overview of the Modern2020 project

Development and Demonstration of monitoring strategies and technologies for geological disposal

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Overview
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This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement n° 662177

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Background about Monitoring in Geological Disposal of Radioactive Waste

Context & References

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Scope of Monitoring

- Monitoring is a broad subject covering all aspects of geological disposal, e.g. monitoring of society and monitoring technical performance of barriers
- Always need to explicitly state the reason for monitoring, what is monitored and the timeframe over which monitoring will be undertaken
- **Modern2020** is focused on monitoring of the engineered barrier system and near-field rock during the operational period in support of post-closure safety demonstration and support for decision making ("**repository monitoring**")
  - ✓ Some work may have a slightly different focus, e.g. on monitoring after closure


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Extensive « literature » on monitoring (20 years)

IAEA TECDOC 1208 (2001)	Monitoring of Geological Repositories for High Level Radioactive Waste
European Commission Project Report EUR 21025 (2004)	Thematic Network on the Role of Monitoring in a Phased Approach to Geological Disposal of Radioactive Waste
IAEA Safety Requirements WS-R-4 (2006)	Geological Disposal of Radioactive Waste – Requirements on monitoring programs
IAEA Safety Standards GSR Part 4 (2009)	Safety Assessments for Facilities and Activities – e.g. Maintenance of the safety assessment
IAEA Safety Standards – Draft Safety Guide DS357 (2011)	Monitoring and Surveillance of Radioactive Waste Disposal Facilities
All program specific developments (WMOs) and regulatory/safety guidelines	MoDeRn National Context Summary Report and Country Annexes Report

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Modern-FP7 project (2009-2013)

MoDeRn was a collaborative project co-funded by the European Commission under the 7th Framework Programme

EURATOM Programme

Call for propositions FP7-Fission-2008 « **Nuclear Fission and radiation protection** »

Topic « **Strategies and technologies for repository monitoring** »

Duration: (4 1/2 years)

It aims at providing a **framework for the development and possible implementation of monitoring activities** and associated **stakeholder engagement** during relevant phases of the radioactive waste disposal process.

18 partners from 12 countries

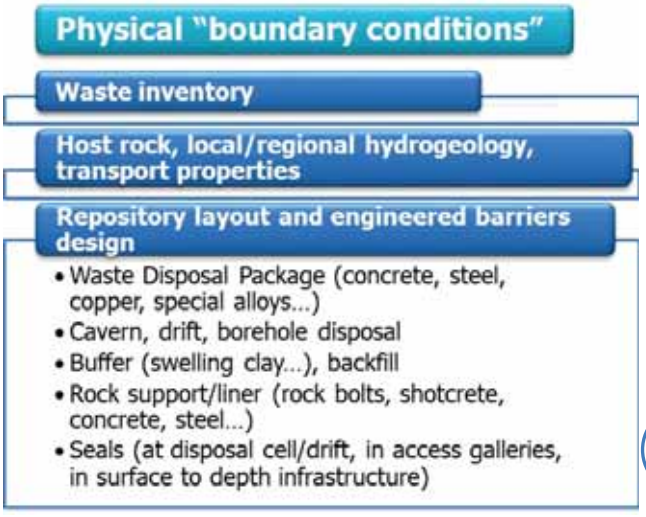
Coordinator : Andra

Budget : 5 million €

EU contribution : 2.8 million €

Published project documents are available on:

