MODERN 2020

Development and Demonstration of monitoring strategies and technologies for geological disposal

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safe solutions for radioactive waste

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

Approach and key messages

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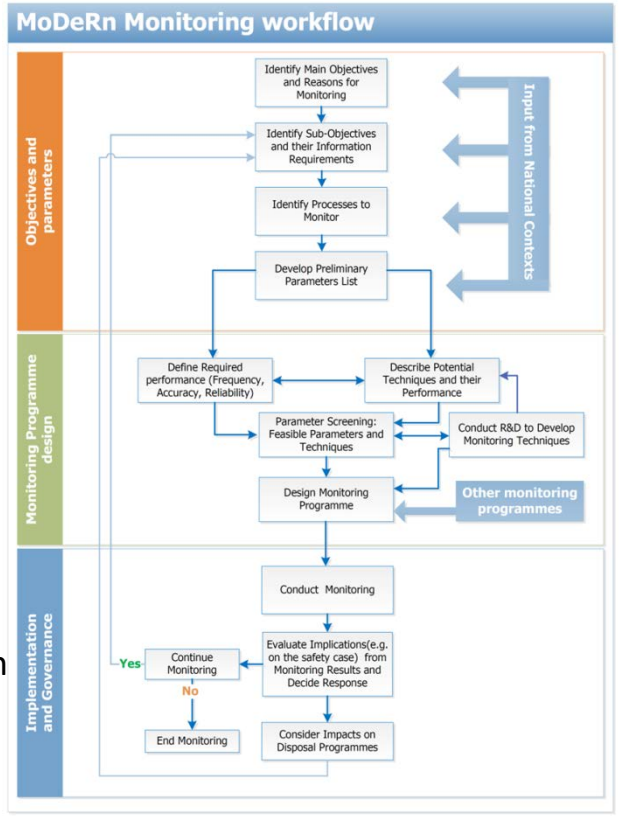
Reference framework

- 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

Objectives & Parameters

Programme-design

Implementation & Governance



MoDeRn (2013a), *Monitoring During the Stages Implementation of Geological Disposal: The MoDeRn Project Synthesis*. MoDeRn Deliverable D6.1.

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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

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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**

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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

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Aspects and Elements of monitoring strategy

Aspect	High-level strategy elements
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

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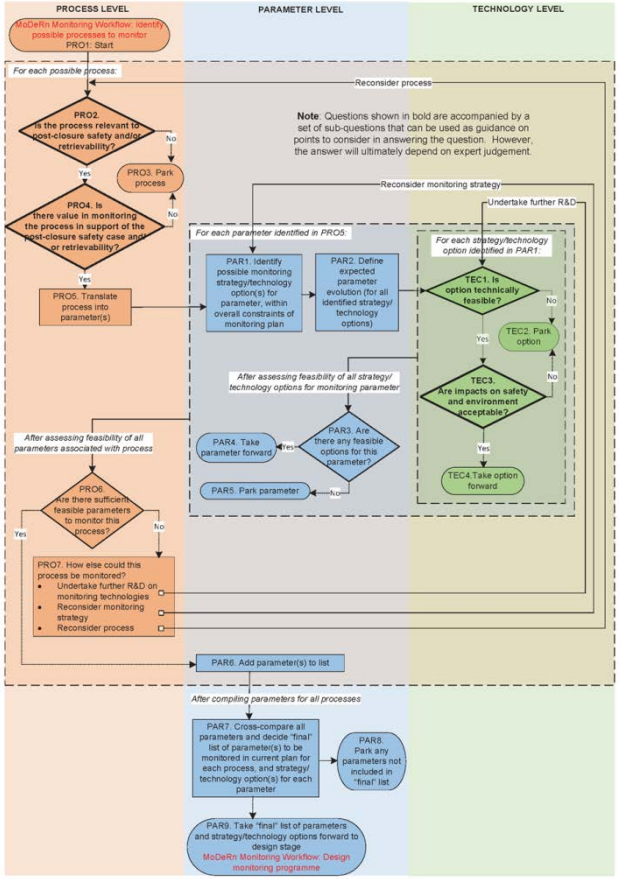
Identification of parameters to monitor

