Implementing Geological Disposal of Radioactive Waste
Technology Platform

Rapporteur feedback slides from EF8 technical break out sessions

Technical topic ‘Progress in site investigation and characterisation techniques’

Bernd Frieg
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Summary of working group attendees

- **WMO** = Puram, RWM, SKB, Andra, Nagra, Enresa, SURAO, Dekom, BGE
- **TSO** = VTT
- **RE** = BRGM, KIT, FZJ, IST-ID/C²TN, SCK-CEN, V REZ, TUS, ENEA, GSL, TU Braunschweig, AMPHOS 21, HZDR, UJV REZ, LEI, IBRAE RAN,
- **Regulator** = BFE
- **Private company** = BRENK Systemplanung
- **Civil Society representatives** = ……
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Presentations

- Hungary / Peter Molnar (Puram) - Site characterisation in the Hungarian early-stage programme
- UK / Rob McLaverty (RWM) - Preparation for site characterisation in the UK: a needs-driven exercise
- Switzerland / Bernd Frieg (Nagra) - Site characterisation in the final stage of selecting the site in sedimentary clay rock in Switzerland
- Sweden / Peter Wikberg (SKB) - Site characterisation in the Swedish crystalline rock before and after submitting the construction licence
- France / Jacques Delay (Andra) - Site characterisation in the French sedimentary/clay rock programme, close to construction licence submission

The research leading to these results has received funding from the European Union’s European Atomic Energy Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreements n° 228194, n° 228299 and n° 228298.
Working group aims

• A geological disposal site characterisation programme will need to meet the information requirements of the design and disposal system safety assessments and also contribute towards the development of a site descriptive model.

• Typically, a site characterisation team will need to define the parameters to be measured to provide this information.

• This technical session will seek to address aspects of advanced site characterisation techniques and identify topics for potential knowledge transfer towards emerging programs.
Summary of working group contributions

Methodological topics for site selection

• Shared disposal options for countries with small inventories – international siting investigations – how to realise collaboration?
• Public participation: how to make it successful? --> NEA – IGSC (International Group for Safety Case) efforts already in place.
• What were the motivating factors to move the next stage?
• Is the schedule a key element?
National Geological Screening
Sectoral Plan – 3 stages towards site selection

<table>
<thead>
<tr>
<th>Stage</th>
<th>Timeframe</th>
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<tbody>
<tr>
<td>Stage 1</td>
<td>2008 - 2011</td>
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<td>Stage 2</td>
<td>2012 - 2018</td>
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<td>Stage 3</td>
<td>~ 6 years</td>
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INITIAL SITE INVESTIGATION

PURPOSE
Select priority site within candidate area.

RESULTS
- Homogenous rock area of 5–10 km² selected as priority site.
- Description of surface ecosystems and fundamental geoscientific conditions.

LEGEND
- Interpreted lineaments and fracture zones of varying size
- Seismic reflection measurement profile
- Deep cored borehole

PREREQUISITE
Candidate area of up to 200 km² has been selected on the basis of feasibility study.

CANDIDATE AREA

SITE

SCOPE
- Regional area.
- One or more subareas.
- General field investigations, mainly:
  - airborne geophysics and ground geophysics
  - geology and surface groundwaters, and
  - inventory of flora, fauna and cultural environments.
- Limited percussion drilling.
- Initiate long-term monitoring of near-surface groundwaters and ecosystems.
- General studies regarding the execution of a deep repository.

SCOPE
- Seismic reflection and VSP (downhole) for preliminary mapping of fracture zones and depth.
- 2–3 deep (~1000 m) cored borehole for checking essential conditions within groundwater chemistry (dissolved oxygen, salinity), rock mechanics (stresses, strength), geology and hydrogeology.
- Initiate long-term monitoring of seismic movements and deep groundwater.
- Establish initial site-adapted layout and analyze feasibility.
- Safety assessments based on requirements and criteria and compare with SR 97.

RESULTS
- Preliminary site description (based on in-depth information as well).
- Preliminary facility description.
- Preliminary safety judgement.
Geoscience in Siting Process

From regional to local scale for investigations

A progressive approach

Regional scale

Local scale

+ observations and experiments (URL)

Relevant area for disposal

More and more detailed investigations in time

(in relation with steps of GDF development)
From 1991 to now...
Global overview

At each step of siting process, geosciences had, have and will have a large role in the decision.
Summary of working group contributions

Site characterisation topics

- Bring together in a more comprehensive way the lessons learned from site investigations for construction (e.g. ramp and shaft construction) and accompanying monitoring (e.g. Andra, SKB).
- Requirement driven approach from safety case versus geology based approach. The question is what a program needs to know and when: what justifies the decision?
- Strategy of limited extensive deep boreholes (e.g. Nagra) vs. multiple boreholes with limited objectives (e.g. Andra)
Summary of working group contributions

Timing questions of programme elements for site selection

• At which stage the inventory has to be defined?
• How does the inventory affect the footprint of the facility? -> Andra?!
• At which stage waste package needs to be defined?
• At which stage the decision of the location of the site specific URL needs to be defined?
Some questions in an early-stage site characterisation programme

At which stage the **inventory** has to be primarily defined?
- decision on the back-end strategy of the fuel cycle influences the heat production and volume of the waste, footprint of the facility

At which stage **type of waste packages** has to be basically specified?
- influences the size of the shafts and tunnels, excavation and support methods, facility layout, disposal equipment etc.

