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POPLU Staff Exchange Visit

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Executive Summary

The Full-Scale **D**emonstration **O**f **P**lugs **A**nd **S**eals (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 POPLU test at the ONKALO underground rock characterisation facility in Olkiluoto (Finland) on 30 June-2 July 2015.

The primary objective of the visit was to observe ongoing work at the POPLU experiment, including:

- Instrumentation of the first plug part: attachment of strain, temperature, and humidity sensors and observation of already installed pressure and displacement sensors.
- Reinforcement of the first plug part and part-reinforcement of the second plug part.
- Installation of the injection feeding tubes.
- Assembly of formwork for the first plug part.

The outcomes from the visit, as assessed by the four participants, are documented in post-visit forms and can be summarised into the following points:

- The visit was very well organised, and the timing was ideal to allow observation of as much of the structure and instrumentation of the POPLU plug as possible.
- Nearly all individual learning objectives were successfully met.
- The experience and learning gained by the participants as a result of the exchange will be of great benefit to their future work.
- The participants asked challenging questions of the hosts concerning a number of technical areas, all of which the hosts were able to answer satisfactorily.

List of Acronyms

ÄHRL:	Äspö hard rock laboratory
DOMPLU:	Dome Plug
DOPAS:	Full-scale Demonstration of Plugs and Seals
EC:	European Commission
EE:	Expert Elicitation
ELSA:	Entwicklung von Schachtverschlusskonzepten (development of shaft closure concepts)
EPSP:	Experimental Pressure and Sealing Plug
FSS:	Full-scale Seal
POPLU:	Posiva Plug
URCF:	Underground rock characterisation facility
URL:	Underground research laboratory
WMO:	Waste management organisation
WP:	Work package

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 **D**emonstration **O**f **P**lugs **A**nd **S**eals (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.

1.2 Objectives of the POPLU Experiment

The objectives of the POPLU experiment include:

- Construction of full-scale deposition tunnel end plug.
- Development of detailed structural design, including concrete recipe for the plug.
- Plug slot excavation method development
- Production of quality manual for quality control practices and risk mitigation for the plug.
- Instrumentation and performance monitoring of the plug (especially water tightness).

1.3 Introduction to and Objectives of the Staff Exchange Visit

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 POPLU test at the ONKALO URCF in Olkiluoto (Finland) on 30 June-2 July 2015. The attendees of the visit were:

- Jo Smith from GSL.
- Mark Crawford from GSL.
- Pär Grahm from SKB.
- Michal Roll from CTU.

The primary objective of the visit was to observe ongoing work at the POPLU experiment, including:

- Instrumentation of the first plug part: attachment of strain, temperature, and humidity sensors and observation of already installed pressure and displacement sensors.
- Reinforcement of the first plug part and part-reinforcement of the second plug part.
- Installation of the injection grout feeding tubes and observation of the already installed injection tubes and bentonite tape strips.
- Assembly of formwork for the first plug part.

Secondary objectives included:

- Learning about different aspects of the POPLU experiment and development work done as part of the experiment, through presentations and observation.
- Obtaining an overview of the whole POPLU demonstration, given that many of the different plug components would still be visible at this stage in the work, including:
    - the constructed and instrumented filter layer .

- the finalised plug slot where the reinforcement of the plug acts as a shelter against any possible falling rock blocks during construction.

- Introduction to the method tests used for the plug material and casting development according to the regulatory guides.

The final programme of the visit is shown in Appendix 1.

1.4 Report Structure

The remainder of this report is set out as follows:

- Section 2 summarises the learning objectives and learning outcomes of the visit to the POPLU test from each participant.
- Section 3 describes the expectations of Posiva from the visit.
- Section 4 presents the overall outcomes of the visit including major learning points.
- Section 5 provides a self-assessment from each participant on the learning outcomes of the visit.
- Section 6 presents conclusions and a summary of lessons learned.
- Appendix 1 provides the final visit programme.
- Appendix 2 provides the learning objectives and outcomes for each participant, as defined prior to the visit using the pre-visit template.
- Appendix 3 provides lists of materials collected from the visit by each participant.

2 Visitors' Learning Objectives and Outcomes

This section summarises the learning objectives and outcomes of the visit from the participants, based on the pre-visit and post-visit templates completed by each participant. The actual completed templates are provided in Section 5 (post-visit) and Appendix 2 (pre-visit).

2.1 Learning Objectives

Each participant set their own learning objectives prior to the visit, and these were shared with Posiva to allow the programme to be tailored to the specific interests of the visitors.

All visitors were interested in observing the construction of the POPLU plug, from tunnel and slot excavation to assembly of components, preparations for casting and sensor installation. They also wanted to learn about the background and context to the construction, with individual topics of interest including:

- Plug design and technological solutions.
- Monitoring strategy and plans.
- Specification and management of requirements, how they are arranged in a safety classed structure, and the link between requirements and experimental testing.
- Risk management for the POPLU experiment.
- Barrier functions and operational aspects.

Another common objective was to observe, understand and gain direct experience of the logistics and restrictions of working in tunnels underground, and the procedures in use at the ONKALO site.

Other objectives varied according to the particular experience and background of the visitors; for example, those newer to the industry wanted to gain further knowledge and understanding of underground research laboratories and of the Posiva's disposal system in general, while one of Pär Grahm's objectives, having been involved in the DOPAS project with SKB, was to observe and evaluate the differences between the POPLU and DOMPLU experiments.

2.2 Learning Outcomes

Following the visit, all participants completed a post-visit form comparing their actual learning outcomes to their objectives. All participants reported that the exchange had been very successful and that their learning objectives had been almost entirely fulfilled. The overall EFQ[1] level of learning was 5-6, with levels for individual knowledge, skills and competence learning outcomes ranging from 2 to 7. Some aspects were identified where there had not been enough time to go into detail (e.g. risk management and justification for the monitoring strategy), but this was felt to be inevitable in such a short visit.

The participants were agreed that the visit had taken place at the ideal time in the POPLU implementation schedule, to allow as much of the structure and instrumentation as possible to

[1] Level of learning descriptors are defined using the European Qualification Framework (EQF). Further information is available at https://ec.europa.eu/ploteus/content/descriptors-page.

be observed, and that it had been very well organised and run by Posiva. Opportunities to ask questions, including some about detailed aspects of Posiva's technical programme that required some time and effort to answer, and to visit the VLJ repository and Olkiluoto visitor centre, were also appreciated.

The participants also reported that their experiences and learning from the staff exchange would be of great benefit to their future work, ranging from geotechnical mapping procedures and inputs to the Euratom Modern2020 project to planning and organising new full-scale underground experiments and accounting for regulatory requirements in building repositories.

3 Posiva’s Expectations of the Visit

Posiva's expectations of the site visit were that the participants would be able to draw conclusions from the information presented to them and in that light question the decisions made in the POPLU experiment. This would show that the participants have assimilated the presented information and would challenge the hosts in presenting the reasoning behind the decisions made and the POPLU experiment in general. This process would possible lead to a new line thinking and enhance the development of the deposition tunnel end plug design and the future experiments.

4 Outcomes of the Expert Staff Site Visit

This section describes the major learning points from the visit.

4.1 Major Targets Visited and Observed

The major target visited during the exchange was the POPLU experiment. This was located in the demonstration area of ONKALO (Figure 4.1), the plug itself being located in demonstration tunnel (DT) 4, with pressurisation pipes and wiring for monitoring equipment led through from DT3. A container in DT3 will house computers for processing the monitoring data and transmitting it to the surface.

