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Report no 2 - EPSP experiment in Czech Republic

Author(s) **Teppo Uusi-Uola, Posiva Oy¹ and Yassine Dabouz, Andra**

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¹ at the time of the staff exchange

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ABSTRACT:

As part of WP6, staff exchange visits have been proposed with the intention of sharing the practical experiences from the DOPAS tests within the consortium and between the consortium organisations. This report is a Deliverable within WP6, and describes the objectives and outcomes of a staff exchange visit to the **Experimental Pressure and Sealing Plug (EPSP)** experiment in the Joseph Underground Research Centre (Czech Republic) on 12-14 November 2014.

The objectives of the visit were to:

- Provide an opportunity to members of DOPAS organisations to observe underground shotcreting operations of the EPSP Inner Plug.
- Provide feedback and recommendations from the visit participants on the procedures used to construct the inner plug, with a view to improving these procedures in future implementations.

In the staff exchange two consortium staff members participated: One from Posiva Oy (Finland) and another from ANDRA (France).

RESPONSIBLE:

The views represented in this report are those of the authors of this report and they do not represent the views of the DOPAS consortium or the consortium partners. Any reproduction of this report or parts of it requires the consent of the authors.

REVIEW AND OTHER COMMENTS:

The report was reviewed by Dr. Marja Vuorio and Ms. Marjatta Palmu from Posiva Oy during Autumn 2015 after it was reviewed by the visit host (Jiri Svoboda from CTU). The deliverable cover template has been added by M. Palmu.

The report status of the staff exchange reports was changed by the GA no 3 approval from RE to PP with the limitation that the report will be available during the project duration only on request to persons. This report will be posted to the DOPAS web site after the project has ended and it has been approved by the European Commission.

APPROVED FOR SUBMISSION:

Johanna Hansen, Posiva OY, DOPAS Coordinator on 31.12.2015

DOPAS

Deliverable no 6.2.1 Version no 1.0

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Executive Summary

The Full-Scale **Demonstration Of Plugs And Seals (DOPAS)** Project is a European Commission (EC) programme of work jointly funded by the Euratom Seventh Framework Programme and European nuclear waste management organisations (WMOs). A set of full-scale experiments, laboratory tests, and performance assessment studies of plugs and seals for geological repositories will be carried out in the course of the project.

The DOPAS Project focuses on tunnel, drift, vault and shaft plugs and seals for crystalline, clay and salt rocks. The project is coordinated by Posiva Oy, Finland. Work Package 6 (WP6) of the DOPAS Project aims to integrate critical analyses of the achievements and results from the implementation and monitoring of the plugs and seals being tested in DOPAS by cross-review of partner activities. WP6 includes the use of the Expert Elicitation process, including a pilot of the process, exchange visits, and preparation of the final public technical summary report.

As part of WP6, staff exchange visits have been proposed with the intention of sharing the practical experiences from the DOPAS tests within the consortium and between the consortium organisations. This report is a Deliverable within WP6, and describes the objectives and outcomes of a staff exchange visit to the **Experimental Pressure and Sealing Plug (EPSP)** experiment in the Joseph Underground Research Centre (Czech Republic) on 12-14 November 2014.

The objectives of the visit were to:

- Provide an opportunity to members of DOPAS organisations to observe underground shotcreting operations of the EPSP Inner Plug.
- Provide feedback and recommendations from the visit participants on the procedures used to construct the inner plug, with a view to improving these procedures in future implementations.

The learning outcomes from the two participants at the visit are documented and can be summarised into the following points:

- Participants have seen shotcrete technology. Discussion on various aspects of the ESPS mock-up were held, including requests for clarifications on the concreting procedures and the challenges encountered at the various steps of the operation. One of the main challenges was to transport the fibred concrete from the production plant into the niche.
- The visit was provided an opportunity to obtain a greater understanding of the materials involved in the plug erection (bentonite, fibered low pH concrete, rock environment).
- The exchange provided the opportunity to gain knowledge regarding Republic Czech Conceptual design of the plug that may be used on the **Deep Geotechnical Repository (DGR)**.
- A visit to the Joseph gallery was organised to show other experiments being carried out within the Underground Research Centre. Some of which are related to the future DGR.
- A visit into SÚRAO's offices has been organised in order to discuss on Republic Czech's radioactive waste activities and on the overall DGR programme.
- A visit of the ÚJV Řež a.s. facilities gave the opportunity to the visitors to gain overall information regarding nuclear research program in the Czech Republic.