www.modern-fp7.eu



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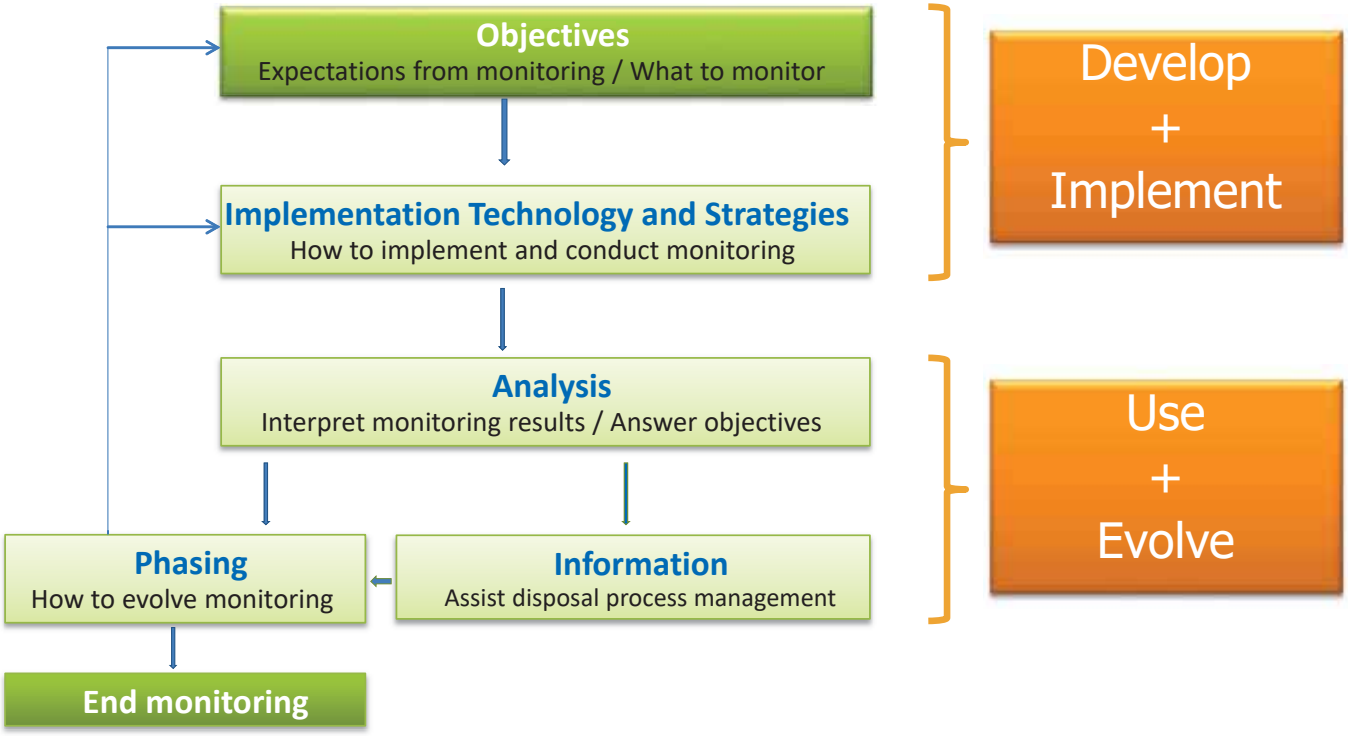
Reference Framework

Key steps to develop/implement/use/evolve a monitoring program



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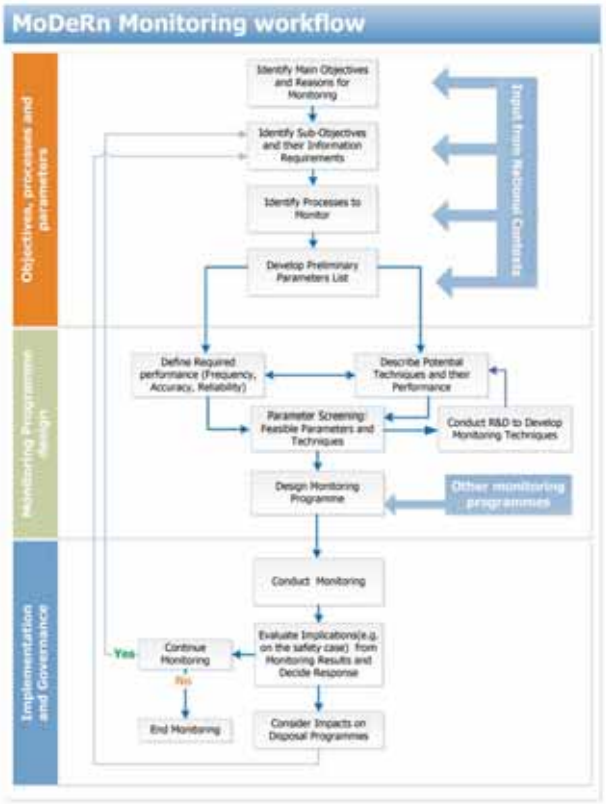
Modern-FP7 project contribution