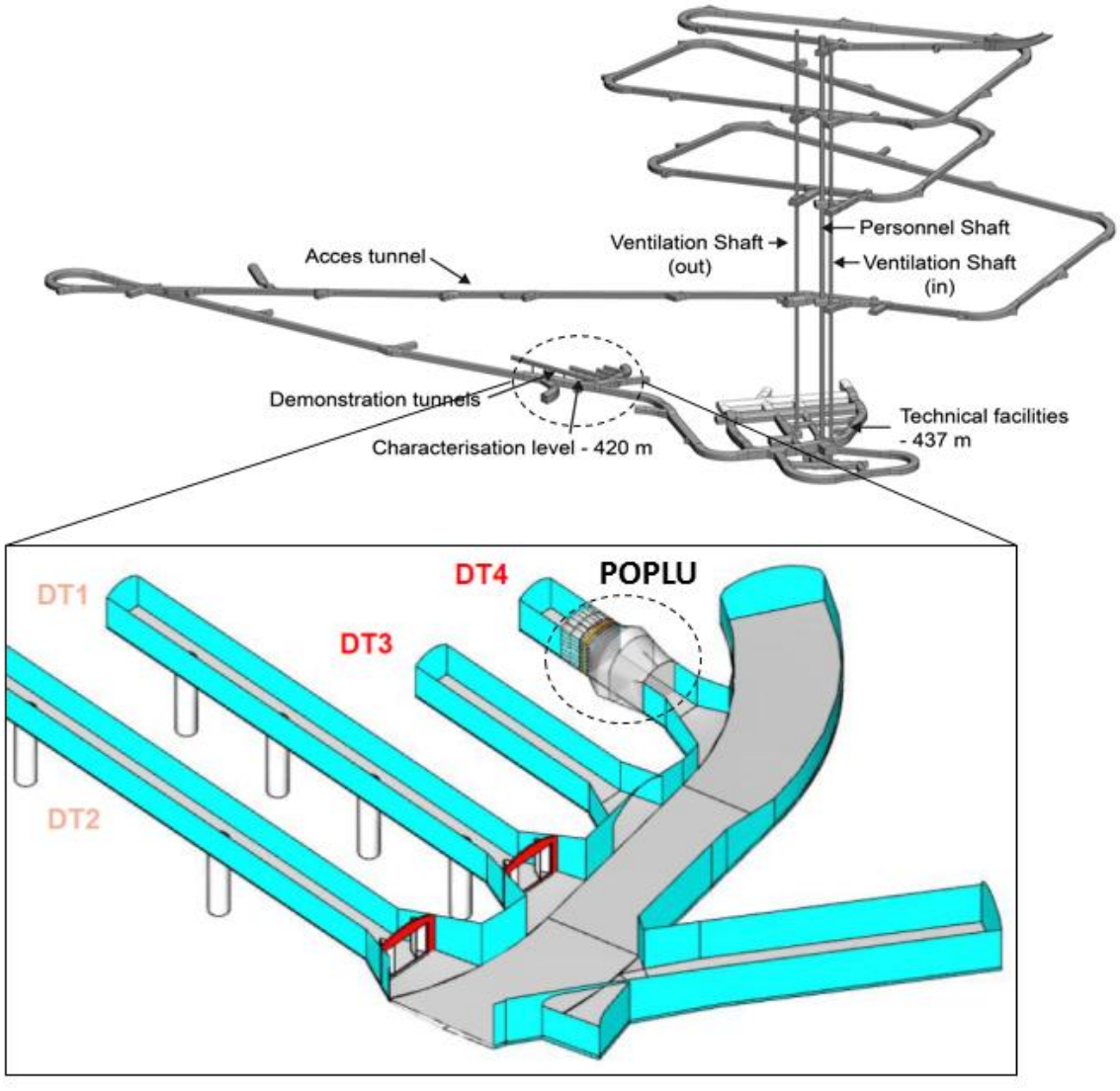

Figure 4.1 Location of the POPLU experiment in ONKALO (indicated by dashed circle in the lower panel), also showing other demonstration tunnels (DT). ©Posiva

The plug being tested in the POPLU experiment is a wedge-shaped plug and will be cast in two parts, as illustrated in Figure 4.2. A new low-pH concrete recipe (with self compacting properties) developed by Aaro Kohonen Oy will be used for POPLU. The design volume of the 1st plug part is 91 m^3 and volume of the 2nd plug part is 72 m^3. The plug sections are

reinforced with a large number of stainless steel bars around the edge of the structure. Additional bars will be placed through the centre of the plug just before casting to allow sensors to be attached in the centre of the plug parts, but at the time of the visit the interior of the plug was as clear as possible to allow work to take place from the inside of the structure. Strips of bentonite tape run around the outside of the plug (attached to the excavated slot surface), creating additional barriers to grout and water.

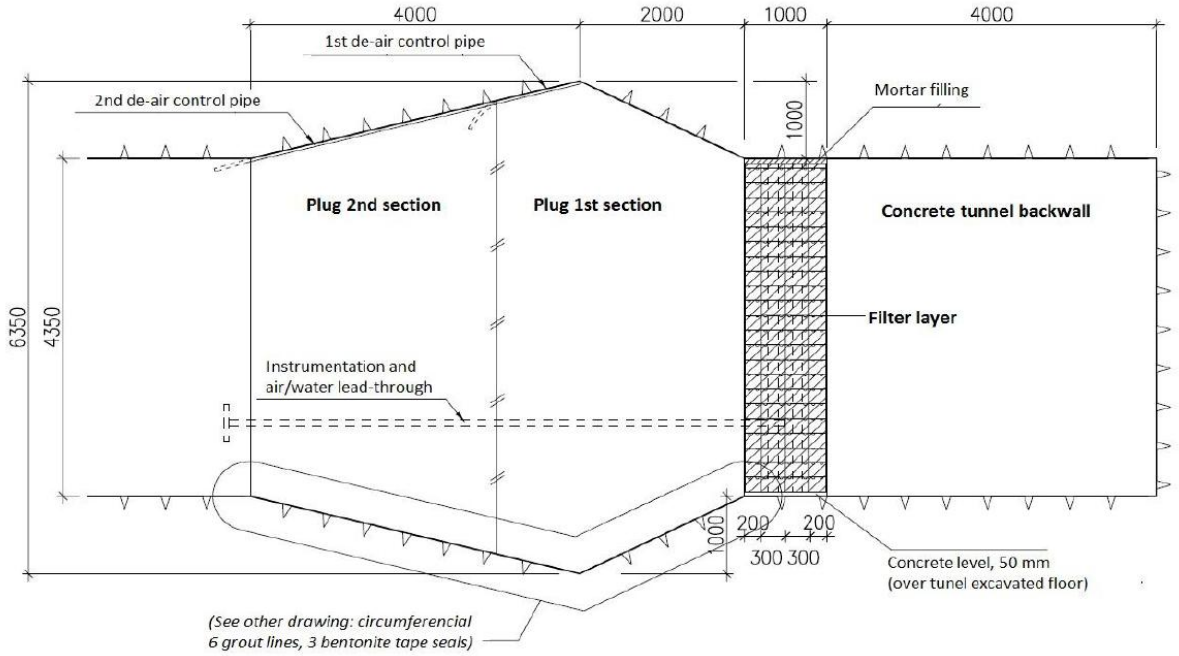

Figure 4.2 Detailed design of POPLU (January 2014), showing the two plug parts to be cast in the excavated slot (wedge shape), the filter layer for water injections behind the plug, and the concrete back wall at the tunnel face. ©Posiva

At the time of the visit, installation of monitoring sensors and other preparations for the casting of the first part of the plug (expected in the following 1-2 weeks) were ongoing. All major parts of the plug structure could be observed, including the lightweight low-pH concrete blocks (hollow LECA®) that make up the filter layer, which were visible behind the steel reinforcements at the back of the plug. A significant part of the tunnel and slot excavations could also be observed, as construction of the second part of the plug will not begin until the first part is cast. Only the concrete back wall behind the filter layer, and the sensors already installed there, were not visible. Plywood boards of the formwork were being installed at the front of the first part of the plug throughout the visit. To be able to attach POPLU formwork, a concrete support frame had been erected at the entrance of DT4.