List of Acronyms

DOPAS:	Full-scale Demonstration of Plugs and Seals
EC:	European Commission
EDZ:	Excavation damaged zone
EPSP:	Experimental Pressure and Sealing Plug
DGR:	Deep geotechnical repository

List of DOPAS Project Partners

The partners in the DOPAS Project are listed below. In the remainder of this report each partner is referred to as indicated:

Posiva	Posiva Oy	Finland
Andra	Agence nationale pour la gestion des déchets radioactifs	France
DBE TEC	DBE TECHNOLOGY GmbH	Germany
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit	Germany
Nagra	Die Nationale Genossenschaft für die Lagerung Radioaktiver Abfälle	Switzerland
RWM	Radioactive Waste Management Limited	UK
SÚRAO	Správa Úložišť Radioaktivních Odpadu (Radioactive Waste Repository Authority – RAWRA)	Czech Republic
SKB	Svensk Kärnbränslehantering AB	Sweden
CTU	Czech Technical University	Czech Republic
NRG	Nuclear Research and Consultancy Group	Netherlands
GSL	Galson Sciences Limited	UK
BTECH	B+ Tech Oy	Finland
VTT	Valtion Teknillinen Tutkimuskeskus (Technical Research Centre of Finland)	Finland
UJV	Ustav Jaderneho Vyzkumu (Nuclear Research Institute)	Czech Republic

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1 Introduction

1.1 Background

The Full-Scale **Demonstration Of Plugs And Seals** (DOPAS) Project is a European Commission (EC) programme of work jointly funded by the Euratom Seventh Framework Programme and European nuclear waste management organisations (WMOs). The DOPAS Project is running in the period September 2012 – August 2016. Fourteen European WMOs and research and consultancy institutions from eight European countries are participating in DOPAS. The project is coordinated by Posiva Oy, Finland. A set of full-scale experiments, laboratory tests, and performance assessment studies of plugs and seals for geological repositories will be carried out in the course of the project.

DOPAS aims to improve the industrial feasibility of plugs and seals, the measurement of their characteristics, the control of their behaviour over time in repository conditions, and their performance with respect to safety objectives. The DOPAS Project is being carried out in seven Work Packages (WPs). WP1 includes project management and coordination. WP1 is coordinated by Posiva Oy, Finland. WP2, WP3, WP4 and WP5 address, respectively, the design basis, installation, compliance testing, and performance assessment modelling of the five full-scale experiments and laboratory tests. WP2, WP3, WP4 and WP5 are coordinated by SKB, Sweden; Andra, France; RWM, UK; and GRS, Germany, respectively. WP6 and WP7 address cross-cutting activities common to the whole project through review and integration of results, and their dissemination to other interested organisations in Europe and beyond. WP6 and WP7 are coordinated by Posiva Oy, Finland.

The DOPAS Project focuses on tunnel, drift, vault and shaft plugs and seals for crystalline, clay and salt rocks:

- *Crystalline rocks*: experiments related to plugs in horizontal tunnels, including the Dome Plug (DOMPLU) experiment being undertaken by SKB at the Äspö Hard Rock Laboratory (ÄHRL) in Sweden, the Posiva Plug (POPLU) experiment being undertaken by Posiva at the ONKALO underground rock characterisation facility (URCF) in Finland, and the **Experimental Pressure and Sealing Plug** (EPSP) experiment being undertaken by SÚRAO and the Czech Technical University (CTU) at the Josef underground research laboratory (URL) in the Czech Republic.
- *Clay rocks*: the Full-Scale Seal (FSS) experiment, being undertaken by Andra in a warehouse of a surface facility at St Dizier, is an experiment of the construction of a drift and intermediate-level waste disposal vault seal.
- *Salt rocks*: tests related to seals in vertical shafts under the banner of the Entwicklung von Schachtverschlusskonzepten (development of shaft closure concepts – ELSA) experiment, being undertaken by GRS and DBE TEC.

