Design Basis, Strategies and Decisions for Monitoring of Repository for Radioactive Waste

Approach and key messages

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This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement n° 662177
• National legislation and regulatory demands

• Guiding principles from international organisations (IAEA, NEA, EU)

• Generic process for scoping, designing and implementing a repository monitoring programme - the MoDeRn project


This project has received funding from the Euratom research & training programme 2014-2018 under grant agreement 662177
General objectives

- Support and document a move from generic towards actual, implementable monitoring programmes
- Provide tools and methodologies at generic level which may be adapted and adopted by different national programmes

Specifically develop:

- basis for **designing** monitoring programmes
- **strategies** for designing and implementing monitoring programmes
- principles for using monitored data in **decision** making
Main outcome

Focusing on operational period

✓ Link of monitoring results to safety case update established

✓ Monitoring strategies identified

✓ Methodology for identification of parameters to monitor devised

✓ Role/Utilisation of and decisions based on monitored data established

Details given in presentations Day 1 14:00 and Day 3: 09:00
Link between monitoring and safety case update

- Monitoring may provide information on the operating phase performance of the disposal system
- Input to periodic updates of safety case
- Compare with expected evolution

- Check consistency with safety case
- Base for stakeholder dialogue
## Aspects and Elements of monitoring strategy

<table>
<thead>
<tr>
<th>Aspect</th>
<th>High-level strategy elements</th>
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</table>
| **Where** | Monitoring *in situ* in the main repository, with or without retrieval of monitored components at the end of the monitoring period  
- Monitoring in a **pilot facility**  
- Monitoring in an on-site at **Underground Rock Characterization Facility** |
| **What** | **Waste packages** (and surrounding EBS and near-field rock)  
- **Dummy packages** (and surrounding EBS and near-field rock)  
- **Specific elements of the EBS** (e.g. small-scale batch tests)  
- **Geological barrier** (near-field rock and far-field rock)  
- **Biosphere** |
| **When** | **Before repository operation** or during commissioning  
- **During the period of waste emplacement**  
- **After closure of the repository** |
| **How** | Not considered |
Identification of parameters to monitor

- Consideration of processes, parameters and technologies
- Methodology for screening parameters to be monitored
- Tested in 7 safety cases by respective WMO
- Safety as main driver

Modern2020 Screening Methodology
## Parameter screening test cases

<table>
<thead>
<tr>
<th>WMO</th>
<th>Safety Case</th>
<th>Description</th>
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<tbody>
<tr>
<td>Andra</td>
<td>Cigéo</td>
<td>The safety assessment for Cigéo, the planned repository for high-level waste (HLW) and long-lived intermediate-level waste (ILW-LL) in the Callovo-Oxfordian Clay in France, based on the Safety Options Report 2016.</td>
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<td>France</td>
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<tr>
<td>BGE TEC</td>
<td>ANSICHT</td>
<td>The new safety assessment concept developed for a repository sited in clay in Germany.</td>
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<td>Germany</td>
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<tr>
<td>Nagra</td>
<td>Opalinus Clay</td>
<td>Demonstration of disposal feasibility for spent fuel, high-level waste (HLW) and long-lived intermediate-level waste (ILW) in a clay host rock in Switzerland.</td>
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<tr>
<td>Switzerland</td>
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<tr>
<td>NRG</td>
<td>OPERA</td>
<td>An evaluation of the technical feasibility and safety performance of a repository for low and intermediate-level waste (L/ILW) and HLW in the Boom Clay, in the Netherlands.</td>
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<tr>
<td>Netherlands</td>
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<tr>
<td>Posiva</td>
<td>TURVA 2012</td>
<td>Posiva’s 2012 safety case for disposal of spent fuel in crystalline rock in Olkiluoto, Finland.</td>
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<td>Finland</td>
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<td>SKB</td>
<td>SR-Site</td>
<td>Long-term safety for the final repository for spent nuclear fuel at Forsmark, Sweden.</td>
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<td>Sweden</td>
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<td>SURAO</td>
<td>Reference Project 2011</td>
<td>Update of the reference project of a deep geological repository in granite at a hypothetical locality, Czech Republic.</td>
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<td>Czech Repub.</td>
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</table>
Conclusions on Parameter screening Test cases

1. Determining parameters is challenging but achievable.
2. Principal justifications are that parameters are relevant to post-closure safety and/or retrievability – to build further confidence in the safety case by demonstrating understanding and validating performance, so direct link to safety case is not necessary.
3. Need to focus on more detailed aspects of monitoring programme design, such as selection of sensor type, number and locations.
4. Need to assess the impact of the monitoring system on the safety case.
5. There is **no common set** of parameters that should be monitored, choice will depend strongly on the specific drivers, constraints and objectives in national context.

6. Screening process and its results must be **transparent and understandable** to future generations and external stakeholders.

7. It is advantageous to plan repository monitoring at an **early** stage e.g. to allow technology development, design may take account of monitoring needs, building stakeholder confidence.
1. It is **useful** across the range of programmes, is flexible and can be adapted to the needs of individual programmes.

2. It guides users to provide **justified** reasons for monitoring a process.

3. Several starting points are possible, with or without relevance to safety.

4. It is part of the overall MoDeRn Monitoring Workflow, not a standalone activity.

5. Processes need to be linked to a specific repository component or location in order to be meaningfully evaluated.
Decisions based on monitored data

Decisions are taken relative to an expected evolution of monitored parameters, in space and time.

The comparisons of monitored to expected evolution also involves a subjective component, a value judgement.

Critical are therefore:
• the definition of expected evolution
• measures of comparisons both being highly specific to the site and technical solution.
Type of decisions supported by monitored data

- **Technical**: related to the installation of engineered barriers and excavation of the host rock e.g., decisions on the final design of the closure system or decisions on the timing of backfill installation in specific parts of the repository.

- **Disposal programme**: main stages in the disposal programme, and moving from one stage to the next.

- **Governance**: overall approach to management of radioactive waste and control of the programme, e.g. changes in the role and responsibilities of the relevant organisations, and the manner in which stakeholders are involved in the programme.
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement no 662177
Achievements

- Identified need to harmonise objectives of monitoring, model/modelling and decision making maintaining a holistic view.
- Devised a parameter screening methodology.
- Applied the screening methodology to actual safety cases successfully.
- Identified principles, issues and workflow on responding to monitoring data.
- Identified a range of decisions and responses based on monitoring data.
- Produced a revised/updated overall MoDeRn monitoring workflow.
Remaining challenges

1. To determine that the repository monitoring system does not have a significant detrimental impact on the safety case.

2. To establish procedures for responding to monitoring results which are transparent and traceable.
Remaining challenges

Several coupled processes are active in the repository system.

Singular monitoring parameter evaluations relative expected evolution are necessary but not sufficient as basis for decision making, sometime with far reaching consequences.

Therefore necessary to:

3. Move from 1D singular parameter temporal predictions to 4D system behaviour predictions.

4. Establish principles for assessing 4D monitoring responses relative action triggers.
Thank you!