
MoDeRn Project: Lessons Learned and Further Work Requirements

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IGD-TP Exchange Forum N° 4
Prague Congress Centre
29-30 October 2013

IAEA Monitoring Requirements

- **Monitoring provides input to safety assessments, continuing assurance of operational safety of the facility and confirmation that actual conditions are consistent with the assumptions made for safety after closure**
- **During the operational period, the monitoring programme should be used to demonstrate compliance with the regulatory requirements and licence conditions for operation, including compliance with safety requirements for environmental and radiation protection**

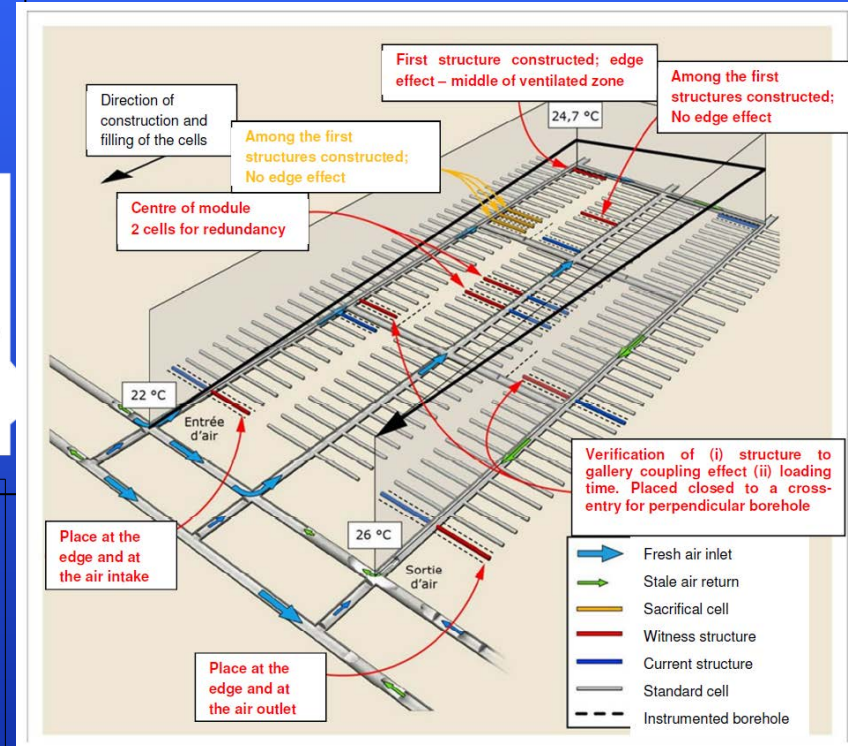
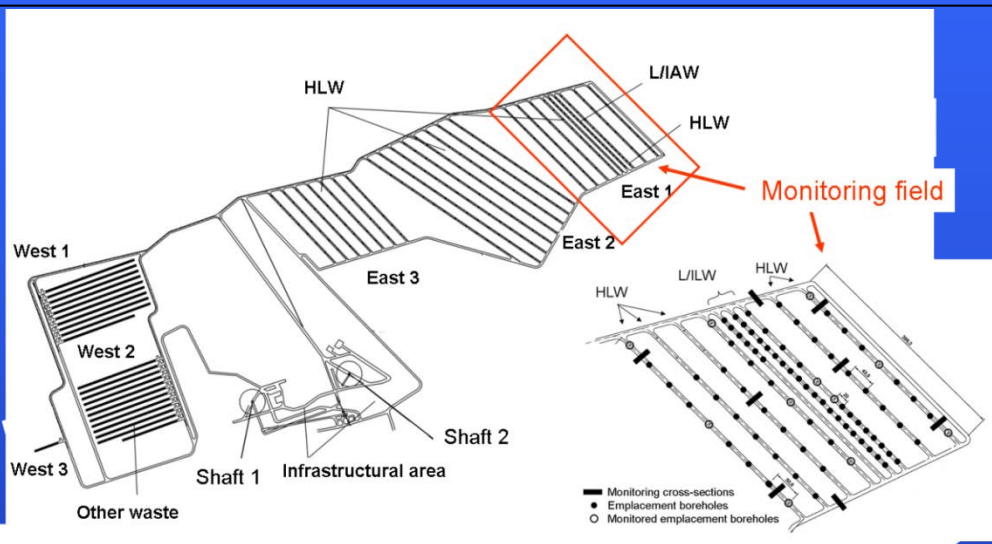
What Did MoDeRn Achieve?