Each experiment represents a different state of development. The Swedish experiment was started prior to the start of the DOPAS Project. The Finnish, Czech and French experiments are being designed and constructed during DOPAS. The German tests focus on the early stages of design basis development and on demonstration of the suitability of designs through performance assessment studies, and will feed into a full-scale experiment of some shaft seal components to be carried out after DOPAS.

WP6 aims to integrate critical analyses of the achievements and results from the implementation and monitoring of the plugs and seals being tested in DOPAS by cross-review of partner activities. WP6 includes the use of the Expert Elicitation (EE) process,

including a pilot of the process, exchange visits, and preparation of the final public technical summary report.

As part of WP6, staff exchange visits have been proposed with the intention of sharing the practical experiences from the DOPAS tests within the consortium and between the consortium organisations.

This report is a Deliverable within WP6, and describes the objectives and outcomes of a staff exchange visit to the ESPS test in the Joseph Gallery (Czech Republic) on 12-14 November 2014. The attendees of the visit were:

- Teppo UUSI-UOLA from Posiva Oy
- Yassine DABOUZ from Andra

1.2 Objectives of, and Programme for, the Staff Exchange Visit

The overall objectives of the visit were to:

- Provide an opportunity to members of DOPAS organisations to observe underground shotcreting operations of the EPSP Inner Plug.
- Provide feedback and recommendations from the visit participants on the procedures used to construct the inner plug, with a view to improving these procedures in future implementations.

The programme of the visit is shown in **Table 1**.

Table 1: Programme of the ESPS staff exchange visit.

Time (at hrs)	Topic	Location
DAY 1	12th November 2014	URC Josef – Josef Gallery
09:30	Transport to Josef	Prague
11:00	Welcome and Introduction	URC Josef
	Q&A	
11:45	<i>Lunch break</i>	
13:00	EPSP overview	
14:00	Safety procedures	
14:30	Visit to EPSP & Josef lab	
16:00	<i>Break</i>	
16:15	EPSP construction	
17:00	Instrumentation	
18:00	<i>Dinner</i>	
18:30	Material characteristics	
19:30	Bentonite sealing of EPSP	
20:00	Main visit to EPSP	
	Q&A	
<i>(Very) late night</i>	Transport back to Prague	

Time (at hrs)	Topic	Location
DAY 2	13th November 2014	Prague, ÚJV Řež a.s.
12:00	<i>Lunch</i>	Prague
13:00	Transport to ÚJV Řež a.s.	Rez
14:00	Excursion to ÚJV Řež a.s.	
15:00	Laboratory works of EPSP	
16:00	Physical models	
	Q&A	
17:00	Transport back to Prague	
DAY 3	14th November	Prague, SÚRAO
09:00	Deep geological repository program in the Czech Republic	
10:00	Site selection process, geological survey in the Czech Republic	
10:30	Break	
10:45	Deep geological repository design in the Czech Republic	
11:15	Social aspects	
	Q&A	
12:00	Closing of the Exchange staff	
12:30	Lunch	

1.3 Report Structure

The remainder of this report is set out as follows:

- Section 2 lists the learning objectives and learning outcomes of the visit to the ESPS test from each participant.
- Section 3 describes the expectations of CTU and from the visit.
- Section 4 presents the overall outcomes of the visit including major learning points and feedback provided to CTU and SÚRAO.
- Section 5 presents the individual learning outcomes.

2 Visitors' Learning Objectives and Outcomes

This section lists the learning objectives and outcomes of the visit from each participant.

