

# Translating the experience from full-scale plugs and seals into a comprehensive DOPAS TRAINING WORKSHOP 2015

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## ABSTRACT

The DOPAS project includes a component of knowledge transfer that was carried out in several ways during the project like in this seminar. One means was the creation and implementation of the DOPAS training workshop in 2015. Other means include also the three staff exchange programmes that took place to the FSS experiment in France, to the EPSP experiment in Czech Republic and to POPLU experiment in Finland. In addition, the project itself has benefited from the knowledge transfer from the experience waste management experts who have contributed to the review work of the project deliverables with the means of an expert elicitation process. A five-day week training workshop was carried out in September 2015 in the Czech Republic. The training planning was based on four major learning units and related learning outcomes including the provision of a full learning cycle with both theoretical and hands-on application of the tasks needed to plan, to construct, and to monitor a full-scale in-situ experiment. The trainers were mainly the experiment and work package leaders of the project from eight partner organisations. The curriculum followed the content of the DOPAS project plan starting from requirements and finishing with the technical feasibility considerations related to plugs and seals giving the participants an opportunity to construct and reflect on their own country's approach in contrast to the DOPAS approaches.

The training workshop was run with great success and very favourable replies were received from the participants and from the tutors to the extensive feedback collected.

## 1. Introduction to the context of the training workshop

The DOPAS project carried out the full-scale demonstration experiments on the plugs and seals needed for the geological disposal facilities and the experiences were used to produce a 5-Day Training Workshop on the Role of Full-scale Experiments on Plugs and Seals in Demonstrating Safety and Performance of Geological Disposal. This activity was included into the DOPAS WP7 as a part of the knowledge transfer and experience dissemination activities of the project for technical and scientific audiences, mainly young scientists, professionals and postgraduates in geological disposal.

This DOPAS activity had the objective to add to the scientific integration of the results and lessons learned and to share these by training of students and engineers from the EU

Member States. Further, the training was targeted for participants outside the project consortium and it was intended to capture all the stages of the DOPAS work plan. An additional objective was also to define the training so that at a later stage the recognition of the learning outcomes from the training workshop could take place e.g. according to using the ECVET tools (5).

The training was designed and implemented in September 2015 after the project had been running around three years. This enabled a training design that was based on the project's original conceptual framework and at the same time, it exploited the lessons learned during the three years of implementing the experiments. The project and the training workshop started from the requirements, safety functions, and constraints of plugs and seals leading into the implementation of full-scale construction of monitored repository plugs and the development shaft sealing components. The training workshop was designed to provide the participants a full learning/action cycle<sup>1</sup> including both theoretical knowledge and practical skills acquired in team work and in an underground training facility environment, the Josef Underground Laboratory in Czech Republic, at the Czech Technical University in Prague and at UJV Rez, a. s. The trainers for the workshop came from eight project partner organizations sharing the experience from all of the five DOPAS experiments: FSS in France, EPSP in Czech Republic, DOMPLU in Sweden, POPLU in Finland and ELSA preparatory experiments from Germany.

The training process included the planning, implementation and assessment of the workshop that is reported as a part of the DOPAS project including the training materials that will be publicly available on the DOPAS website <http://www.posiva.fi/en/dopas> at the end of the project. The following chapters describe the content of these stages.

## **2. Planning for the DOPAS training workshop**

The initial ideas for the DOPAS training workshop were produced in collaboration with Posiva Oy and the Czech Technical University's (CTU) Centre of Experimental Geotechnics in June 2013, when the location and the time for the training was agreed. The week in September scheduled for the training provided unhindered access for the trainees to the Josef Underground Laboratory and research centre. The other training locations were at the faculty of Civil Engineering at the CTU in Prague and at the UJV Rez, a. s. in the Czech Republic.

The detailed content planning for the training started in May 2015 together with the eight consortium members complemented. Four planning meetings were held using remote connections (teleconferencing and a video link) and two weeks prior the meeting a face-to-face material review meeting was held in Helsinki, Finland. The planning consortium consisted of Posiva, SKB, Andra, CTU, SURAO, RWM and GRS complemented with UJV Rez staff and with training materials from Nagra adding the ninth member to the planning group. The duration of the training workshop was fixed to five days. In addition to the planning group members, the practical implementation of the training workshop was carried out with the help of additional tutors and lecturers from the Czech Republic.