A manhole in the steel reinforcements and an erected scaffolding platform inside the first plug part allowed the visit participants to observe the plug structure, already-installed sensors and bentonite tape strips surrounding the plug from the inside. A ladder to a second scaffolding platform allowed close-up viewing of the top part of the plug structure.

A total of 85 wired sensors will be installed across the entire plug structure, including strain gauges, thermocouples, pressure sensors (total pressure and pore pressure), humidity sensors and displacement sensors. Additionally, six wireless sensors will measure temperature in the filter layer; the antenna is located directly opposite the sensors in DT3. Furthermore, drill holes from DT3 allow rock extensometers to record impact on rock about 70 cm from the POPLU tunnel (DT4).

As mentioned in Section 1.2 one of the major POPLU objectives is to verify water tightness of the cast plug. Hence, water will be injected into the filter layer from a pressurisation system located in DT3. At time for the visit, the pressurisation system was not yet in place but pressurisation pipes had been installed in one of the lead-through boreholes to DT4, and these could be examined by the visit participants. One of the pressurisation pipes was intended to be used for de-airing. To measure the water flux past the plug during pressurisation, leakage will be collected in a weir on the downstream side of POPLU. The weir had already been excavated in the tunnel floor by help of the grinding tool, also used for the slot production. The leakage measurement system, including a suction pump, will be installed subsequent to removal of formwork of the second plug part.

The visit participants were also able to view a series of “mock ups” (method tests) of the plug. These are downscaled castings made during the design stage of the plug, in order to test various aspects of the plug design (such as the concrete recipe) and casting procedure.

A selection of photographs taken during the visit by the visitors is included below, illustrating the main observations (Figure 4.3 to Figure 4.10).

Figure 4.3 Front of the first part of the plug structure, showing stainless steel bar reinforcements, manhole in the bottom left for access to the plug interior, and formwork boards being fitted. Photo by Jo Smith.

Figure 4.4 Lightweight low-pH concrete blocks (hollow LECA®), of the type that make up the filter layer. Photo by Michal Roll.

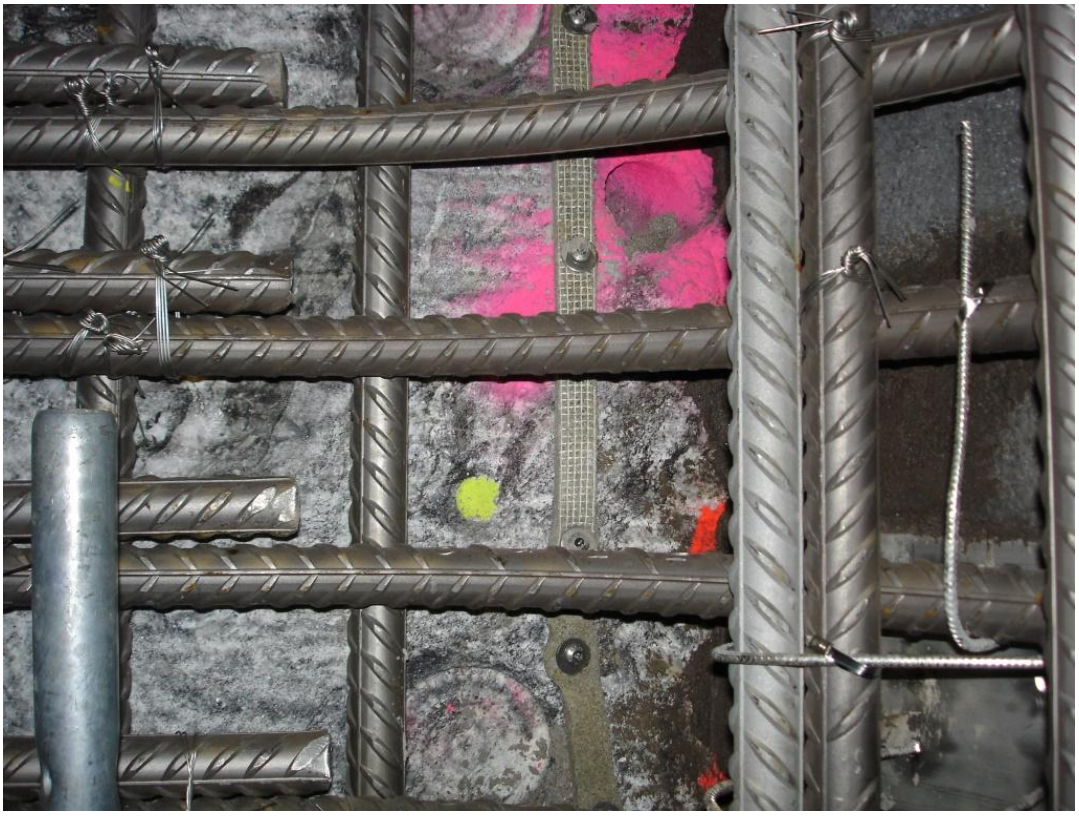

Figure 4.5 Close-up of stainless steel reinforcements, and bentonite tape attached to rock in the centre of the picture. Photo by Mark Crawford.

Figure 4.6 Structure of the top part of the plug from the inside, showing layers of reinforcements. Photo by Jo Smith.