2.1 Learning Objectives

Teppo UUSI-UOLA

The main objectives set out before the visit were to:

- Learn more about techniques of shotcreting
- Learn more about other plugs that are built in Dopas-project
- Get more information about techniques of using bentonite

Yassine DABOUZ

The main objectives set out before the exchange were to:

- Learn about the involved materials characteristics
- Learn about other (than Andra's) plugs and repository designs
- Observe the underground concreting methods and find out how methods need to be adapted for these conditions

2.2 Learning Outcomes

The staff exchange was well organised with a full set of presentations from the three Czech partners (SÚRAO, CTU and ÚJV Řež a.s.). Discussions regarding all aspects of the experiment have been carried out. The visitors have been able to observe shotcreting operations in underground conditions. The learning outcomes for each participant are listed below.

Teppo UUSI-UOLA

The main learning outcomes from the visit are as follows:

- Obtained more information about working in hard conditions and small tunnels.
- Obtained more information about materials (shotcrete, bentonite) that was used in ESPS
- Obtained information about difficulties about contracts that is involved in this project.
- Visited the Joseph Gallery and had the opportunity to observe the different experimentations that are being carried out in-situ.
- Had the opportunity to discuss various aspects of the Czech Nuclear Research programme by visiting the ÚJV Řež a.s. facilities.
- Had the opportunity to discuss the spent fuel management activities in the Czech Republic and the future radioactive waste repository programme of Czech Republic.

Yassine DABOUZ

The main learning outcomes from the visit are as follows:

- Obtained a better understanding of the difficulties that can be met in underground conditions. More precisely, difficulties related to concrete routing and space availability have been discussed and solutions to counter these difficulties have been observed.
- Obtained a greater understanding of the concrete and bentonite materials used in the EPSP erection and the development of its specification. A large number of laboratory experiments were carried out to test different bentonite mixture compositions. Concrete formulations and specifications have been produced by the Contractor and have been tested by the EPSP project teams.
- Visited the Joseph Gallery and had the opportunity to observe the different experimentations that are being carried out in-situ.
- Had the opportunity to discuss various aspects of the Czech Nuclear Research programme by visiting the ÚJV Řež a.s. facilities.
- Had the opportunity to discuss the spent fuel management activities in the Czech Republic and the future radioactive waste repository programme of Czech Republic.

3 CTU's and SÚRAO's Expectation of the Visit

Generally, the expectations of the host were to give others information about the ESPS part of the DOPAS project, to show:

- How the works are carried out
- What challenges ESPS had to face

One of the objectives was also to get independent feedback from people not directly involved (from their experience point of view).

4 Outcomes of the Expert Staff Site Visit

This section describes the major learning points from the visit and the feedback provided to the host organisation at the end of the visit.

4.1 Major Targets Visited and Observed

The works had already started by site preparation, followed by shape adjustments and rock improvements. In parallel the instrumentation has been prepared and complimentary laboratory programme is ongoing

The main aim of the visit was to observe the inner plug shotcreting operations of the inner plug.

The concreting procedure starts with the transport of concrete from the Concrete factory that is in Prague (approx. 1h transport to the gallery entrance). The concrete is then transferred into smaller transport trucks that are able to circulate within the gallery. The concrete is then brought into the ESPS niche.

Photographs of the different steps are given in Figure 1: Concrete truck delivering concrete at the gallery entrance Figure 2: Transporting the concrete within the Joseph Gallery and Figure 3: Transferring the concrete into the concrete pumps.



Figure 1: Concrete truck delivering concrete at the gallery entrance



Figure 2: Transporting the concrete within the Joseph Gallery



Figure 3: Transferring the concrete into the concrete pumps

Once the concrete is within the pumps, the concrete operations can start within the niche.





Figure 4: Shotcreting operations

The gallery being a bottle neck, the concrete provision is not continuous and makes also the concreting operation not continuous. Indeed, the operator had to stop and wait for concrete at each shift in order to restart concrete works. This made the concreting works very long (23 hours for 38m³).