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<sup>1</sup>see Kolb, Lewin, and Dewey (1984) later in the text

<b>Planning group member</b>	<b>Organisation, country</b>
Marjatta Palmu, task leader of the training workshop, WP6 leader of DOPAS	Posiva Oy, Finland
Radek Vašíček, DOPAS training workshop course leader	CTU, Czech Republic
Jacques Wendling, Performance assessment of Andra's programme	Andra, France
Régis Foin, FSS experiment leader	Andra, France
Jiri Svoboda, EPSP experiment leader	CTU, Czech Republic
Pär Grahm, DOMPLU experiment leader	SKB, Sweden
Petri Koho, POPLU experiment leader	Posiva Oy, Finland
Lucie Bělíčková, Prague and Rez organization	SURAO, Czech Republic
André Rübel, Safety and performance assessment, WP5 leader of DOPAS	GRS, Germany
Dean Gentles, Application of lessons to other waste management programmes, WP4 leader of DOPAS	RWM, Great Britain

**Tab 1:** Planning group of the DOPAS training workshop

The planning approach was based on producing a complete action cycle for the learners based on Kurt Lewin's concept (1) and on the philosophy of Dewey (2). This concept has been further applied to training and represented in Kolb's Learning cycle (2). This same concept was used as the basis of Deming's wheel PDSA<sup>2</sup> (3), too, well known to people engaged in quality management and the implementation of ISO 9000 based quality systems (4). The application of Kolb's cycle in learning can start at any point of the cycle as long as the whole cycle is included in the learning process. In addition to this guideline, the training emphasized the need to combine both theoretical and practical activities carried out in small groups. The purpose was to ensure that the participants could learn knowledge, skills and competences (KSC) during the process. In the same way, the learning outcomes were defined by setting up the training from four main learning units following the ECVET (5) approach.

One of the main planning decisions made was to emphasize two themes in the training. First, the aim was to give the participants an orientation to reflect on the purpose of the plugs and seals and the time that is applicable to the plugs and seals and for their needed isolation and containment function. These vary significantly among the various plugs and seals depending on the repository safety concept and on the host rock environment. In addition, the training order was planned in such a way that each of the learning outcomes was presented first by introducing one experiment in detail. This was then followed by shorter introductions related to the other experiments and with an exercise or activity requiring the participants to apply what they had just learned. The approach aimed to provide the participants themselves an opportunity to start to identify and contrast the differences between the choices made for the five different DOPAS experiments and to understand the underlying reasons for the differences. One of the feedbacks from the participants confirmed the usefulness of this approach in creating increased interest in the participant to gain more knowledge about the national programme and in being able to assist in the programme by using the learning outcomes.

The expected Learning Outcomes (LO) for the participants were

- To understand the process/es of designing a full-scale experiment from a set of requirements related to the performance of the safety function/s of a plug or a seal as a repository component in geological disposal.
- To be able to contrast the differences of such processes resulting from the different

<sup>2</sup> "Plan, Do, Study Act" cycle

boundary conditions e.g. from the host rock environments (clay, crystalline rock, and salt), the experimental settings (above ground, underground experimental facilities vs. real repository conditions) and other site and disposal concept specific features.

- To comprehend the linking of different experiment project's related subprojects and tasks and their inputs and outputs as a part of the experiment implementation.
- To acquire hands-on experiences in experimenting with materials' testing and monitoring techniques needed in an experiment, and
- To know how the individual experiments and their outputs contribute to the overall demonstration and demonstration programmes for safety of the waste management programmes at the different stages of repository development.

The training design included four main Learning Units (LU) consisting of a total of 10 topics that were related to the desired Learning Outcomes (LO):

**Learning Unit 1:** From requirements to the design basis of plugs and seals (DAY 1) including

Understanding requirements management and their application for plugs and seals design basis

- The purpose of plugs and seals in clay
- The purpose of plugs and seals in crystalline rock
- Requirements - understanding and applying them (sources, requirements as a system)

The Design Basis development work flow for plugs and seals - Application of requirements management system to plugs and seals and developing a design basis from them.

- Developing a design basis for an experiment
- Case Example of the Czech experiment EPSP
- Scoping the DOMPLU experiment. Moving from the initial design to an experiment in place including Exercise 1

**Learning Unit 2:** Preparation of an in-situ or full-scale plug or sealing experiment (DAY 2)

How to come up with a coherent demonstration program for plugs and seals?

- Theoretical basis to Andra's iterative safety assessment process and the latest safety assessment round
- Actual case example about the last round of safety assessment iteration in Andra's demonstrator programme in clay (FSS) - Explicit description of the last iteration cycle

The role of instrumentation and monitoring in an experiment including the Exercise 2 (sensors, their installation and analysis of results)

Monitoring for performance assessment of experiment components (Thermal processes, Exercise 2 continuation) (DAY4)

**Learning Unit 3:** Design of a seal for an experiment/ demonstrator within the broader context of RD&D programmes (DAY 3 - DAY 4)

What is the state of the art in the demonstrator (RD&D) programs today?