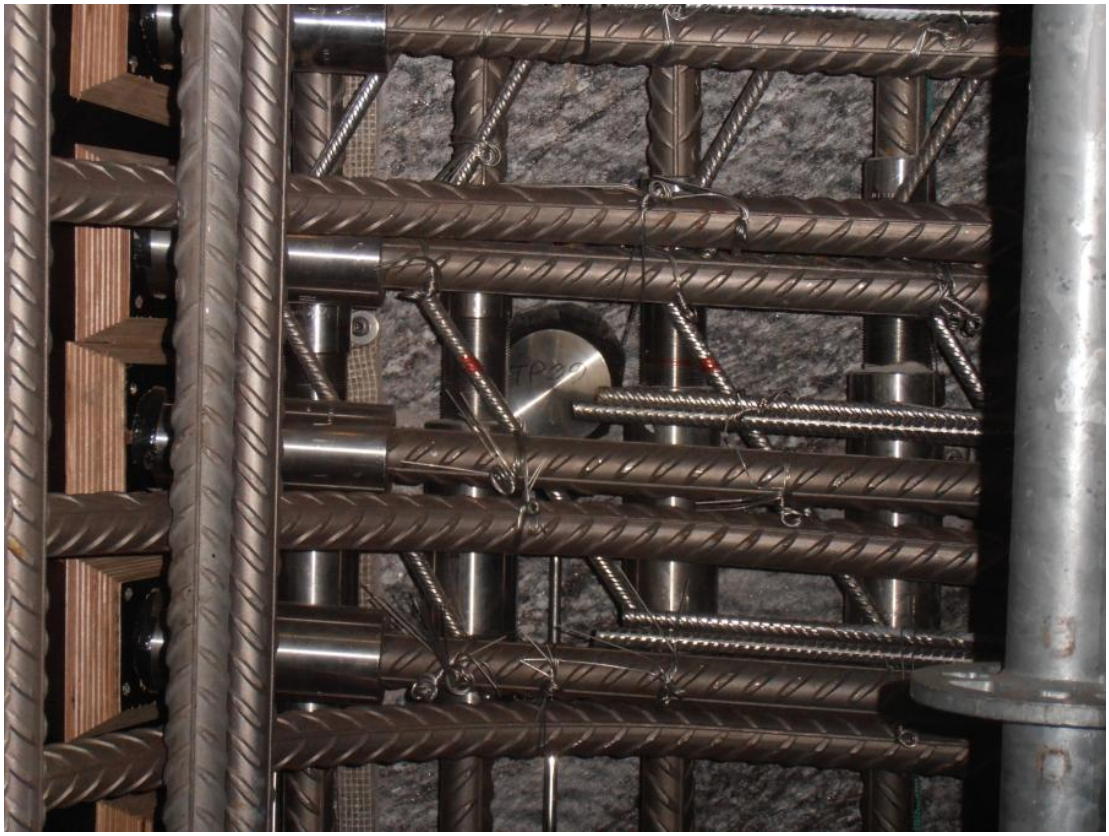

Figure 4.7 Pressure sensor in place. Photo by Michal Roll.

Figure 4.8 Strain gauge in place. Photo by Michal Roll.

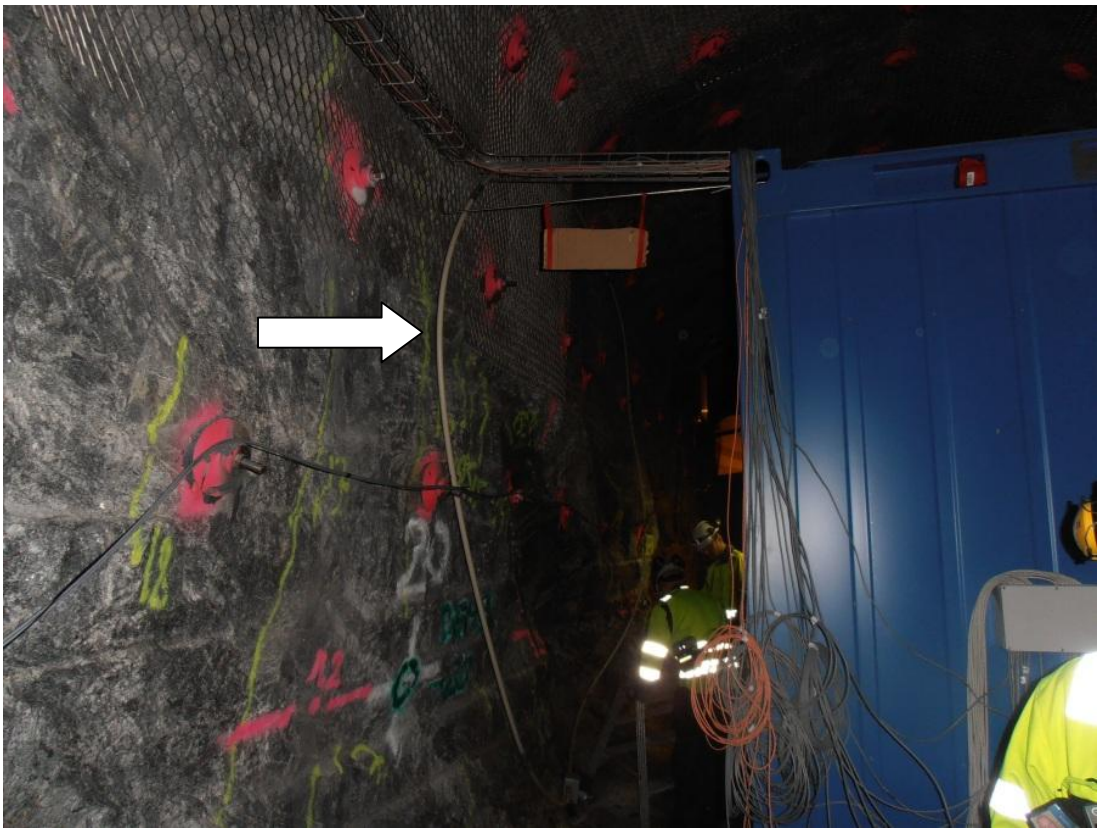

Figure 4.9 Antenna loop in DT3 (indicated by the arrow) for receiving wireless signals from the thermosensors. Photo by Michal Roll.

Figure 4.10 Mock ups of the plug. Photo by Mark Crawford.

4.2 Major Learning Points from the Targets/Tasks

A summary of the major learning points is given in Section 2.2 and the detailed learning outcomes of each participant listed in Section 5.

4.3 Major Feedback to the Host by the Visitors

The visitors asked a number of challenging questions of the hosts during the visit, on topics including:

- Reasoning behind constructing the test plug in very high quality rock when in reality it might have to perform in lower quality rock.
- Requirements for the plug in the reference design and motives for experiment design and materials choices, particularly in comparison with DOMPLU experimental designs.
- Installation techniques.

The hosts were able to provide good answers to all questions, and in some cases, detailed answers were researched and provided following the visit. Although the visitors did not ask anything for which an answer could not be found, their questions mirrored the questions that Posiva has been asking during the planning and implementation of the POPLU experiment, and caused Posiva to explain and justify their decisions.

Pär Grahm noted several instances where lessons learned from the DOMPLU experiment had been incorporated into the POPLU plans, thereby minimising risks to the POPLU project results.

4.4 Other Activities Carried out During the Visit

To set the scene for the underground observations in ONKALO, a number of informative and interesting presentations were given on the following topics:

- Introduction to the DOPAS project.
- General introduction to the POPLU experiment.
- Selection of the location for the POPLU experiment and rock suitability classification (RSC).
- POPLU tunnel excavation and slot production.
- POPLU design and treatment/consideration of foreign materials.
- POPLU construction.
- POPLU testing and monitoring.
- Worker safety at ONKALO.
- Certain authority (STUK) requirements related to POPLU, for instance need for approval of installation plans and all materials to be used, safeguard issues and inspections.

In addition to the POPLU experiment, a general underground tour of the ONKALO site was undertaken, during which the participants visited the service area and the sites of several other experiments (current, past and planned for the future). These included:

- Demonstration tunnels 1 and 2. Several test deposition holes have been drilled in these tunnels, for the purpose of testing the boring machine that drills the holes, the machine that emplaces the bentonite rings in the holes, and the RSC methodology. DT2 (Figure 4.11) is also a possible location for the Full scale in-situ System Test (FISST) that will be performed over the next few years. The FISST is another opportunity for Posiva to test the installation and performance of a plug, which would be located in front of the fracture zone that DT2 intersects.
- REPRO (Rock matrix REtention PROperties) experiment, investigating breakthrough of radioactive tracers (including caesium and tritium) between an injection hole and a monitoring hole. This is a long-running study, with the present experiment due to start in August 2015.