The MoDeRn project developed a set of documents to support the design and implementation of monitoring programs:

- ✓ A framework, presenting the workflow, with a systematic top-down approach to developing monitoring programs
- ✓ Case studies provide examples of monitoring programs in 3 host rocks
- ✓ National Contexts
- ✓ The State of the Art in technologies for monitoring, complemented by 5 programs of research and demonstration in URL
- ✓ The basis for SH communication and National Engagement Reports



What?

How?

Use?

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Recent developement

IAEA Safety Guide SSG-14 (Geological Disposal Facilities for Radioactive Waste)

- ✓ *"performance monitoring should be used to provide confirmation of assumptions made in the safety case"*
- ✓ *"A programme of monitoring should be included as part of the safety case and should be refined with each revision of the safety case. 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"*

- Repository monitoring is part of the safety case and the repository monitoring programme should be developed alongside development of the overall safety case
- Other types of monitoring, e.g. monitoring associated with on-going site characterisation also play a role in the safety case

NEA (2014), Monitoring of Geological Disposal Facilities: Technical and Societal Aspects. NEA/RWM/R(2014)2

- **Identifying safety-relevant processes and parameters may not**, on its own, result in an implementable and logical monitoring plan
  - ✓ "The current, and justifiable, tendency is to measure as many parameters as possible so as to contribute in the most comprehensive way towards both the compilation of a complex description of the disposal system and the understanding of its performance under real conditions
  - ✓ With the transition from the repository development stage to implementation, it becomes necessary to optimise the selection of the parameters to be monitored which is motivated by practical reasons since it would be difficult to install and operate such a large number of monitoring systems over long time periods in the final disposal system
  - ✓ Thus, 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."

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Modern 2020

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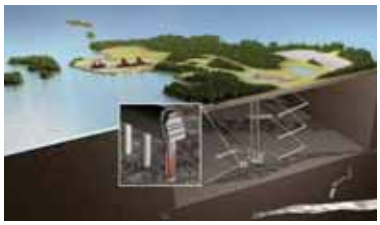
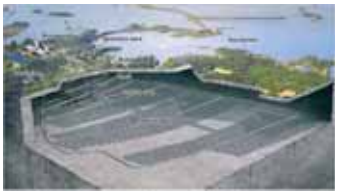
Why a « monitoring project » at this time?

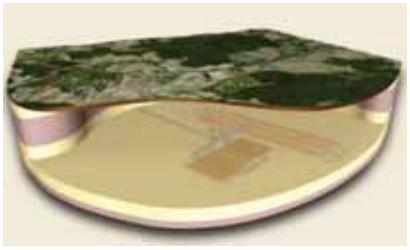
- Three countries with the same challenge: **License application (LA)**
- **Monitoring plan (monitoring aspect)** will be elements required by authorities (regulator, …) or lay stakeholders…



Posiva–
Finish Concept-
LA in 2015



SKB –
Swedish Concept-
LA start in 2011



Andra –
French Concept-
LA Start in 2020

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What are the Modern2020 targets?

1. **Target 1:** be more practical
   - ✓ contribute to tailored monitoring programs for a Member State WMO that plans to submit a license application
   - ✓ specifying what **should** be included in a repository monitoring program during operations
   - ✓ improving monitoring technologies
   - ✓ example for good practice and a starting point for further development
- **Target 2**: engage public stakeholders in "monitoring" R&D project
  - ✓ Monitoring can increase confidence and understanding
- **Target 3: How monitoring can contribute/facilitate steps towards decision making**
  - ✓ Use monitoring data
  - ✓ Evolvement of a monitoring program

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How the Modern2020 project was organised to be able to reach the targets