- Andra's scientific programme and its current state. The main questions replied to for the next safety assessment report (DAC<sup>3</sup> 2017) and after the submission of DAC?
- Plugs as a part of the demonstration programmes in Nordic countries (YJH<sup>4</sup> and FUD and in the stages of licensing) - including alternatives

Behaviour of plug components and materials

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<sup>3</sup> DAC = Demande d'Autorisation de Construction French construction license.

<sup>4</sup> YJH = 3 year Finnish R&D programme plan, FUD = 3 year Swedish R&D programme plan for nuclear waste management

- The use of individual tests to complement existing material and process knowledge (case of REM<sup>5</sup> metric experiment)
  - Instructions for laboratory Exercises 3-4 on material behaviour at UJV Rez a.s.
- Introduction to Safety Assessment and integration of the experimental work and process modelling in the safety assessment/ safety case.

#### **Learning Unit 4:** Construction Feasibility of a plugging experiment (DAY 4 and DAY 5)

Practical underground work concerns in setting up an in-situ or full-scale experiment

- Risk management for large-scale experiments and work underground
- Case example of POPLU experiment (recipe development, method tests and casting, start slot location + RSC<sup>6</sup> and design; moving into real repository construction, as built vs. design) and related exercise on identifying and prioritizing risks for full-scale experiments
- Feasibility of a seal in a clay rich host environment. How to adapt the technological process including alternative concept/s
- Working methods underground and for experiments
- Lessons learned from the experiments until today - Panel on experiences, constraints and lessons learned

How to further apply the lessons learned for the future

- The use the DOPAS experiences in a waste management programme not yet in the demonstration stage or without a site - Case of RWM
- Preparing for ELSA experiment.

The different learning units were tied together with more general activities like general presentations on DOPAS, Josef facilities and on the Czech geological disposal programme. The planning group members took turns in chairing the different training days during the week and at the same time triggered discussion in the training group on the topics at hand. The planned exercises included group work on experiment project management, risks, hands-on production and installation of sensors into the underground facility, handling and interpretation of the measurement data, laboratory tests related to cement bentonite interaction and uni-axial testing on material samples for identifying strength and failure mechanisms.

During the last day, the participants were given an opportunity to interview the tutors in a closing panel focusing on the lessons learned from the DOPAS experiments. In addition, the day included a self-assessment by the group on how they had attained their objectives for the training.

### **3 Implementation of the DOPAS training workshop**

The training workshop was advertised on different venues and using contact lists of the planning group in the waste management community and universities and relevant websites in addition to the DOPAS website were used. These websites included e.g. the IGD-TP ([www.igdtp.eu](http://www.igdtp.eu)) and the ENEN association ([www.enen-assoc.org](http://www.enen-assoc.org)) sites. The number of participants to the training workshop was limited to 12 persons. The training workshop was not oversubscribed, but some last minute cancellations enabled the participation of few more participants who had been alerted to this opportunity only after the registration closing.

The participants came from Czech Republic (3 persons), Finland, Germany (2 persons), Great Britain, Hungary (3 persons), Poland, and Sweden. Four of the participants were

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<sup>5</sup> REM = resaturation test related to the FSS experiment clay materials by Andra

<sup>6</sup> Rock Suitability Criteria

active students in the German and Czech universities, at the same time they were working at various organizations. Seven of the participants came from consulting or engineering organizations, two came from waste management organizations and the rest from an authority and research organizations and universities. All of the participants had a scientific or technical background, with most of them with a background in geotechnical engineering or geology.

The training materials were distributed to the participants via a protected internet site for downloading prior the start of the workshop. The materials consisted of about 40 different presentations, of five major exercises and of other supporting materials, presentations of the tutor organizations and of the documentary movie "Into eternity" by director M. Madsen shown at the courtesy of the producer Magic Hour Films of the movie.

The first training day took place in Prague at the CTU. The purpose of the day was to provide the training participants an orientation to the training topic and at the same time to get them acquainted with each others. The content focus was on the requirements and design basis of plugs and seals and on their purposes. The practical experiments included the presentation of the Czech and Swedish plug experiments, EPSP and DOMPLU. The introductory day's short exercises in pairs and small groups promoted the participants to get to know each other for supporting and open-minded cooperation during the workshop.

The second day continued at the Josef facilities with the presentations about the interactive process of safety assessment in the case of Andra and about the role of the FSS experiment in it. The training also included an introduction to the Josef facilities, the role of monitoring and instrumentation in the experiments, and a hands-on exercise in preparing thermal sensors and their installation into the Josef underground into the vicinity of the heater assigned for this exercise purpose. The data was then collected and interpreted during the fourth day when the training group returned to Josef again.