This general tour and visits to additional experiment sites were valuable in giving an overall impression of the ONKALO site and the variety of work being undertaken there, as well as the controls and measures needed to ensure the safety of an underground site. In particular, insights were gained into how Posiva is managing interactions with highly mineralised groundwater (which could lead to corrosion of containers), including careful location of access ramp and other tunnels in relation to major faults, and evaluation of the hydraulic conductivity of smaller faults, fissures and cracks through a classification system.

Figure 4.11 DT2 with test deposition holes and water as a result of leakage from fracture zone. Photo by Mark Crawford.

Visits were also made to the Olkiluoto Visitor Centre and to the ONKALO Exhibition, which is located within TVO's VLJ repository for low and intermediate level waste at Olkiluoto. The former is the public visitor centre for the Olkiluoto nuclear power plant and contains comprehensive, informative and hands-on displays on all aspects of the nuclear fuel cycle, including disposal. The latter is the public visitor centre giving more detailed and specific information about ONKALO, and allows visitors to experience an underground environment similar to ONKALO (albeit at a much shallower depth). Both centres were impressive and worthwhile visiting, and several participants also valued the opportunity to visit the VLJ repository, even though it was not possible to see the waste silos themselves.

A walking tour of Old Rauma and dinner with the hosts following the conclusion of formal activities on the second day of the trip, and a tour of Posiva's offices at the Vuojoki mansion on the final morning, enabled participants to learn more generally about the heritage of the area and provided opportunities for informal discussions.

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

This section provides a self-assessment from each visitor on the outcomes of the visit using the template provided in the Staff Exchange information documents.

Jo Smith

Was my staff exchange visit successful?

Yes, very successful. The visit was very well-organised, with informative presentations and plenty of time underground to observe and learn about the POPLU experiment (and other activities in ONKALO). The timing of the visit was excellent as it allowed us to see as much as possible of how the plug is being constructed and instrumented. There were also plenty of opportunities to ask questions to various experts, and if the requested information could not be found immediately it was provided at a later time. These factors enabled all pre-visit objectives to be met (and overall expectations of the trip to be exceeded).

What did I learn?

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level: 5

Give also a free text assessment of the achievement of your learning objectives and learning outcomes:

My learning objectives (as listed in the pre-visit form) have all been met in full or in part. My understanding of the monitoring strategy is not quite complete but I think this can be filled in by reading the design basis report, and will also become clearer once results are available. My KSC learning outcomes (as listed below) are more or less as anticipated; the only change I have made based on my actual experience is to the EFQ level of the identified skills (relate design basis to implementation changed from 5 to 4; critical evaluation changed from 4 to 5).

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

KNOWLEDGE	EQF Level 1-8
Knowledge and high-level understanding of techniques for monitoring plugs and implementation procedures, as used in the POPLU experiment	5
Experience and observations of methods/restrictions for working underground	4
Knowledge of DOPAS project objectives, strategies and interim outcomes	5
Overview of Posiva's programme for radioactive waste disposal	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
Relate design basis / requirements to implementation of experiment	4
Critically evaluate experiment design and/or implementation	5

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

COMPETENCE	EQF Level 1-8
Use practical observations and experiences to increase own knowledge and understanding; usefully absorb information and apply it in other contexts	5
Work with other visitors to evaluate observations of the POPLU experiment and provide constructive feedback to Posiva	5

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

The hosts (Petri Koho and others) were pleased with the visitors' contributions during the visit; in particular asking thoughtful questions (e.g. about the location of the plug in terms of rock quality). Although we did not ask anything for which an answer could not be found, our questions mirrored the questions that Posiva has been asking during the planning and implementation of the POPLU experiment, and caused Posiva to explain and justify their decisions.

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

Following the visit, I intend to read through the DOPAS WP2 report on requirements and design basis, to relate these to what I have observed in POPLU. I would also like to gain an overview of the other ongoing DOPAS experiments (FSS, EPSP and DOMPLU) to understand the similarities and differences to POPLU and how the experiments will be used together to draw useful conclusions about plugging and sealing in geological repositories. I am also interested in seeing the final report of the POPLU experiment, to see what monitoring data was obtained and what this shows about the experiment.

As a result of the visit I have gained valuable first-hand experience and knowledge of large underground experiments and plugs that I expect to use in a general way in my future career. The specific knowledge gained from observing the installation of monitoring equipment will directly aid my involvement in the Modern2020 project on repository monitoring.

I would like to suggest the following development ideas for any future staff exchange visits. Also any other free text feedback is appreciated.

No suggestions – the visit was impeccably planned and organised, and it is difficult to think of how it could be improved. As well as the presentations and time to observe the experiment, I valued the visits to the Olkiluoto and ONKALO visitor centres, as well as the dinner together in Rauma, so I would suggest that similar activities be included in future exchanges if possible.

Mark Crawford

Was my staff exchange visit successful?

Yes. It fulfilled all of my objectives and will greatly assist in my future work on the DOPAS project and my thinking for input to the Modern2020 project. The visit was very well-organised, with informative presentations and plenty of time underground to observe and learn about the POPLU experiment (and other activities in ONKALO). The timing of the visit was excellent. There were also plenty of opportunities to ask questions to various experts.

What did I learn?

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level: 5-6

Give also a free text assessment of the achievement of your learning objectives and learning outcomes:

The following were discussed / demonstrated: - Overview of the DOPAS project, the POPLU experiment, and relationship to the other experiments included in DOPAS. - Design of the POPLU plug and the relationship of the experiment to the current POSIVA reference design and how the findings of the experiment will support future decisions with regard to the reference design. - Selection of the location of the experiment and the arrangement of associated construction and monitoring equipment. - Preparation of the tunnels and excavation of the slot for the experiment. - Construction of the experiment to-date (concrete backfill and filter), and installation of the steel re-inforcement (rebar) prior to the first casting. - Design and specification of the concrete for the plug and the casting methodology. - Design and installation of monitoring sensors. - Past experiments in ONKALO (tunnel excavation, drilling of deposition holes) and future plans (REPRO, FISST). - Safety requirements for working underground and regulatory oversight at ONKALO.

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

KNOWLEDGE	EQF Level 1-8
The POPLU plug design and its development.	6
The hierarchy of requirements applied to a safety classed structure.	6
The requirements on the plug in the POSIVA reference design and the differences to the POPLU experiment.	6
Instrumentation of the POPLU experiment and the broader issue of performance confirmation and testing of disposal repository components.	5
The POSIVA disposal concept and plans for its implementation at ONKALO.	5-6

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
Reinforcement of the plug.	5
Use of grouting and injection tube installation.	5
Attachment of monitoring (strain, temperature, and humidity) sensors.	4-5
Work methods in tunnel conditions including reinforcement and concrete works.	4-5

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

COMPETENCE	EQF Level 1-8
Plug site selection based on RSC (Rock Suitability Classification).	6
Concrete recipe and work method development including concrete mock-ups (method tests).	6
Testing and monitoring of the POPLU experiment.	5
Working safely underground.	4-5

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

Challenged host on requirements for the plug in the reference design, experiment design choices, installation techniques (note that the host was able to provide answers to all questions).

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

I would like to learn of the results of the experiment in due course, particularly in terms of the experience when actually installing the concrete plug and both the short-term monitoring of temperature, pressure and rock response during installation and long-term monitoring of water flow.

