need to actually enter the site once deposition activities begin. This would also allow for continued use of the prototype BIM and BTD equipment once field operational versions of these devices were put into use.

Subsurface trials were undertaken at ONKALO on completion of the surface trials and minor modifications of the equipment identified as being necessary. A video showing the operation of the BTD and BIM were provided, together with underground trials of potential means of recovering buffer from a borehole. These trials all indicate a viable technology for installation of buffer in a KBS-3V geometry and if necessary its removal. As noted above and also in the documentation of these trials, the key shortcoming thus far has been the very slow installation rate achieved.

3 Review of documents generated as part of LUCOEX WP5 reporting activities.

As part of the documentation activities associated with LUCOEX WP5 a series of reports and memoranda were generated by the project team. These were identified in the LUCOEX project deliverable list. The authors provided draft versions of 10 documents for technical and editorial review and comment. These documents were all reviewed for technological and non-technological content and were then returned as annotated drafts, and where necessary with accompanying review commentary to the WP5 project leader for consideration and new drafts were produced for final submission to LUCOEX project files.

A listing of the specific documents provided for review is as follows:

D5.02 Buffer emplacement test.
D5.03 Designing the gap filling tool
D5.04 KBS-3V buffer emplacement testing
D5.05 Quality Assurance and Problem handling
D5.07 Development of quality assurance tools
D5.08 Plans for solving emplacement problem situations
D5.09 Final Report LUCOEX – WP5
D5.11 Project expert review report
D5.14 Interim report on the project reviews:
D5.17 WP5 News Letter
D5.19 LUCOEX FP7 WP5 Article Material

The documents reviewed provided a comprehensive description of and commentary about the various aspects of buffer block handling and installation in a KBS-3V deposition hole as per Posiva's spent fuel management concept. The reports provided good technical detail regarding the equipment needed, how their design was accomplished and the results of operational trials both on the surface as well as underground. Additionally, approaches to accomplish removal of buffer materials from a placement hole were developed and at least in part demonstrated, again both as surface trials and also underground under conditions approaching those in a deposition tunnel.

The documentation also identified areas where technological limitations or challenges were encountered and where possible, these were addressed as part of WP5 activities. The process developed for buffer installation appears to be viable and robust, although a more extensive program of repeated deposition trials will be necessary to fully assess factors such as equipment robustness, process disruption risks and to develop a better statistical basis for evaluation of placement accuracy. As noted above, the main issue remaining at the end of these trials is associated with the rate at which buffer block placement can be achieved. This should be the topic of future development and trials as it will impact on many associated repository operations.

4 Summary of LUCOEX WP5

Planning of a four year R&D project such as LUCOEX is very challenging and while the final results of WP5 meet the original goals, there was the need to apply a flexible approach to how work was done. As a result of ongoing feedback and re-evaluation of results as they were obtained and assessed, it proved most effective to manage this work's budget and schedule within a bounding framework, allowing for revisions as necessary. A tighter maintenance to the original schedule might have been possible if activities were broken down into smaller parts. However that approach would lose the advantages of a more broadly based project team such as was available to WP5. With this "critical mass" of participants, valuable interactions between the participants of the various tasks occurred, resulting in more thoroughly evaluated products, as well as identification of overlapping areas of interest and concern. The result was cost-effective production of good quality working prototypes of the machines needed for buffer installation in a KBS-3V geometry. This all led to successful testing of this machinery for use in Posiva's disposal geometry.

It should be noted that the work associated with LUCOEX WP5 has been integrated into Posiva's overall repository concept development and demonstration activities. Construction activities and schedules associated with ONKALO also needed to be accommodated in WP5's scheduling. As a result, there were challenges associated with shared resources, however with effective communication and co-operative scheduling all the arrangements needed to complete this work were successfully accomplished. This also highlights the need for and effectiveness of the flexible activities scheduling approach taken to achieve the goals of WP5.

The now developed prototype machines are a good starting point to begin developing a more optimised disposal technology. Major changes that will need to be considered are associated with improving the Buffer Transportation Device and also a better (faster and still accurate) means of positioning of buffer blocks within the deposition hole. There may also be a need to consider changes to the dimensioning and positioning of buffer components. The dimensions and positioning requirements now defined require exacting measuring techniques which are difficult to achieve in the current equipment design. Development of a sufficiently robust

technology for use in block positioning in an actual disposal application is a potentially major cost item and so further work in this area is called for.