The research leading to these results has received funding from the European Union’s European Atomic Energy Community’s (Euratom) Seventh Framework Programme FP7/2007-2013, under Grant Agreement No. 323273 for the DOPAS project.
Outline of this lecture

1. Information about the DOMPLU experiment
   - Objectives (partially based on requirements)
   - Experimental layout
   - Photos from installation
   - Example of results and conclusions

2. Scoping a technical development project
   - Useful tool: Work Breakdown Structure (WBS)
   - Group work: Create a WBS for the DOMPLU full scale experiment
Part 1 – Information about DOMPLU
The DOMPLU experiment

- DOMPLU is a full-scale test of the plug system in realistic conditions at Äspö HRL (-450 m) with 4 MPa water pressure in the deposition tunnel.
Acknowledgement

- DOMPLU is conducted as a joint project between SKB and Posiva. Correspondingly, SKB takes part of Posiva’s plug project POPLU in ONKALO.

- Both DOMPLU and POPLU are part of the Full-Scale Demonstration Of Plugs And Seals (DOPAS) project.
DOMPLU objectives (major)

• Construction of a dome plug system according to design specifications (SKB TR-10-16) in the license application.

• Improve the plug design and verify quality control of installation and commissioning in full-scale.

• Control water tightness of the plug. Recent analyses allow a maximum leakage of <0.1 l/min past the plug. (SKB TR-14-22, in preparation)
Preparations before full-scale

• Laboratory tests of plug component materials:
  – Filter/Drainage (gravel in different fractions, geotextiles, LECA)
  – Bentonite Seal, MX-80 blocks and pellets
  – Low-pH Concrete, recipe B200 (SKB R-09-07)
• Analytical and Numerical calculations for design purposes and full-scale test predictions
  – Hydro-Mechanical modelling of Bentonite Seal – Filter - Backfill
  – Thermal and structural responses of the Concrete Dome
• Downscaled (1:10) tests of the plug system (6 trial cycles)
• Äspö HRL field-tests (slot excavation, contact grouting)
• Pilot borehole core characterisation and water injections
DOMPLU layout

56 sensors in the concrete dome
- Gap-width, deformation, strains and temperatures.

3 supplementary sensors in the lead-through pipe and the drainpipes
- Pore pressures

48 sensors in the bentonite seal, filter and backfill
- Total and pore pressures, RH & temperatures, displacements.

BETONGKUPOL / CONCRETE DOME - 179CM (centre)
BETONGBALKAR / CONCRETE DELIMITER - 30CM
BENTONITTÄTNING / BENTONITE SEAL - 50CM
MACADAM FILTER - 30CM
LECABALKAR / LECA BEAM DELIMITER - 30CM
ÅTERFYLLNADSBLOCK / BACKFILL ZONE - 100CM
BETONGVÄGG / CONCRETE WALL - 50CM

Monitoring of leakage
- On-line scale
Slot excavation by wire sawing

- Symmetrical octagon design (16 cuts, $\approx 8.8$ m)
- Safety scaffold structure for workers protection
The excavated slot

- View of the excavated slot for casing of the concrete dome
- Model composed of laser scanning data
Installation 1 (3)

- 3 lead-through pipes for sensor cabling and water inlet pipes
  - Backfill blocks/pellets and LECA beams
  - Gravel filter, bentonite seal (MX-80 blocks/pellets) and concrete beams
Installation 2 (3)

- Grouting tubes (3 sections)
- Geotextile (2 layers)
- Concrete sensors
- Cooling system
Installation 3 (3)

- Formwork (by Doka)
- Casting (94 m$^3$ B200)
  - Non-reinforced structure
- Chillers (redundant)
DOMPLU in operation

- Monitoring have been carried out since March 2013.
- Full water pressure 4 MPa was reached in February 2014.
- Data freeze for the DOPAS project: September 30, 2014.