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Key Modern2020 objectives

- To Develop a method to select and justify monitoring parameters (WP2)
- To apply methodology to real concepts and programmes (WP2)
- Develop collective opinion and guidance to how to use monitoring results (WP2)
- Develop monitoring technologies (WP3)
- To monitor large/full-scale demonstrators (WP4)
- To engage local public stakeholders in national and international repository monitoring R&D (WP5)
- To develop ideas on how to communicate monitoring data (of the type gathered through *in- situ* monitoring) to public stakeholders (WP5)
- Identify the potential to increase the democratic quality of the overall process of implementing geological disposal as a long term management strategy (WP5)
- Maintain and enhance knowledge and competences (WP6)

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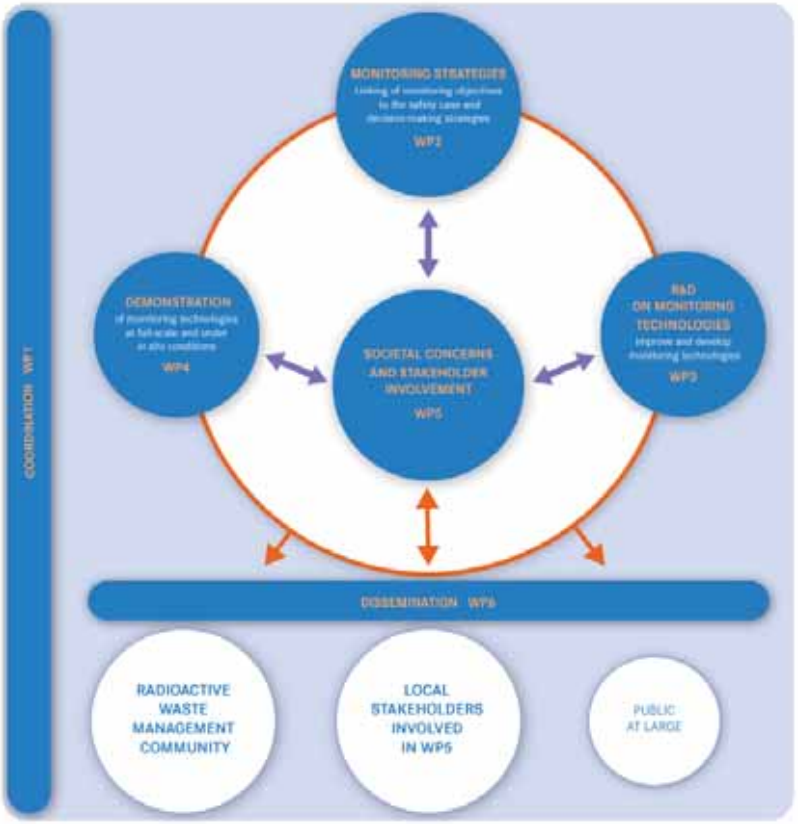
Approach



- **WP2 Strategy**: Linking of monitoring objectives to the safety case and decision-making strategies.
- **WP3 Technology**: Research and development on monitoring technologies.
- **WP4 Demonstration and Practical Implementation**: Demonstration of monitoring technologies at full-scale and under *in situ* conditions.
- **WP5 Societal concerns and Stakeholder Involvement**: Development and evaluation of ways for integrating public stakeholders concerns and societal expectations into national repository monitoring programmes

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Modern2020 consortium

Consortium: 29 partners EU + non-EU countries (Coordinator : Andra)

8 radioactive waste management organisations	ANDRA, enresa, nagra., ONDRAF/NIRAS, Radioactive Waste Management, SKB, SÚRAO
5 organisations undertaking research on radioactive waste management in their respective country	BGE TEC, ENEA, NRG, RWMC, VTT
1 technical support organisation	IRSN
6 organisations with specialist technical monitoring expertise	ARQUIMEA, AMBERG INFRAESTRUCTURAS, AREVA, EDF, EDV EURIDICE DIE
8 academic research units	ETH Zürich, GÖTEBORG UNIVERSITY, TECHNICAL UNIVERSITY OF LIBEREC, UMONS, Universiteit Antwerpen, Xlim
2 specialist consultants	Galson, NiDia

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The modern2020 project

Modern2020 project is a **collaborative project funded by Euratom under grant agreement n°662177.**

It aims at providing a **framework for the development and possible implementation of monitoring** and associated stakeholder engagement during **operational phases** of the radioactive waste disposal process.