It shall be noted that part of the instrumentation devices was already installed within the niche prior to concrete operations. The rest had to be installed during the concreting operations.

4.2 Major Learning Points from the Targets/Tasks

The major learning points have been given in section 2.2 and a summary of these is given in the Executive Summary sections of the document.

4.3 Major Feedback to the Host by the Visitors

The visit was organized very well and we got good overall view about EPSP and things that are related in that.

4.4 Other Activities Carried out During the Visit

A visit to the ÚJV Řež a.s. facilities (LR-0 reactor and laboratories) has also been carried out during the visit. This visit gave the visitors the opportunity to discuss the different experimentations that were carried out at the ÚJV Řež a.s. and more particularly the laboratory tests that were done in relation with the EPSP experimentation.

A visit of the SÚRAO offices has also been organised. During the visit, some presentations regarding the spent fuel management activities that are carried out in Czech Republic have been given. Presentations related to the Deep Geotechnical Repository programme in Czech Republic have also been given to the visitors.

5 Self-Assessment of Achievements of the Visitor's Learning Outcomes and the Host's Expectations

5.1 Yassine Dabouz

HOW WERE MY LEARNING OUTCOMES ACHIEVED?

5.1.1 Was my staff exchange visit successful?

Yes, I consider the staff exchange as being successful. The objectives of learning more about the plugs design and materials have been achieved. Additionally, observation of underground shotcreting works has been enriching for me.

5.1.2 What did I learn?

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level: 5
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The achievement of learning objectives and learning outcomes:

Learned about involved materials characteristics. Also learned about other (than Posiva's) plugs and repository designs, observed more underground concreting methods and find out how methods need to be adapted for these conditions

KNOWLEDGE (*described as theoretical and/or factual.*)

KNOWLEDGE	EQF Level 1-8
Concrete works	4
Concrete properties	5
Plug design	5
Bentonite properties	4

SKILLS (*described as cognitive (involving the use of logical, intuitive and creative thinking) or practical abilities (involving manual dexterity and the use of methods, materials, tools and instruments).*)

SKILLS	EQF Level 1-8
Evaluation of practicability and implementation of designs using full-scale tests	5

COMPETENCE (*described in terms of responsibility and autonomy.*)

COMPETENCE	EQF Level 1-8
Experience of understanding and evaluating full-scale demonstration works	4

5.1.3 How did my expertise contribute to the host's experiment during or after the visit?

Independent feedback was given to the host during the exchange. Questions also raised up regarding the challenges of the project.

5.1.4 What would I like/need to learn after this visit experience? How did the visit assist me in my work?

It would be interesting to have a feedback regarding the final concrete properties of the inner plug (pH, compressive strength, voids...).

5.1.5 I would like to suggest the following development ideas for any future staff exchange visits.

Provision of host expectations ahead of the visit would enable better preparations of the visitors and better feedback.

5.2 Teppo Uusi-Uola

5.2.1 Was my staff exchange visit successful?

Yes, I consider the staff exchange as being successful. My objectives related to gaining new information on the shotcreting from the EPSP experiment were fulfilled.

What is my special interest in this DOPAS experiment?

Interest in Shotcreting works and Materials properties

What are my objectives in this site visit?

Gain practical knowledge

What benefit to my work is this site visit going to bring?

Have a better understanding on potential site issues

5.2.2 What did I learn? (see the detailed explanations in section 5.1)

KNOWLEDGE	EQF Level 1-8
Shotcrete works	6
Shotcrete materials	6
Plug design	5
Bentonite materials	4

SKILLS	EQF Level 1-8
Shotcrete works in tunnels	5
Quality control of materials	5

COMPETENCE	EQF Level 1-8
Quality control of materials	5

5.2.3 How can my expertise contribute to the host's experiment as a result of the visit?

Please specify the areas of your expertise you believe fit well for the experiment you visit and describe your tentative contribution.

Feedback was provided to ESPS teams after the visit to further improve the shotcreting works based on the ONKALO experiences.