Fig 1. "Who has experience with soldering?" Day 2 practical exercise on sensor making in one of the groups.

Photos: Marjatta Palmu, Posiva Oy



Fig 2. "Let's put the sensors in place" at Josef Underground Laboratory.

The third day started at UJV Rez a.s., where practical works continued after the presentations about the French and Nordic research and development programmes where the experiments are on part of the planned work. The work continued at the UJV Rez laboratories with the practical exercises. After the laboratory exercises the group moved to the SURAO information centre in the centre of Prague. The focus was on the Czech siting programme and on stakeholder communication. The evening ended with a "movie night" and discussion related to the "Into eternity" documentary.

The fourth day took place in Josef again. The content focused on the general principles of safety assessment and on the technical feasibility of the plug and seal construction. Presentation of the POPLU, DOMPLU and FSS plugs' construction works were given and the participants worked on identifying the potential risks related to the experiments in the Nordic countries. The second part of the long day at Josef was spent in analyzing the sensor data from the sensors installed in the heated rock. Finally, the day was finished with a visit to the Josef cathedral with Czech music and the light show.

Last training day brought the group back to Prague, where the participants learned about the German ELSA experiment and related materials, about how RWM aims to use the lessons learned, and the experiments' lessons learned were summarized in a tutor panel. The afternoon was filled with the participant presentations on the outcomes of their exercises during the week. They received feedback from the various tutors on their findings. The groups sent their exercise reports to the tutors after the training course and were given a further evaluation of their work, too. The day and the official training course finished with the participants assessment on their attainment during the week. In practice, beautiful Prague saw still a group of enthusiastic training participants enjoying their last

night in the golden city.

#### 4 Assessment of the DOPAS training workshop

The participants' activities and interaction was observed during the whole week. The group worked very well together and assisted each others in the exercises. All wanted to perform their tasks very well and if they felt that they had not reached the target they had set, the felt a bit disappointed. Each exercise carried out was followed by both the peer assessment of the other group's outcomes compared with the group's own results and complemented with the tutor/s' feedback.

In the beginning of the workshop the participants set their own expectations and goals for the training (see ref. 6, p.4) and most of their objectives were achieved. In addition to the group assessment, the participants also gave their individual evaluation of the workshop on an evaluation form. The outcomes of the evaluation varied on a scale from 1-5 between from 4.3 to 4.8 on average on nine different evaluated items. Replies were received from all participants. The tutors made a similar evaluation independently and came to the same conclusion as the participants.

**D - Demonstrative**

**O - Optimistic**

**P - Positive**

**A - Accurate**

**S - Serious**



DOPAS Training Workshop  
2015 as described by one of  
the participants.

Entering Josef cathedral. Photo: Marjatta Palmu

Fig 3. DOPAS Training Workshop 2015 participants and tutors on Day 4

The participants received a training workshop diploma with a recommendation letter from the workshop organizers supporting the recognition of the amount of work done in the workshop to equal four ECTS for academic studies.

The outcomes of the training workshop are to be documented using the ECVET approach in the form of KSC needed for each of the learning units and related learning outcomes before the end of the project. This documentation is intended to make it easier for any future users of the training material to apply it using the similar principles and approaches in their training.

#### 5 Conclusions and acknowledgements

The workshop was successfully implemented and well received from both the participants

and the tutors. The planning process also assisted in structuring the connections of the DOPAS work for the tutors engaged in the process and this contributed also directly to the planning of the expert elicitation of the DOPAS work package deliverables. Much work was done to produce the plan and to implement it. We hope that when the training workshop report comes out, also other trainers find the materials useful and use them in future training.

Defining and implementing the workshop content according to ECVET tools was beneficial for both – the participants and organizers - as this course provided first opportunity to experience and use the ECVET approach for many of them.

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## 7 DOPAS specific abbreviations

DOMPLU	Dome Plug deposition tunnel plug experiment carried out in Äspö Hard Rock Laboratory in Sweden by SKB in collaboration with Posiva
DOPAS	Full-scale Demonstration of Plugs and Seals, Euratom FP7 Framework project
EPSP	Experimental Pressure and Sealing Plug experiment in Josef Underground Laboratory in Czech Republic

FSS	Full-scale Seal experiment in St.Dizier France
POPLU	Posiva Plug wedge shaped deposition tunnel plug experiment in ONKALO underground rock characterization facility in Finland by Posiva in cooperation with SKB.
ELSA	Entwicklung von Schachtverschlusskonzepten (development of shaft closure concepts) related tests and future experiment in Germany

For further explanations please visit <http://www.posiva.fi/en/dopas>.