- **Consideration of monitoring objectives and strategies, and guidance on the development of repository monitoring programmes**
 - **Developed MoDeRn Monitoring Workflow**
- **Developed and demonstrated innovative EBS-based monitoring and data transmission technologies – seismic tomography, microseismic monitoring, high-frequency wireless data transmission, low-frequency wireless data transmission, fibre optic sensing, digital Image correlation, corrosion sensors**
 - **Technical requirements and state-of-the-art**
- **Three near-field monitoring case studies, and evaluation of failure detection approaches**
- **Developed a better understanding of the views of public stakeholders on monitoring**

What Is Required Next?

- Understanding of how *actual* results of monitoring can be used to support decision making
- Better understand monitoring requirements from the safety case perspective to guide further development of monitoring technologies and to allow these developments to be better integrated with requirements of the safety case
- Demonstration of how monitoring programmes can be tailored to site-specific conditions and site-specific safety cases
 - Develop experience in evaluating monitoring results
 - Use of monitoring to support optimisation of the disposal system
- Implementation of monitoring systems
 - Ensure monitoring systems do not interfere with operational safety and practicability
 - Ensure monitoring systems do not entail excessive cost

MoDeRn Case Studies



Comparison with WIPP Compliance Monitoring Parameters

- For the WIPP Compliance Monitoring Programme, ten parameters are monitored with respect to confirming post-closure performance

Monitored Parameter	Pre-closure	Post-closure
Culebra Member groundwater composition	X	X
Culebra Member change in groundwater flow	X	X
Probability of drilling intersecting a brine reservoir	X	X
Drilling rate (number of new boreholes per km ²)	X	X
Subsidence	X	X
Waste activity	X	
Creep closure and stresses	X	
Extent of deformation (around the excavations)	X	
Initiation of brittle deformation	X	
Displacement of deformation features	X	