The visit will assist me greatly in my support to GSL input to the Euratom DOPAS project and input to the initial part of the Modern2020 project. In particular, the detail of the visit will help ensure accuracy and clarity in the reporting of the POPLU test in the various DOPAS deliverables that GSL are responsible for under WP2 and WP4. A particular issue arising from the visit that I will endeavour to consider in future work is how to develop requirements / specifications such that flexibility to adapt engineering to achieve desired safety functions in individual circumstances is achieved.

I would like to suggest the following development ideas for any future staff exchange visits. Also any other free text feedback is appreciated.

None. The tour of the facility and experiment and the level of detail of the presentations were ideal. Obviously, it is only possible to view a snapshot in time of the developing experiment, but the timing of the visit to DOPLU was ideal as the interior of the plug and rear filter could be viewed before casting, while the concrete mock-ups gave an impression of how the concrete plug itself will look after casting.

As well as the presentations and viewing the experiment, the visits to the VLJ repository and the Olkiluoto visitor centre were informative and valuable. The dinner in Rauma and the tour of the house at Vuojoki gave us the chance to learn more generally of the heritage of the area, and I would suggest that comparable activities be included in future exchanges if possible.

Pär Grahm

Was my staff exchange visit successful?

Yes, all my learning targets were fulfilled or almost fully met. The knowledge I received will be essential for my future work in reviewing POPLU within the DOPAS project and to evaluate the POPLU and DOMPLU experiments. The visit was extremely well prepared and well-structured. The timing of the visit was perfect to study essential parts of the plug installation. I also appreciated the opportunities to ask questions to various experts. About risk management, time was not enough to go into details.

What did I learn?

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level: 6

Give also a free text assessment of the achievement of your learning objectives and learning outcomes:

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

KNOWLEDGE	EQF Level 1-8
Advanced knowledge of POPLU design and monitoring plans	6
Comprehensive knowledge about ONKALO specific requirements for work	5

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
Critical awareness of the risk management for work underground at ONKALO	7
Specialised skill in planning and organisation of a full-scale experiment	7
Advanced skill in understanding the technical solutions used for POPLU	6

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

COMPETENCE	EQF Level 1-8
Evaluation of ongoing installation work conducted for POPLU	5-6
Review of the coordination of on-site contractors for POPLU	5-6

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

I challenged the host on technical questions about POPLU experiment design and motives for the design choices. I was especially interested in identifying differences between the POPLU and DOMPLU experimental designs. I noted several cases where lessons learned from the DOMPLU experiment had been incorporated in the POPLU plans. This will hopefully contribute to minimising risks in the POPLU project results. In general, I received good answers to all my questions, some of them were given via e-mail by Petri Koho subsequent to the visit.

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

My new experience from the POPLU staff exchange will certainly be valuable for my work in planning and organising new full-scale experiments underground. The specific requirements of the authority (STUK) on work in ONKALO will be helpful in understanding how SKB should prepare when building a repository for Spent Nuclear Fuel in Forsmark.

I would like to suggest the following development ideas for any future staff exchange visits. Also any other free text feedback is appreciated.

Nothing to add. The program was perfectly prepared, though perhaps a bit time consuming for the host organisation.

Michal Roll

Was my staff exchange visit successful?

Yes, almost everything was fulfilled.

What did I learn?

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level:

Give also a free text assessment of the achievement of your learning objectives and learning outcomes:

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

KNOWLEDGE	EQF Level 1-8
Clay barrier technology(mineralogy, geochemistry, physical conditions inside plug)	6
Sensors, types and location in plug	4
RSC and other things take account in selection for high radioactive waste repository location.	5
Concrete recipe and mock-up tests.	4
Underground hydrochemistry in seaside areas.	2
Sensors set up.	2

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
Sensors, work with received data using specialized programme, digital outcomes.	3

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

COMPETENCE	EQF Level 1-8
Design clay barriers.	6

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

I'm not sure if there was some contribution, maybe discussion about clay material options.

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

Geotechnical mapping procedures (Q-classification) used in ONKALO site and I already received these materials.

I would like to suggest the following development ideas for any future staff exchange visits. Also any other free text feedback is appreciated.

Maybe chronological photos with already finished works (parts) of experiment can help (just for illustration).

6 Conclusions

This report has described the objectives and outcomes of a staff exchange visit to the POPLU test at the ONKALO URCF in Olkiluoto (Finland) on 30 June-2 July 2015.

The primary objective of the visit was to observe ongoing work at the POPLU experiment, including:

- Instrumentation of the first plug part: attachment of strain, temperature, and humidity sensors and observation of already installed pressure and displacement sensors.
- Reinforcement of the first plug part and part-reinforcement of the second plug part.
- Installation of the injection feeding tubes.
- Assembly of formwork for the first plug part.

The outcomes from the visit, as assessed by the four participants, are documented in post-visit forms and can be summarised into the following points:

- The visit was very well organised, and the timing was ideal to allow observation of as much of the structure and instrumentation of the POPLU plug as possible.
- Nearly all individual learning objectives were successfully met.
- The experience and learning gained by the participants as a result of the exchange will be of great benefit to their future work.

The participants asked challenging questions of the hosts concerning a number of technical areas, all of which the hosts were able to answer satisfactorily.

A-1 Final Visit Programme

Organisation	Document name	Version	Page(s)
Posiva	**PROGRAMME TEMPLATE**	1.0	1 (2)
FORM USED BY HOSTS	Written on: June 30th 2015	Review June 30th 2015	
	Written by: Petri Koho	Date of issue June 30th 2015	
DOPAS WP6, Task 6.2			

DOPAS STAFF EXCHANGE VISIT PROGRAMME *(FINAL)*

Name:
POPLU Experiment

Location:
ONKALO, Eurajoki, Finland

Main host contact and contact information:

Host's contact person:	Petri Koho
Address:	Posiva Oy, Olkiluoto, FI-27160 Eurajoki, Finland
Telephone:	+358 2 8372 3823 or Mobile: +358 40 867 6367
E-mail:	petri.koho@posiva.fi
Office hours:	08:00 - 16:00 (UTC +3)

Time (at hrs)	**Topic**	**Contact person** and phone/host	**Location/Meeting point**
DAY 1	**30/06/2015**	**Tuesday**	**ONKALO gate**
09:00	Meet at the ONKALO gate		
09:05	ONKALO safety procedures		ONKALO gate
09:15	Welcome and practicalities of the site visit		Lohko-Tulppa
09:45	POPLU experiment presentations	KHPT	Lohko-Tulppa
09:50	DOPAS presentation	EJOH	Lohko-Tulppa
10:15	POPLU general presentation	KHPT	Lohko-Tulppa
10:45	POPLU location selection, RSC	JENA	Lohko-Tulppa
11:45	Lunch		Keskuskonttori
13:00	POPLU tunnel excavation and slot production	SMRN	Kallio
13:30	POPLU design (and foreign materials)	Samuli Ojanperä, Sweco	Kallio
14:00	Coffee		
14:10	POPLU construction	KHPT	Lohko-Tulppa
15:00	POPLU testing & monitoring	ANKY	Lohko-Tulppa
15:30	ONKALO tour and visit of the POPLU site (incl. mock-ups)	SMRN, KHPT	