- 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

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Parameter screening test cases

	WMO	Safety Case	Description
Clay	**Andra** France	Cigéo	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.
Clay	**BGE TEC** Germany	ANSICHT	The new safety assessment concept developed for a repository sited in clay in Germany.
Clay	**Nagra** Switzerland	Opalinus Clay	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.
Clay	**NRG** Netherlands	OPERA	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.
Crystalline	**Posiva** Finland	TURVA 2012	Posiva's 2012 safety case for disposal of spent fuel in crystalline rock in Olkiluoto, Finland.
Crystalline	**SKB** Sweden	SR-Site	Long-term safety for the final repository for spent nuclear fuel at Forsmark, Sweden.
Crystalline	**SURAO** Czech Repub.	Reference Project 2011	Update of the reference project of a deep geological repository in granite at a hypothetical locality, Czech Republic.

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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.

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Conclusions
Parameter screening Test cases

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.

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Conclusions on Parameter screening Methdology

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.

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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.

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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.

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The MoDeRn Monitoring Workflow

as revised by Modern2020 project.

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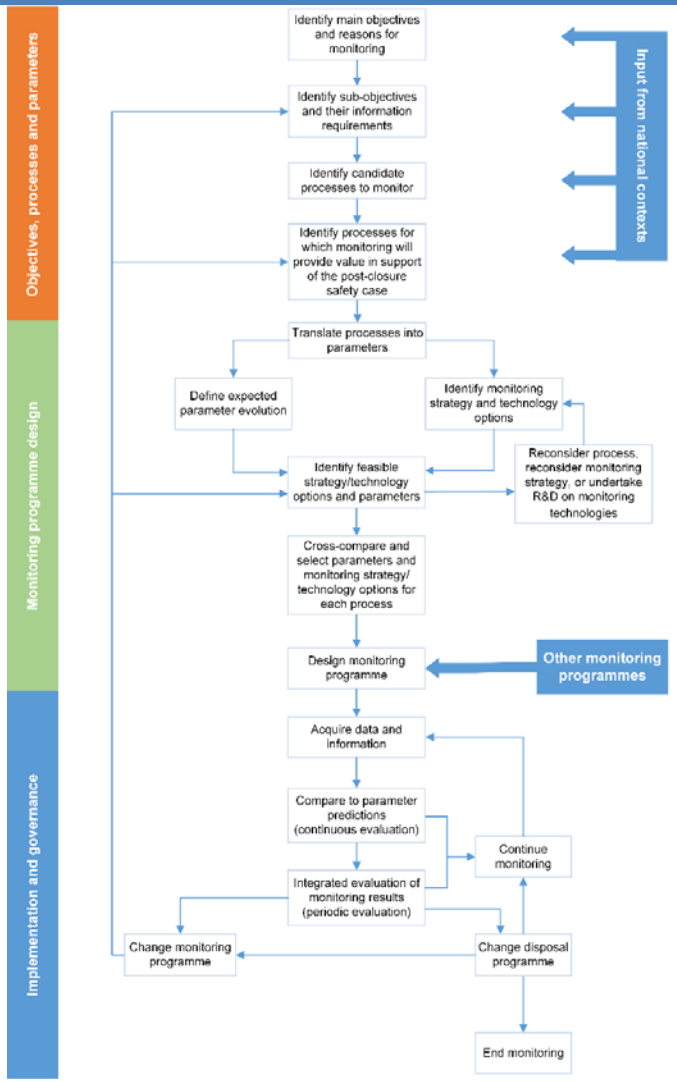
Objectives, processes & parameters

Monitoring programme design

Implementation & governance



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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.

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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.

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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.

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Thank you!

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