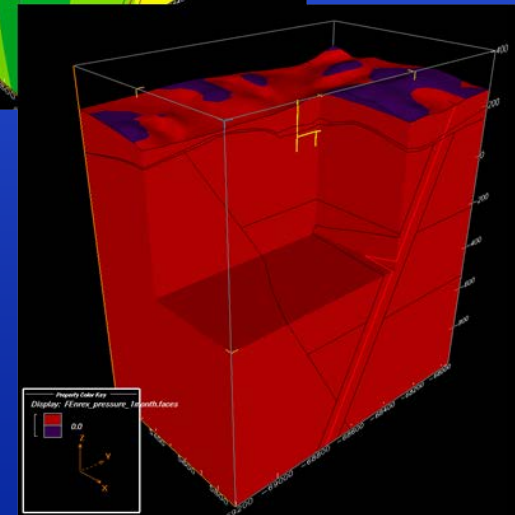
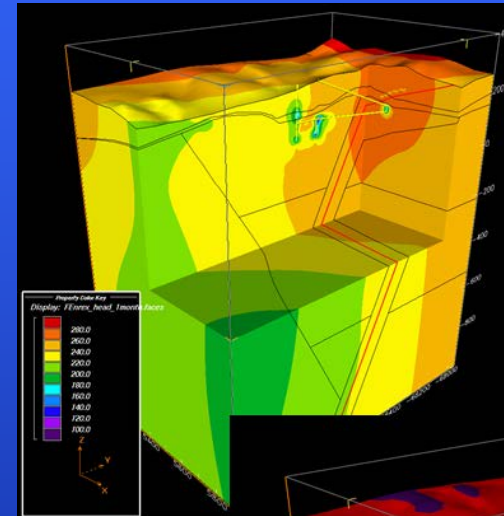
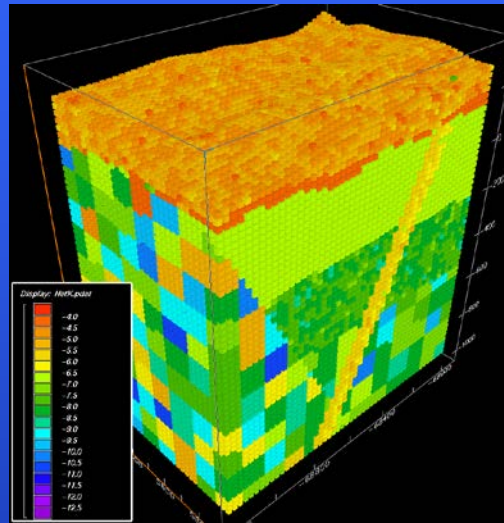
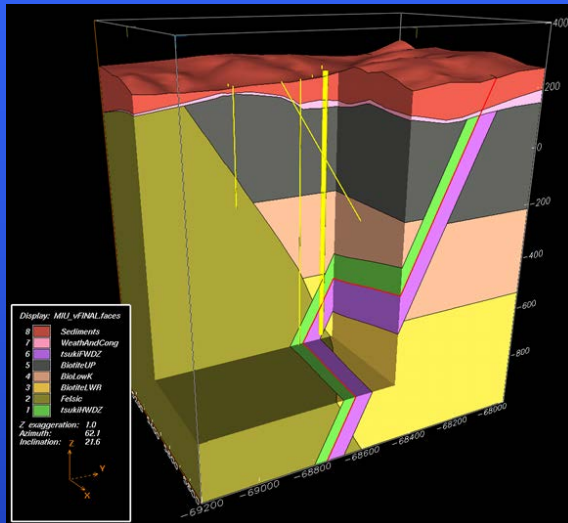
Identifying Parameters to Support the Safety Case

- Identification of monitoring parameters based on safety functions is appropriate and can be used to identify detailed monitoring programme
- However, for reasons of practicability and cost a monitoring programme should not monitor all safety functions, and approaches are required to develop realistic monitoring programmes that meet stakeholder requirements (including regulatory requirements)
- From the implementors perspective, post-emplacement monitoring could focus on continual improvement in the disposal system and optimisation as well as meeting stakeholder requirements
- In a future EC project on monitoring, a work package should be included to evaluate how post-emplacement monitoring could support on-going optimisation of the disposal system
- The work package would undertake a systematic evaluation of a range of disposal concepts to identify how and when monitoring can support uncertainty reduction and optimisation
- Involvement of safety case specialists and disposal system designers in producing more realistic (reduced) sets of monitoring parameters and monitoring requirements, including trigger values

Developing Experience in Evaluating Monitoring Results

- The MoDeRn Project developed a range of techniques suitable for monitoring the EBS and transmitting the monitoring data
- Theoretical, desk-based, studies illustrated how monitoring technologies could be utilised in EBS monitoring programmes
- The MoDeRn Project was unable to evaluate how monitoring results could be used in decision making – this requires case studies in which monitoring data are acquired and evaluated to see if they are appropriate for decision making, three approaches:
 - Investigating how monitoring data from real / planned repositories have actually been used in practice to inform decision making on design of particular systems
 - Use of URL experiments could provide real data for evaluation of performance – e.g. monitoring of DOPAS experiments
 - Synthetic sites/EBS representations from which monitoring data could be sampled and provided to modelling teams, extensive data sets exist from which such sites could be developed and significant experience is available in similar prediction exercises

Synthetic Sites



Conclusions: Possible Tasks

- **Monitoring Programme Requirements**
 - Working with regulators to understand likely requirements on operational monitoring
 - Review of disposal concepts from a post-closure safety case perspective to identify most significant parameters in a structured manner
- **Evaluating Monitoring Results**
 - Case studies of actual facility monitoring linked to radioactive waste management decisions
 - Case studies of underground experiments to guide development of implementable monitoring systems
 - Synthetic exercises to better understand requirements on data and technologies