EUROPEAN COMMISSION
Community research

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

LUCOEX

(GRANT AGREEMENT: 269905)

WP5: KBS-3V Emplacement tests in ONKALO (EMP)

DELIVERABLE (D5:03)
Memo on designing the gap filling tool

Author(s): Jari Talka Insinööritoimisto Comatec Oy
Keijo Haapala, Posiva

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

Date of issue of this report: 01/02/2015
Start date of project: 01/01/11 Duration: 48 Months

LUCOEX

URATOM

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

WP5: KBS-3V Emplacement tests in ONKALO (EMP)

DELIVERABLE (D5:03)
MEMO ON DESIGNING THE GAP FILLING TOOL

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

Contents

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

1. Introduction

This document, designated D5:03 "Memo on designing the gap filling tool", presents the process and development phases associated with designing the gap filling equipment and machines for use in a KBS-3V deposition geometry. It also provides the framework for future design optimization and implementing of Posiva's bentonite buffer gap filling methods and equipment as part of demonstrating the feasibility of the KBS-3V concept.

The development activities associated with this activity were carried out under Work Package "WP5: KBS-3V Emplacement tests in ONKALO (EMP)", in the FP7 EURATOM project LUCOEX – Large Underground Concept Experiments. Specifically, this document is connected to the LUCOEX WP5 Task 5.3 "Quality assurance and problem handling" where Posiva Oy acted as WP5 Leader.

In Posiva's reference design, after the installation of the buffer blocks, the gap between the bentonite buffer blocks and the host rock will be filled with pellets produced from bentonite clay. This work will test the possibility of filling the gap immediately after installation of each buffer block. This approach is being investigated as it is difficult to see where in the eight meter deep gap the problem is located if a single filling step rather than stepwise filling is attempted. Hence problem identification and remediation can be accomplished early in the gap fill installation process. Additionally, this stepwise filling method will allow for faster buffer installation

It should be noted that the gap filling method developed and investigated can only be used in dry holes where the water protection equipment is not needed and the pellets are able to pour unhindered into the annular gap.

The LUCOEX project will be implemented in collaboration with a consortium of international participants:
• Svensk kärnbränslehantering AB (SKB) (Sweden)
• Agence nationale pour la gestion des dechets radioactifs (ANDRA) (France)
• Nationale genossenschaft für die lagerung radioactiver abfälle (Nagra) (Switzerland)

2. Objectives of the work

The main objective of the work described in this document is to design the equipment for filling the gap between the bentonite blocks and the host rock with bentonite pellets.

Expected outputs of the work:

- Lay-out drawings,
- Detailed drawings,
- First prototype construction, and
- Full scale tests and reporting

3. Realised development activities and their schedule

The development of a means to accomplish block installation and also develop a practical method to accomplish pellet filling of the annular gap between the buffer blocks and the surrounding rock are clearly linked. The more complicated component of these activities is buffer block installation and once

a buffer installation machine (BIM) was developed, activities related to pellet installation could be started. The development of the buffer installation machine was started 25th May 2011 by a brainstorming workshop between Posiva and Insinööritoimisto Comatec Oy at Comatec's premises (Fig. 1). The target of the workshop discussion was to identify potentially new innovations that could be used to accomplish installation of buffer blocks in a KBS-3V placement geometry.

Figure 1. Planning meeting with Comatec.

The main outcomes of the workshop were decisions to adopt the following transportation and installation approach:

- The buffer blocks will be transported from the manufacturer's storage to the disposal area inside the air tight containers.
- Installation of buffer blocks to the disposal hole is done by a Buffer Installation Machine (BIM).
- The transportation of buffer blocks inside the containers from the mouth of disposal tunnel to the installation machine is done by a separate Block Transportation Devide (BTD).
- The top part container operates as a vacuum gripper during the installation of blocks to the deposition hole. (Fig. 2)
- Transportation of containers from the buffer block storage to the Onkalo interim storage is done by truck and further close to the mouth of disposal tunnel by a forklift operating in disposal facility.

From these design decisions, new ideas for pellet filling were identified. It was suggested that the top part of the container used to deliver and place buffer blocks could also be used to hold the pellets that would fill the annular gap (Fig. 2). This means that the gap between the host rock and buffer blocks can be filled after the installation of each block – not after all blocks have been emplaced, as it was planned earlier.