EURATOM Research & Training Programme 2014-2018

TOPIC: « Contribute to the development of solutions for the management of ultimate radioactive waste

IGD-TP Topic : Joint Activity 7 - Monitoring

Project Duration: 4 years (Start June 30th, 2015)

Total budget : 8,6 million €

EC contribution : 6 million €

Website : www.modern2020.eu

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MODERN 2020

Development and Demonstration of monitoring strategies and technologies for geological disposal

What you will found in the project?

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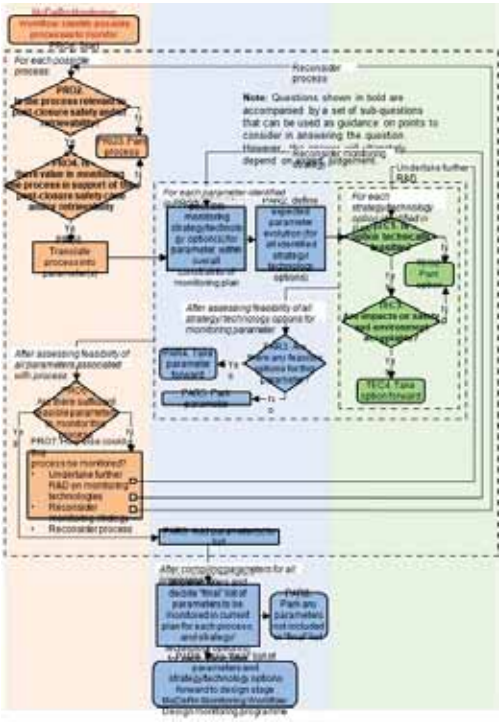
From process to monitoring parameters

- **Identification of parameters to monitor**
- Methodology for screening parameters to be monitored
- Tested in 7 safety cases by respective WMO: Cigéo test case (France) , ANSICHT (Germany), Opalinus Clay (Switzerland), OPERA (Netherlands), TURVA 2012 (Finland), SR-Site test case: (Sweden), Reference Project 2011 (Czech Republic).
- Main driver is safety
- Iterative approach considering, processess, parameters and technological feasibility
- Parameters are either carried forward or parked
- Methodology to be indicative and flexible rather than prescriptive

PROCESS PARAMETER TECHNOLOGY



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From parameters to monitoring technologies

Improve and combine Wireless Data Transmission systems

Improve existing short range (tens of meters) wireless systems based on high or medium frequencies (*Arquimea, ENRESA, IRSN & VTT*)

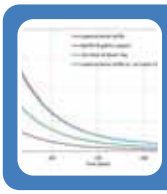
Improve existing long range (hundreds of meters) wireless systems based on low frequencies (*Andra & RWMC*)

Evaluate the use of a combination of different range wireless systems to provide a complete data transmission solution (*Amberg, Andra, Arquimea, ENRESA, EURIDICE, IRSN, NRG, RWMC & VTT*

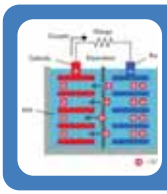
Alternative power supply sources

Nuclear batteries

Induction (10m)