Time (at hrs)	**Topic**	**Contact person** and phone/host	**Location/Meeting point**
17:00	Questions & Answers		Lohko-Tulppa
17:30	End of day 1		
19:00	Dinner in Rauma		Hotelli Vanha Rauma
DAY 2	**01/07/2015**	**Wednesday**	**ONKALO office**
08:30	Review of day 2 programme		Lohko-Tulppa
08:45	Worker safety at ONKALO	TVIU	Lohko-Tulppa
09:15	Visit of the POPLU site to see ongoing work		
11:00	Visit of Olkiluoto visitor centre		
12:30	Lunch		Keskuskonttori
13:30	Visit of the POPLU site to see ongoing work		
16:00	Coffee		Lohko-Tulppa
16:15	Questions & Answers and time for visitors to write down observations of POPLU experiment		Lohko-Tulppa
17:00	Visit of ONKALO exhibition		VLJ-luola
18:00	End of day 2		
DAY 3	**02/07/2015**	**Thursday**	**ONKALO office**
08:30	Review of day 3 programme		Vuojoki
08:45	Recap of host and visitor expectations and discussion of observations		Vuojoki
10:00	Agreement on the site visit reporting schedule and practical arrangements to end the site visit		Vuojoki
10:50	Lunch		Vuojoki
11:30	Closing of the site visit		
11:30	Travel home		

A-2 List of Learning Objectives and Anticipated Outcomes (Defined Prior to the Visit)

Jo Smith

Learning objectives / how is this visit going to assist me in my work

What is my special interest in this DOPAS experiment?

The POPLU visit represents an opportunity to visit an underground lab and gain first-hand experience of what is involved in large-scale demonstrations and experiments, and the challenges being faced and met in the geological disposal of radioactive waste. I am particularly keen to participate in the POPLU visit as it offers the chance to observe and learn more about the instrumentation of the plug and other components of the EBS, which will be directly relevant to my involvement in the Modern2020 project.

What are my objectives in this site visit?

- Observe the instrumentation of the plug, and develop understanding of what is being monitored, why and how.
- Find out whether everything has gone to plan or whether changes have had to be made to the implementation of the experiment, how this has been done and any lessons learned.
- Experience and understand the logistics and restrictions of working underground and how this influences the methods used to instrument the plug.
- Increase knowledge of the DOPAS project and POPLU experiment in particular, with insights from those directly involved.
- Develop further knowledge and understanding of the Finnish programme and the ONKALO facility, with insights from those directly involved.

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

First-hand experience, increased knowledge and understanding of underground monitoring for radioactive waste disposal facilities – will enhance my general understanding and feed directly into Modern2020 work.

Anticipated learning outcomes

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level: 5

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

KNOWLEDGE	EQF Level 1-8
Knowledge and high-level understanding of techniques for monitoring plugs and implementation procedures, as used in the POPLU experiment	5
Experience and observation of methods/restrictions for working underground	4
Knowledge of DOPAS project objectives, strategies and interim outcomes	5
Overview of Finnish programme for radioactive waste disposal	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
Relate design basis / requirements to implementation of experiment	5
Critically evaluate experiment design and/or implementation	4

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

COMPETENCE	EQF Level 1-8
Use practical observations and experiences to increase own knowledge and understanding; usefully absorb information and apply it in other contexts	5
Work with other visitors to evaluate observations of the POPLU experiment and provide constructive feedback to Posiva	5

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.

Support for GSL participation in DOPAS regarding the test strategy for the POPLU experiment. General feedback and observations on experiment strategy and implementation from the perspective of someone not involved in its design or development.

Mark Crawford

Learning objectives / how is this visit going to assist me in my work

What is my special interest in this DOPAS experiment?

Specification of requirements during design. Link between experimental testing and the statement of requirements for seals in the final design. Monitoring and development of tests for performance confirmation.

What are my objectives in this site visit?

See the instrumentation of the test plug structure. Understand how requirements are specified and arranged in a safety classed structure. See the strategy for monitoring of the experiment. Experience the work methods in tunnel conditions.

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

Support to GSL input to EC DOPAS project and input to initial part of Modern2020 project.

Anticipated learning outcomes

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level: 5

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

KNOWLEDGE	EQF Level 1-8
Sealing openings underground in fractured rock – design and specification of requirements and implementation.	
Development of the detailed plug design.	4
Requirements related to a safety classed structure (specification and structuring).	6
Monitoring and performance confirmation – design of monitoring equipment and test plans.	
Instrumentation of experiments / tests of disposal repository components.	4
General	
The POSIVA disposal concept and plans for its implementation at ONKALO.	5

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
Sealing openings underground in fractured rock – implementation.	
Reinforcement of the DOPLU plug.	4
Use of sealing mortar and injection tube installation.	4
Monitoring and performance confirmation – implementation.	
Attachment of monitoring (strain, temperature, and humidity) sensors.	4
Work methods in tunnel conditions including reinforcement and concrete works.	4

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

COMPETENCE	EQF Level 1-8
Plug site selection based on RSC (Rock Suitability Classification).	5
Concrete recipe and work method development including concrete mock-ups (method tests).	5
Testing and monitoring of the POPLU experiment.	4
Working safely underground.	4

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.

Support for GSL participation in DOPAS regarding the test strategy for the POPLU experiment.

Pär Grahm

Learning objectives / how is this visit going to assist me in my work

What is my special interest in this DOPAS experiment?

Learn details about the POPLU design and review installation activities in practice

What are my objectives in this site visit?

Learn about - POPLU design and monitoring plans - Slot excavation results - Sensor installations and data management - Assembly of reinforcement - Assembly of grouting tubes and bentonite tapes - Preparations for the formwork assembly - Preparations for the casting - Risk management for POPLU - Procedures used for on-site work

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

- Better knowledge of POPLU to be able to assess and compare POPLU and DOMPLU experiments. - Experience of coordination and follow-up of work with own staff and contractors - Increased understanding of site specific requirements applied at ONKALO. - Increased understanding of risks and challenges with full-scale installations underground

Anticipated learning outcomes

Level of Learning outcomes	EQF-level:

(EQF level, the most applicable level varies from 4-8):	6

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

KNOWLEDGE	EQF Level 1-8
Advanced knowledge of POPLU design and monitoring plans	6
Comprehensive knowledge about ONKALO specific requirements for work	5

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
Critical awareness of the risk management for work underground at ONKALO	7
Specialised skill in planning and organisation of a full-scale experiment	7
Advanced skill in understanding the technical solutions used for POPLU	6

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

COMPETENCE	EQF Level 1-8
Evaluation of ongoing installation work conducted for POPLU	5-6
Review of the coordination of on-site contractors for POPLU	5-6

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.

My certain area of expertise is the planning and installation of large-scale tests. Of special interest for me is to assess routines and installation procedures used for POPLU and compare this with my experiences from the DOMPLU experiment at Äspö HRL.

Michal Roll

Learning objectives / how is this visit going to assist me in my work

What is my special interest in this DOPAS experiment?

Clay barrier functions in time scale.

What are my objectives in this site visit?

Technological solution of every part of plug and clay preparation (for example: chemical activation if there is some).

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

How to manage construction of plug in one continuous period and also mange inner structures of plug to work together as composite material.

Anticipated learning outcomes

Level of Learning outcomes (EQF level, the most applicable level varies from 4-8):	EQF-level: 3-6

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

KNOWLEDGE	EQF Level 1-8
Clay barrier technology(mineralogy, geochemistry, physical conditions inside plug)	6
Sensors, types and location in plug	4
RSC and other things take account in selection for high radioactive waste repository location.	4
Concrete recipe and mock-up tests.	3

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
Sensors, work with received data using specialized programme, digital outcomes.	3

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

COMPETENCE	EQF Level 1-8
Design clay barriers.	6

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.

