Modern2020

Monitoring During the Operational Period to Provide Further Confidence in the Post-Closure Safety Case: Strategies and Parameters

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Background

- The MoDeRn Project formulated a reference framework and a generic workflow for developing and conducting a monitoring programme
- Further work was required to consider explicitly how monitoring parameters could be identified
Recommendation from the Nuclear Energy Agency


- The current, and justifiable, tendency is to measure as many parameters as possible
- With the transition from the repository development stage to implementation, it becomes necessary to optimise the selection of the parameters
- The identification of those parameters which would sufficiently demonstrate the attainment or approach to the passive safety status of the disposal system would be of substantial benefit
- The recommendations of the NEA have been addressed in Modern2020 through the development of a generic structured approach to the selection of parameters
  ✓ The Modern2020 Screening Methodology
Presentation Structure

• Describe the context for monitoring in support of building further confidence in the post-closure safety case
• Present the Modern2020 Screening Methodology
• Draw conclusions on the selection of parameters to be included in a monitoring programme focused on providing further confidence in the post-closure safety case
Monitoring during the Operational Period and the Post-Closure Safety Case

• To receive a licence to operate, a WMO must demonstrate confidence that the repository will be safe if implemented as designed
• Confidence is underpinned by an extensive research, development and demonstration programme
• The approach to the post-closure safety case explicitly addresses uncertainty and sensitivity of safety to different scenarios
• Demonstration that the repository is implemented correctly is undertaken through Quality Control against design specifications
• The safety case will be updated periodically during the operational period, monitoring during this period could be a significant input
• During the operational period monitoring can be used to build further confidence in the post-closure safety case
Why Monitor?

• The emphasis placed on different reasons for monitoring the near field during the operational period differ from programme one to another
• Monitoring may provide an opportunity to demonstrate understanding of the thermal, hydraulic, mechanical and chemical processes occurring, thereby demonstrating WMO understanding and building further confidence
• Monitoring programmes might focus on the short-term evolution of the repository system to show that this evolution is consistent with the safety case
• Monitoring may also provide the means for continuing to engage with stakeholders and check the evolution of the disposal system following waste emplacement
Limitations in Monitoring the Near Field to Build Further Confidence

- Monitoring has the potential to impact the passive safety of the repository system
  - Explicit demonstration of the significance of any impact is required
  - It may be that we accept a minor and insignificant reduction in passive safety to gain additional understanding of near field processes

- The relevance of processes occurring in the first few decades after EBS emplacement to long-term safety may be difficult to determine
Strategies

- All programmes agree that it is impractical to monitor all of the repository
- High-level strategies will be used to monitor specific parts of the repository during the operational period
- In Modern2020 a strategy consists of four elements:
  - Where: main repository, pilot repository, underground rock characterisation facility
  - What: waste packages and near field; dummy packages and near field; specific EBS elements; the geological barrier; the biosphere
  - When: during construction (baseline for operations); during emplacement; after emplacement; during closure; after closure
  - How: the types of technologies used, including *in situ* sensors; borehole-based sensors; surface–based technologies; air-based technologies
The Modern2020 Screening Methodology

- The Methodology is presented as three strands: processes, parameters and technologies
- Starting point is list of processes or parameters that have been proposed for monitoring
- Basis for decisions are judgements based on existing knowledge
- The Methodology is a stepwise process to allow for traceability and transparency
- Judgements used as a basis for decisions may change, so processes and parameters are parked and not rejected
Identifying Parameters that are Valuable to Monitor

• The first step in the Methodology is to determine if there is value in monitoring a proposed process

• Is the process relevant to post-closure safety and/or retrievability
  ✓ Link to safety functions, safety function indicator, safety assessment parameter or relevant to retrieval

• Is there value in monitoring the process in support of the post-closure safety case?
  ✓ Could monitoring the process: reduce uncertainty further, provide additional confidence, be detectable, support repository design enhancements, result in greater system understanding?
Identifying Strategy/Technology Options and Parameter Predictions

- For each parameter identified, there is a need to assess the feasibility of monitoring it.
- This requires a proposal for the strategy and technology option, and a prediction of the parameter value over the monitoring period.
Feasibility for each Strategy and Technology Option for each Parameter

• For each strategy and technology option, there is a need to determine technological feasibility

• Is the option technically feasible?
  ✓ Can the proposed technology: meet the required accuracy and frequency requirements; function effectively under repository conditions; be undertaken safely; be used without unacceptable operational impacts?

• Are impacts on safety and environment acceptable?
  ✓ Can the technology be applied without significantly affecting the passive safety of the repository system?
  ✓ Are risks to workers acceptable?
  ✓ Is the likely impact of the development, manufacture or deployment of the technology on the environment acceptable?

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Can Parameter be Monitored?

- Once the technical feasibility of monitoring each parameter, for each strategy and technology option, has been assessed a check is made that there are one or more feasible options that allow the parameter to be taken forward.

- Step included in Methodology to ensure process is transparent and traceable.
Can Process be Monitored?

• Once the list of feasible parameters is available, there is a need to check that each process in the list can be monitored.

• If there are insufficient parameters to monitor a process, there needs to be reconsideration of earlier steps in the process.
• The final step in the Modern2020 Screening Methodology is a cross-comparison of feasible parameters

• Project-specific procedures should be identified to ensure that “final” list of parameters provides sufficient redundancy and diversity to meet requirements on confidence of acquired data
Test Case Parameters

- Parameters need to be linked to disposal concept, monitoring strategy, disposal system element/component and technology, examples of parameters include:
  - Temperature
  - Porewater pressure
  - Fluid (gas) pressure
  - Permeability/groundwater flow velocity
  - Confining pressure
  - Swelling pressure
  - Diameter
  - Displacement
  - Hydrogen concentration
  - Oxygen concentration
  - Relative humidity
  - Water content/saturation
  - Porewater pH
  - Porewater/groundwater chemistry
  - Redox Potential
  - Thickness
  - Corrosion rate
  - Mineralogy and chemistry
  - Density (dry and bulk)
  - Pore structure
  - Piping and Erosion
Conclusions

• Deciding on parameters is a value judgement
• Monitoring during the operational phase will be conducted over many decades, and justification for the monitoring parameters will be iterated multiple times
• The Modern2020 Screening Methodology is flexible and can be adapted to programme-specific boundary conditions
• Modern2020 Screening Methodology was trialled in seven test cases to identify several potential monitoring parameters
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