energy harvesting from small thermal gradients



Chemical batteries + ceramic capacitor

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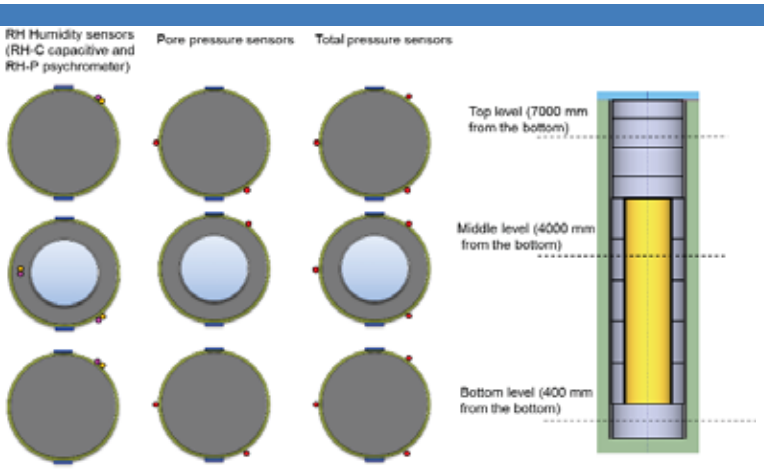
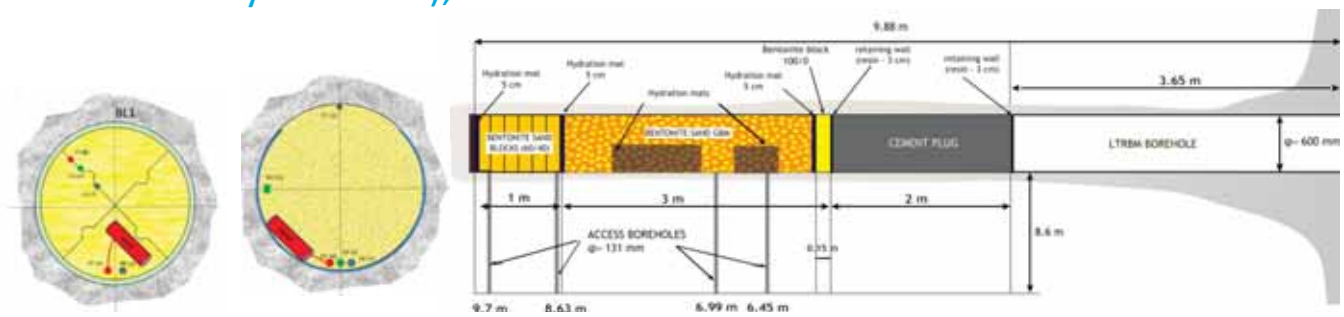
From technologies to real monitoring design



Full scale in situ system test), Onkalo Posiva

AHA demonstrators, Bure, Andra



Long-Term Rock Buffer Monitoring, IRSN Tournemire

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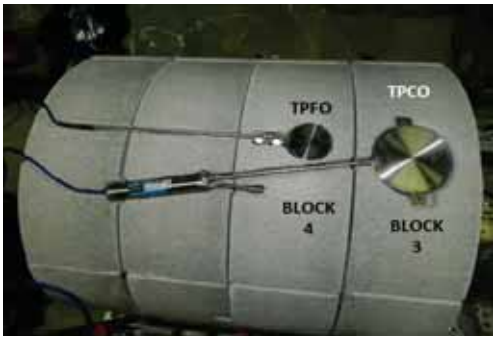
From design to on field implementation