At which stage decision has to be taken about the **location of an URL**? What are the most relevant considerations?
- complexity of the geology, transposition of information from URL to DGR
- influences the facility layout, methods of closure and seals etc.

**Experiences and lessons learned in advanced programmes would help for planning of further RD&D activities including site characterisation in an early-stage programme**
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Summary of working group contributions

RD&D topics

• Research for offshore scenario development (RWM initiative)
• Use of the URL’s in foreign countries to gain experience (e.g. Andra experience / Mt. Terri)
• How do we identify what is new in site investigations?
• Do we need to do more on driving technological development for siting?

• Statement from Peter: Site investigation is not research!
Stripa Mine Project 1977-1992

• Development of **characterization techniques and integrated characterization and modeling** of site data

• Fracture flow and transport modeling

• Basis for understanding of channeling and its importance for radionuclide transport

• Basic designs of engineered barriers (buffer, backfill and plugs) and basic understanding of their performance

• Successful international cooperation
  • Initiation of **Task Force on groundwater flow and transport**
  • Initiation of Task Force on Sealing materials and techniques
  • Knowledge transfer

• **Experience** essential for later work at Äspö HRL and other underground laboratories
The purpose of Äspö HRL

- Provide input to performance assessments
  - *in situ data from a previously non-disturbed rock mass*
  - process understanding
  - assessment of model validity

- **Develop, test and evaluate methods for investigation**, repository construction and waste emplacement

- Provide experience and training of staff
Summary of working group contributions

Management topics

• Practicalities how safety case and site description is linked.
• Establishment of the appropriate workflows.
• How to ensure data management?
• Keeping data accessible for decades?
• Permanent re-evaluation of own approaches – build-up of a learning organization actively and working physically together.
Disposal System Specification

Design Information Requirements

Safety Case Information Requirements

Environmental Assessment Information Requirements

Parameters to be measured

Desk Study

Non-Intrusive Surface-based investigations

Intrusive Surface-based investigations

Underground Investigations

Interpretation and Modelling of Data

Radioactive Waste Management
Exploration boreholes – organisation, planning, tendering

- Tendering of different work packages (not general contractor):
  - Drilling company
  - Logging services
  - Hydraulic Testing
  - On-site geological investigations (multiple work packages)
  - ….
- Drilling at 2 sites in parallel

- Management of each work package remains by Nagra
- Detailed planning as basis for tender a requirement
- Optimisation of the interaction of the individual teams critical (time, resources)
A progressive and converging stepwise approach for siting:

- **First step**, Geo-scientific arguments based on « qualitative » criteria (from safety guidance)
  - Geological stability, no fault, « good » hydrogeology », confinement, …

- **Following steps**, definition of geoscientific arguments based on « quantitative » criteria, derived from **geological investigations and increase of scientific knowledge** (Surveys, URL, numerical simulation)
  - Depth, thickness, head gradient, … mainly linked to long-term safety
    - More and more detailed and suitable area (from regional to local scale)

At each step of siting (about each 4 years), long-term safety assessment is carried out to check global safety

- Checking consistency between {science/safety/design}
  - Quantitative geoscientific arguments plays a major role,

However the characterisation programmes have to take into account local acceptance, local and national administrative requirements…
Conclusion: R&D activities … some thoughts

Horizontal activities
  o **Networking (some example)**
    • An efficient way to learn is to visit the other sites and meet the people that operated the characterisation programmes
  o **Knowledge transfer**

Technical improvements
  o **Drilling technical progresses (mud, tools, logging probes...)**
    • Mont Terri DF experiment
  o **Survey technics, sampling and conditioning methods (QA procedures)**
  o **Development of completions**
    • Taking into account all the developments made in URL (Mont Terri, Bure and other...)
    • New transducers and new acquisition chains (Modern 2020)
Conclusions and suggested way forward

• Knowledge transfer --> first, the requirements need to be refined by those planning to use the knowledge.

• Possible options are:
  – Secondments: Go and learn
  – Workshop
  – Expert network creation
  – Web-based activities: webinar, platform discussion, Whatsapp groups

• **Recommended as a topic taken up by the EURAD knowledge management activities.**