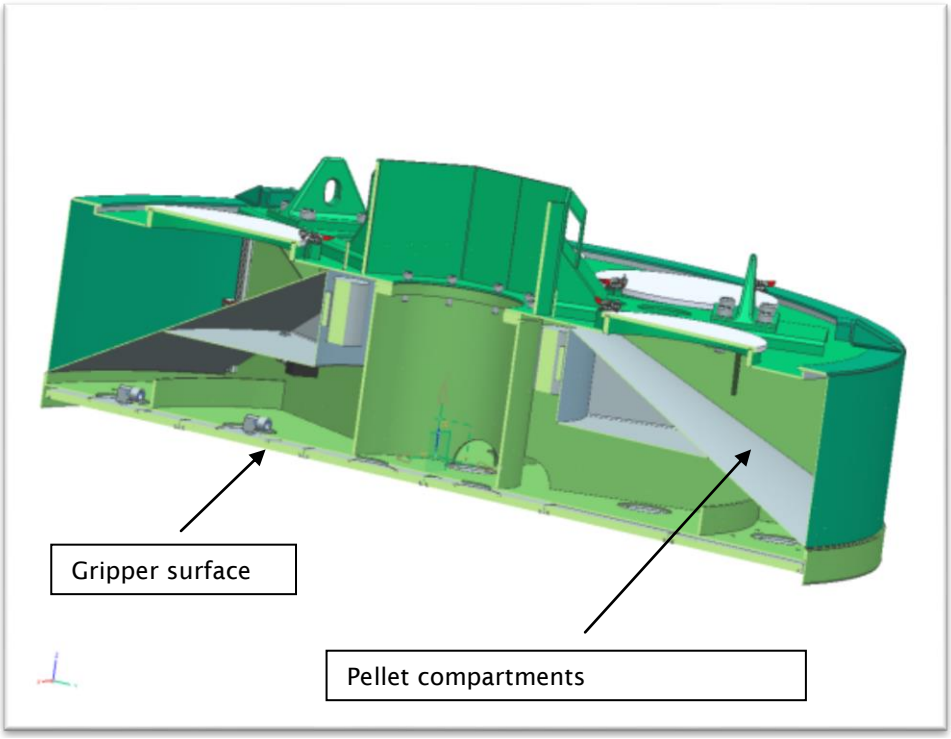

Figure 2. Design for the gripper which includes gap filling compartments.

The basic concept of the pellet filling method has developed further during the summer and autumn of 2011. The work included several project meetings with WP5 members and open project meetings where other LUCOEX partners could participate. Between the meetings, calculations, comparisons, tests et cetera have been completed by WP5 project participants.

4. Results

The result of the development of activities of WP5 associated with pellet filling, is the gap filling tool shown in Fig. 3. This tool is an integral part of the vacuum gripper used for block emplacement. It is composed of 6 compartments that will be filled with predesigned amounts of pellets. By placing pellets in connection with every individual block emplacement, the filling quality and the pellet flow into the gap can be assured. This solution cannot be used together with water protection equipment and also is not appropriate for use in a wet environment.

Preloading of the pellets will occur before the bentonite blocks are sent out from the storage facility. When block placement has been successfully accomplished, a signal will be sent to open the compartments, allowing the pellets to slide out from the compartments by gravity. The pellet delivery tool design includes an option for installing vibrators under each compartment to assist in emptying them.

In order to accomplish gravity feed of dry pellets from the delivery compartment into the annular space associated with the buffer, it is necessary to ensure that the chute associated with the compartment base has an adequate slope. An ideal gradient for the pellet filling compartments was determined through testing the first prototype tool using three alternative pellet types: 8 and 10 mm pillow-shaped compressed pellets and 8 mm cylindrical Cebogel pellets manufactured by extrusion. These tests established that the slope required needed to be at least 27 degrees. (Figures 4 and 5)

