Document ID	Version	Status	Reg no	Page
	0.2	Draft		1 (8)
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Reviewed by			Reviewed date	
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D5.6: Definition of the WP5 emplacement process phases and their quality requirements.

Contents

1 Introduction

This document, D5.6 Definition of the WP5 emplacement process phases and their quality requirements, presents the developed process and related quality requirements of the emplacement process developed in the Work Package (WP) 5 ”KBS-3V Emplacement tests in ONKALO (EMP)” in the FP7 EURATOM project LUCOEX - Large Underground Concept Experiments.

The report is part of the LUCOEX –project and it is one of the deliverables in the project; D5.6 Definition of the WP5 emplacement process phases and their quality requirements. The report provides the framework for designing and implementing Posiva’s bentonite buffer emplacement quality control methods and equipment in order to demonstrate the feasibility of the KBS-3V concept for that part. This report is connected to the LUCOEX WP5 Task 5.3 Quality assurance and problem handling. Posiva Oy acts as the WP5 Leader.

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 RADIOAKTIVER ABFÄLLE (“Nagra”)(Switzerland)

2 Context and scope

This document presents the bentonite buffer emplacement process with its different phases and quality requirements set for each phase.
The emplacement process in WP5 of the LUCOEX project covers the following main phases:

- Buffer block emplacement
- Filling the gap between the bentonite blocks and the host rock
- Quality control
- Handling of the emplacement problem situations

The emplacement process starts from the situation where the emplacement vehicle moves towards the deposition hole, carrying the bentonite block. The preceding phases are excluded from the WP5 focus. Prior to this, the bentonite blocks have been stored and transported so that there have been no changes in their humidity and the block quality has been approved and documented. The canister bearing spent nuclear fuel is transported and emplaced after the emplacement of bottom blocks and ring blocks, before the emplacement of the top blocks. Emplacement of the canister is not included in the emplacement process but it is handled in another project. However, the canister shall be emplaced in connection with the buffer emplacement because its impact on the buffer block emplacement has to be taken into account.

It shall be taken into account in the process that it has to be possible to realize all activities following the canister emplacement by remote control and possible YVL safety classification.

The quality requirements for the emplacement have been defined and are presented at the end of this document. In addition, the emplacement has to respect all requirements concerning work safety.

The baseline for the emplacement demonstrations

The transportation and emplacement tunnels are ready for the realization of the disposal activities. The tunnel floor surface is gravel.

The emplacement demonstration has to be realized and approved in indoor conditions before the demonstrations in the ONKALO underground facility are started. Demonstration of the emplacement in the ONKALO will be utilised and approved firstly with concrete elements and after that the with final bentonite elements.

Assembling of the buffer blocks will be tested and demonstrated with the water protection system, developed for the situations where there is a risk that ground water leakage to the hole.

3 Previous activities: Basic definitions related to emplacement method

A document on Emplacement process problem situations was created at the beginning of the project (MS49 Problem Mapping 2011-05-26) for developing the emplacement process and defining the possible problem situations.

Method for buffer blocks emplacement has been developed on the basis of Posiva's own development work and activities carried out under LUCOEX project. During LUCOEX, Posiva's subcontractor engineering office Insinööritoimisto Comatec has also collected some information and produced two separate internal feasibility reports on the bentonite block handling and vehicles to be used.

4 Development work starting points: Bentonite buffer emplacement process phases

This part describes emplacement process phases. In the title of each phase there are references ("A1, Q1") to the related actions and quality assurance points described in more detail in the table Table 1. "Emplacement process phases and their quality requirements" on page 6 in this document.

4.1 Positioning of the emplacement equipment (A1, A2, QA 0)

- The emplacement equipment carried by the emplacement vehicle is driven to the deposition hole and positioned above the hole to the correct place
- It has to be possible to position the emplacement equipment by remote control when the canister has been emplaced and the emplacement of the upper bentonite blocks is started
- It has to be possible to repeat the positioning 5 times identically and to realize it so that the emplacement of the bentonite blocks can be realized in two phases while safeguarding the defined tolerances are respected.
- The centre point of the deposition hole has to be used as the basis of positioning.

4.2 Emplacement of the buffer blocks (A3 and A4)

- The buffer consist of total 10 blocks
- The buffer blocks are lowered into the deposition hole and installed
- After the canister emplacement, buffer blocks 7-10 are emplaced with remote control
- YVL (ie. Regulatory Guides for nuclear safety of STUK - Radiation and Nuclear Safety Authority Finland) regulations have to be taken into account in the buffer emplacement and equipment design.
- The positions of the buffer block have to fulfil the requirements defined in the annex 1.
- The buffer block positioning has to be based on absolute figures. Measurements based on e.g. the deposition hole host rock surfaces is not allowed.

4.3 Quality control of the buffer block emplacement (QA 1, QA 2 and QA 3)

- The buffer block emplacement quality control activities are realised before the emplacement of a new element or gap filling
- The quality control for blocks 7-10 is realised by remote control
- It has to be possible to demonstrate and document by the quality control measurements and other activities that the block emplacement has been realised according to the plan.
- The attributes to be defined in the quality control are for example the position of the block, horizontality of the block upper surface, positions and dimensions of the gaps, integrity of the block and joints.