- On-line leakage measurements.
- Plastic sheet reduces effects of tunnel ventilation and evaporation.
Water escapes

1. Cables

2. Rock fracture

3. Plug/Rock interface

One significant water escape has been identified in this area (fracture B107), located about 14 meters in front of the pressure chamber.
September 30, 2014: The measured leakage past the plug (in weir) was 0.04 l/min at 4 MPa water pressure (this was about 11% of the inflow)
Conclusions (in selection)

- In general, plug construction was successful and workers safety aspects were handled in a good way. Learnings: Formwork can be redesigned, installations at tunnel ceiling can be improved.
- Initially, all sensors worked well. A few sensors failed during contact grouting and other sensors have failed due to water pressure increase.
- Sensors data correspond very well to predictive calculations.
- The plug is tighter than the rock!
- The leakage past the plug (collected in the weir) is well below 0.1 l/min and the trend is decreasing. Seal is not yet saturated.
DOMPLU coming work

- Technical reporting. DOPAS deliverable D4.3
- DOMPLU results will lead to a “light update” of the basic design of deposition tunnel plugs in the Spent Fuel Repository.
- Operation and monitoring of DOMPLU will continue at 4 MPa water pressure, at least until late 2016.
- DOMPLU will be opened and retrieved in 2017. A final load test (close to the design load of 9 MPa) is a unique opportunity to verify the design of the concrete dome and the numerical models used.
DOMPLU publications

• SKB P-13-37 System design of Dome plug. Creep properties at high stress levels of concrete for deposition tunnel plugs. (published)

• SKB P-13-38 System design of Dome plug. Mechanical properties of rock-concrete interface (published)

• SKB P-14-26 Experience of low-pH concrete mix B200. Material properties from laboratory tests and full-scale castings (in preparation)

• SKB R-14-24 System design of Dome Plug. Experiences from wire sawing of a slot abutment for the KBS-3V deposition tunnel plug (in preparation)

• SKB R-14-25 System design of Dome Plug. Preparatory modelling and tests of the sealing and draining components (in preparation)

• KTH TRITA-BKN147 Instrumentation and Evaluation of the Concrete Dome Plug.

• SKB TR-14-23 System design and full-scale testing of the Dome Plug for KBS-3V deposition tunnels. Main report (in preparation)
Part 2 – Scope Management
Determining the scope

- An essential part of the project planning is to define a scope statement.
- Correct and proper breakdown of the scope is essential for a successful project (i.e. to fulfil the project objectives and meet the Client’s expectation on the deliveries).
- Subdivision of major project deliveries should be done in a Work Breakdown Structure (WBS).

* ISO 21500 Guidance on project management
* ISO 10006 Guideline to Quality in project management
* PMBOK Guide (Project Management Institute)
What is a WBS?

- A hierarchically-structured grouping of project elements:
  - Defines total scope
  - Deliverable-oriented
  - Schematic
  - Id-No. on each work package
  - Can be used for each project phase
Why use WBS?

• Advantages with a Work Breakdown Structure:
  - Gives a common understanding of what to do
  - Improves the accuracy of cost, time, and resource estimations
  - Gives a baseline for performance measurement and control
  - Facilitates clear assignment of responsibilities

• A good WBS makes it easier to keep control of the scope!
  - Regular follow-up of WBS work packages
  - Checkpoint for limitations
  - Any changes of scope to be approved by the Client.
  - Use project change forms!
How to create a WBS (some tips)

• Identification of work packages
  ▪ Engage people with various background and competence (include specialists).
  ▪ Brainstorm on blank paper. For instance, use Post-it notes and pen.
  ▪ Use experiences and lessons learned from similar projects.
  ▪ Arrange the work packages in a strategic and schematic way.

• Verification of scope
  ✓ Summarise and discuss in the project team
  ✓ Use a reference group for review and further input
  ✓ Formal approval by the Client
Group work - WBS

• Create a WBS for the DOMPLU full scale experiment

• Focus on the project phase Installation (including monitoring)

• Use information in the previous presentation (DOMPLU layout, and photos from installation)

• Ask experts (if necessary ;)

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[Logos and text]
1. Project Management
2. Planning
3. Design, modelling and pre-tests
4. Purchase & Manufacturing
5. Installation & Monitoring
5.1
  5.1.1
  5.1.2
  5.1.3
5.2
5.3
6. Reporting
7. Closing

Group work – WBS
Presentation of group work
Thank you for a great team work!

www.posiva.fi/en/dopas

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