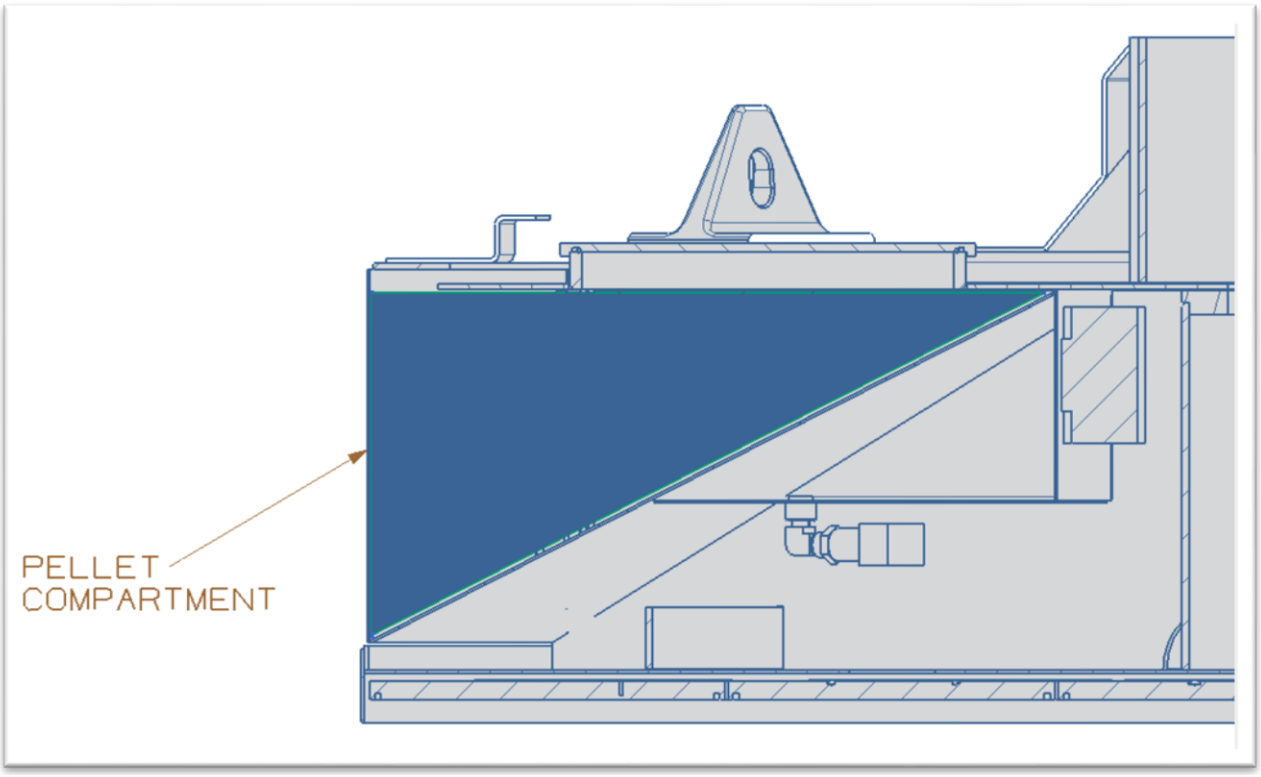

Figure 3. Design of a pellet compartment

Figure 4. Test compartment

Figure 5. Test compartment with pellets

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

5. Identified problems and their solutions

During the work associated with developing a means of delivering and installing pellets into the gap between buffer blocks and the surrounding rock, the following challenges were identified and solutions developed:

- The width of the gap between the buffer block and host rock may vary around the block so uniform filling of the gap with pellets may be challenging.

→ Solution: The six compartments of the gripper can be filled with different quantities of pellets, which make the filling of the gap more uniform. As a preparatory work the volume and form of the disposal hole shall be defined by laser-scanning before the installation. This information will be used to define the optimal centre axis point of the buffer stack and the volume of the gap in different sectors around the buffer. This information will be used to define the amount of pellets to different compartments.

- Pellets must not end up on top of a buffer block in any situation

→ Solution: The gap will not be filled completely, the space a few centimeters below a block's top will be left empty.

- The hatch releasing the pellets from the compartment had to be designed so that the entire gap around the block would be filled simultaneously.

→ Solution: The entire edge of the pellet compartment doors will be lifted up simultaneously.

- It has to be ensured that every single pellet will fall into the gap.

→ Solution: verifying tests and if needed, adding vibrators to the structure. In the tool structure there is a provision for vibrators.

- If water protection is used in the hole, this gap filling method cannot be used.

→ Solution for such situation: The gripper can be used without pellet filling. All blocks will be emplaced first and the entire gap will be filled at once with another pellet filling tool after the water protection system has been removed from the hole.

6. Evaluation of the work / process

The initial design concepts for a gap filling tool were more complicated than those provided in the current approach. This new developed tool is simple and no problems have occurred in integrating it into the block emplacement tool. The manufacturing schedule of the complete gripper meant that the gap filling tool could not be tested separately. With regard to the pellet alternatives tested, the deposition tool did not work with cylinder shaped pellets manufactured by extrusion (tended to hang-up in the compartments). However, this did not cause problems, as these types of pellets had already been determined to be unsuitable for using gap filling (tendency to bridge in the small dimension of the gap, resulting in non-uniform installation). Rounder, roller-compacted pellets are the current reference shape for use in gap filling in the deposition borehole.

7. Next steps / work phases

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

The next step in the buffer gap filling tool development is testing the equipment and implementing possible changes and corrections. These activities will be documented though a series of design documents and reports on the results of installation trials.