5 Filling the gap between the buffer blocks and host rock

5.1 Gap filling (A5)

- The gap between the buffer block and host rock will be filled with bentonite pellets, either after the emplacement of each block or in planned phases
- For blocks 7-10 it has to be possible to carry out the gap filling by remote control as there may be needs to realise it after the canister emplacement when the earlier emplaced buffer block(s) do not provide adequate protection against the canister radiation
- The compactness and quantity of gap filling has to fulfil the requirements

5.2 Gap filling quality control (QA 4)

- After gap filling, the acceptability of the filling is verified by quality control activities before the emplacement of a new block or realisation of other activities
- For blocks 7-10 it has to be possible to carry out the quality control activities by remote control as there may be needs to realise it after the canister emplacement when the earlier emplaced buffer block(s) do not provide adequate protection against the canister radiation
- The attributes to be defined in the quality control are for example compactness of the filling and filling quantity

6 Quality requirements and emplacement process

The quality requirements for the emplacement process are presented in the table 1 below and the process for emplacement activities in the figure 1 after the table.

IMPORTANT:

The quality requirements and parameters have been defined for determining the maximum capacities of the equipment and machines developed for the emplacement tasks. Following this, the requirements presented may be stricter than what will be needed for the actual emplacement process.

Table 1. Emplacement process phases and their quality requirements (see also the process chart next page)

ID[1]	Main phase	Activity type	Action	Objective	Assessment	Requirements	Indicative time frame	Ref. doc[2]	Remarks
A 1	1.Buffer block emplacement	Alignment	Positioning of BIM for buffer installation	To position the BIM on the correct x-y coordinates		± 5mm	< 4 min	1	
$QA0_1$	3.Quality control	Measurement	Orient BIM position before emplacement	Position of the BIM	Measurement of BIM position	± 5mm	< 2min	1	
A2	1. Buffer block emplacement	Alignment	Move and positioning of BTV connection to BIM	Position of the BTV			< 1 min		
$QA\ 0_2$	3.Quality control	Data logger check	Reading the log	Buffer ready for lifting	Check of transportation conditions	No changes on conditions.	< 2 min	1 2	
A 3	1.Buffer block emplacement	Lifting	Lifting the buffer from container	Buffer lifted from container and ready for move to emplacement point			< 2 min		
QA 1	3.Quality control	Measurement	Checking the buffer against cracks	Solidity of buffer	Check of cracking and solidity of buffer	Cracks > 0.2 mm	< 6 min	2	
CP 1	1.Buffer block emplacement	Check point	Approval for emplacement	Approval of buffer block for realizing the emplacement and approval of the position of the block for realizing the emplacement			< 1 min		
$QA\ 2_1$	3.Quality control	Checking	Checking that the touch point surface is clean and solid	Cleanliness and solidity of the touch point	Check of surface	< 5mm x 10mm (diameter x length).	< 1 min		

A4	1.Buffer block emplacement	Assembling	Lowering the buffer to final position	Achieve the correct position of the buffer			< 4 min		
QA 2_2	3.Quality control	Measurement	Position of the buffer after installation	The position of the buffer within ±1mm tolerance from the planned XY coordinate		± 1mm	< 1 min	1	
QA 2_3	3.Quality control	Measurement	Angle measurement of the emplaced bentonite block	Angle of the installed block		0	< 1 min	3	
QA 3	3.Quality control	Checking	Measurement of gap between block and host rock	Gap width between block and host rock		50 mm± 25mm	< 1 min	1	
A 5	2.Gap filling	Filling	Filling the gap between the buffer block and host rock	To ensure compactness of the buffer			< 1 min		
QA 4	2.Gap filling	Measurement	Measuring the surface	To ensure compactness of the filling	Check of filling surface	No pellets over the required level of filling	< 1 min		
CP 2	1.Buffer block emplacement	Check point	Approval of emplacement	Approval of buffer block emplacement					
A6	1.Buffer block emplacement	Lifting	Lifting the vacuum gripper up and new positioning	To lift the vacuum gripper			< 5 min		

1: Explanations:

A: "Action"
QA: "Quality Assurance"
CP: "Check point"

2: Reference documents:

1: LUCOEX project WP5 (2011): *MS 49 Problem Mapping / Annex 1. Buffer dimensions and tolerances*.
2: Ahonen Lasse, Petri Korkeakoski, Mia Tiljander, Harri Kivikoski, Rainer Laaksonen (2008): *Quality Assurance of the Bentonite Material;* Posiva Working Report 2008-33.

3: Kauppinen, Jussi (Comatec Oy) (2011): *LUCOEX WP5 LOT 2 Feasibility study. Quality Assurance of the Bentonite Buffer Installation Process Accomplished by BIM.* (Unpublished)

Figure 1: Process chart