Give new thoughts about material choice in plug construction (activated clays, bentonite, geopolymers or SCC – self compacted concrete) or discussion about interaction between clays and high mineralized waters in underground facility.

A-3 List of Materials Collected

Materials collected by Jo Smith

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
1	Posiva, information pack cover	Brochure	Public	
2	Posiva, 2013, Pocket Guide to Final Disposal	Brochure	Public	
3	Posiva, A2-size folded information leaflet, including ONKALO map and photos on reverse	Brochure	Public	
4	TVO, Fortum & Posiva, Geological disposal of spent nuclear fuel in Olkiluoto	Brochure	Public	
5	DOPAS Training Workshop leaflet	Brochure	Public	
6	DOPAS 2016 Seminar leaflet	Brochure	Public	
7	VTT, POPLU Plug – Summary of cables and plug cable flanges	Drawing/diagram	Public - locate in DOPAS project folder for future reference.	
8	VTT, POPLU Plug – Summary of sensors	Other document - table		
Photographs – 71 in total (details provided below)				
9-10	General views of maintenance hall	Photographs (2)	Other - locate in DOPAS project folder for future reference and possible use in DOPAS reports (subject to permission from POSIVA).	
11-13	Grinding machine in maintenance hall	Photographs (3)		
14	Air ventilation ducts in maintenance hall	Photograph		
15	Machine with covered working area	Photograph		
16	Water collection pools	Photograph		
17	Concrete rings outside demo area	Photograph		
18	Demo tunnel 1 general	Photograph		
19-20	Demo tunnel 2 general	Photographs (2)		
21-23	Open deposition hole in DT2	Photographs (3)		
24	Closed deposition hole in DT2	Photograph		
25	Ropes in DT2	Photograph		
26-27	REPRO experiment	Photographs (2)		
28	Entrance to DT3	Photograph		
29	Inside container in DT3	Photograph		

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
30-33	Lead-through pipes	Photographs (4)	Other - locate in DOPAS project folder for future reference and possible use in DOPAS reports (subject to permission from POSIVA).	
34-37	Pressurisation pipes	Photographs (4)		
38	DT3 ceiling	Photograph		
39-41	DT4 – plug construction general	Photographs (3)		
42	Concrete blocks used in filter layer	Photograph		
43-48	Plug construction (moulding etc.)	Photographs (6)		
49-55	Olkiluoto Visitor Centre	Photographs (7)		
56-61	Mock-ups	Photographs (6)		
62-74	Inside plug – reinforcements, sensors etc.	Photographs (13)		
75-76	DT3 – extensiometers, wireless antenna	Photographs (2)		
77	Temperature sensors (in DT3 container)	Photograph		
78-79	DT2 – leaking fracture zone	Photographs (2)		

Materials collected by Mark Crawford

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
1	Posiva, information pack cover	Brochure	Public	
2	TVO, Fortum & Posiva, Geological disposal of spent nuclear fuel in Olkiluoto	Brochure	Public	
3	Posiva, 2013, Pocket Guide to Final Disposal	Brochure	Public	
4	Posiva, A2-size folded information leaflet, including ONKALO map and photos on reverse	Brochure	Public	
5	Pocket Guide – Final Disposal	Brochure	Public	
6	VTT, POPLU Plug – Summary of cables and plug cable flanges	Drawing	Public - locate in DOPAS project folder for future reference.	

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
7	VTT, POPLU Plug – Summary of sensors	Other written material – table	Public - locate in DOPAS project folder for future reference.	
8	DOPAS Training Workshop 2015 – Registration Form	Brochure	Public - for office info.	
9	DOPAS 2016 Seminar leaflet	Brochure	Public - for office info.	
10	Rock core	Other – rock core	Other – keep in office "library" for future reference	
11	Photos - Deposition hole and Demo Tunnel 2 * 3 - DOPLU Tunnel 3 through-tube ends and water injection pipe ends - DOPLU Tunnel 3 extensiometer - DOPLU Tunnel 4 from end - DOPLU experiment rebar * 5 - Tunnel surface scaling / grinding machine bit - Outside - MOCK-UPs * 5 - Visitor centre * 5 - VLJ repository and VLJ information board	25 in total	Other - locate in DOPAS project folder for future reference and possible use in DOPAS reports (subject to permission from POSIVA).	

Materials collected by Pär Graham

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
1	Posiva, information pack cover	Brochure	Public	
2	TVO, Fortum & Posiva, Geological disposal of spent nuclear fuel in Olkiluoto	Brochure	Public	
3	Posiva, 2013, Pocket Guide to Final Disposal	Brochure	Public	

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
4	Posiva, A2-size folded information leaflet, including ONKALO map and photos on reverse	Brochure	Public	
5	Pocket Guide – Final Disposal	Brochure	Public	
6	VTT, POPLU Plug – Summary of cables and plug cable flanges	Drawing	Public - locate in DOPAS project folder for future reference.	
7	VTT, POPLU Plug – Summary of sensors	Other written material – table	Public - locate in DOPAS project folder for future reference.	
8	DOPAS Training Workshop 2015 – Registration Form	Brochure	Public - for office info.	
9	DOPAS 2016 Seminar leaflet	Brochure	Public - for office info.	
10	Rock core	Other – rock core	Other – keep in office "library" for future reference	
11	Photos of POPLU · Lead-through pipes DT3 (2) · POPLU front view (5) · LECA block detail (1) · Formwork seal detail (1) · Reinforcement (8) · Mock-up (1) · Formwork details (3) · Bentonite strips detail (1) · VTT staff (2) · Injection tube detail (2) · Pore pressure sensor (1) · Strain sensor (1) ·	28 in total	Other - locate in DOPAS project folder for future reference and possible use in DOPAS reports (subject to permission from POSIVA).	

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
12	Other photos · Water collection weir DT1 (1) · Grinding tool (2) · TVO visitor centre (3) · VLJ repository rock wall (1)	7 in total	Other - locate in DOPAS project folder for future reference and possible use in DOPAS reports (subject to permission from POSIVA).	

Materials collected by Michal Roll

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
1	Posiva, information pack cover	Brochure	Public	
2	TVO, Fortum & Posiva, Geological disposal of spent nuclear fuel in Olkiluoto	Brochure	Public	
3	Posiva, 2013, Pocket Guide to Final Disposal	Brochure	Public	
4	Posiva, A2-size folded information leaflet, including ONKALO map and photos on reverse	Brochure	Public	
5	Pocket Guide – Final Disposal	Brochure	Public	
6	VTT, POPLU Plug – Summary of cables and plug cable flanges	Drawing	Public	
7	VTT, POPLU Plug – Summary of sensors	Other written material – table	Public	
8	DOPAS Training Workshop 2015 – Registration Form	Brochure	Public	
9	DOPAS 2016 Seminar leaflet	Brochure	Public	
10	Rock core	Other – rock core	Other	

#	Material reference (e.g. author, year/date, name, location)	Material type	Dissemination level (Public, Restricted, Other) and planned use of the material	Comments
11	Photos Technical floor (16) Demonstration tunnels T2 (10) T3 (12) T4 - plug, entrance + second part (15) Low and middle radioactive waste depository (13) Mock-up wedges (details) (3) Radionuclides tracers experiment (2) Visiting center (16) Eurojaki mansion (18) Shoe water cleaning device(1)	99 in total	Other – personal use (presentation for employees of URC Josef)	
12	Working report 2008-77	Digital form (link)	Public	