Optical fiber , AHA demonstrators, Bure, Andra



Long-Term Rock Buffer Monitoring, IRSN Tournemire

Wireless Pore water pressure

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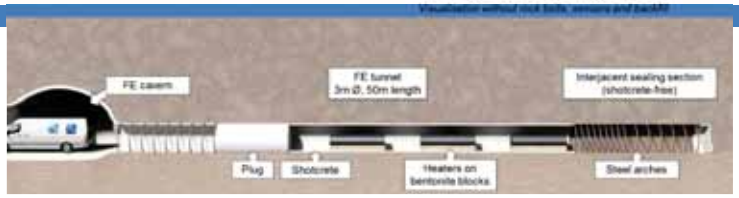
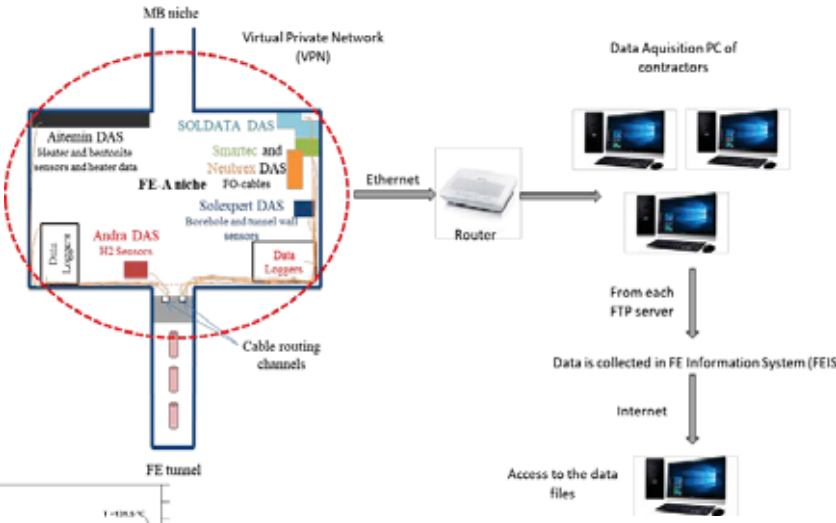
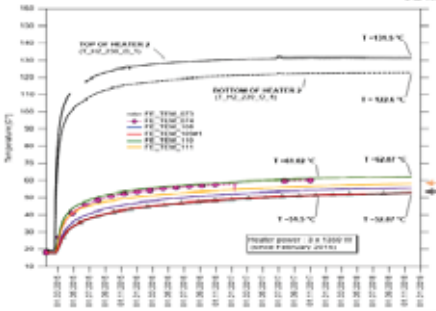
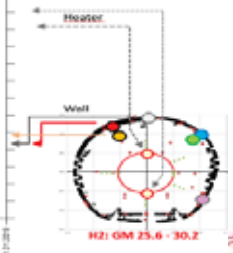
From implementation to data treatment









Fibre-optic cables for distributed strain and temperature sensing (cables with single and/or multimode fibres) were installed at FE tunnel wall and in boreholes.

Mont Terri , FE experiment, Nagra

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From data treatmeant to interpretation

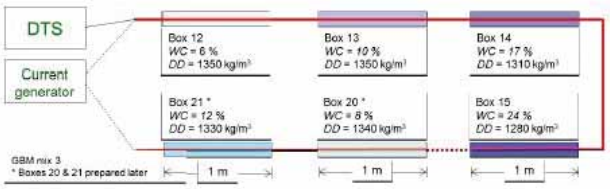


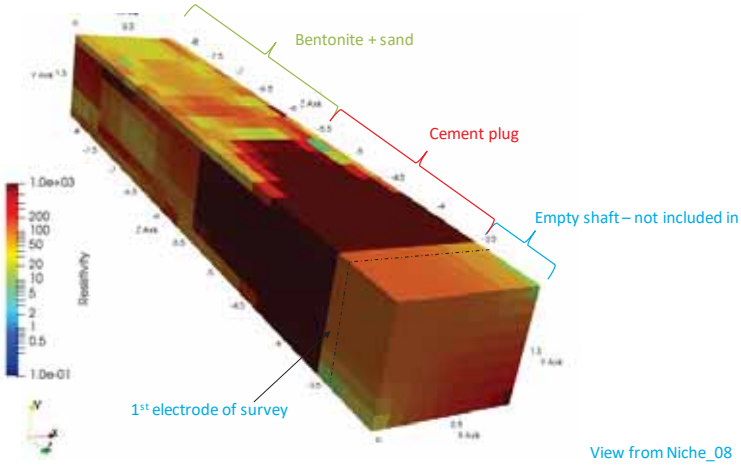
Fig. 5-1: Test setup with various water content conditions

Note: Actual dry density achieved in each box is also shown. Boxes 20 and 21 were added 26 days after Boxes 12 – 15.

Fig. 5-2: Photograph of the test setup

Note: For the higher water content boxes, metal clamps were used to costrain the volume.

Calibration test at Grimsel laboratory



View from Niche_08

ERT experiment, U Stratclhyde, Tournemire

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From interpretation to responses to monitoring results

decision making process

- Terminology on performance measures and response plans
- Development of a generic performance measures scheme
- Development of a generic action list
- Development of a set of high-level guiding principles on performance measures and response plans

Generic Response	Explanation
Desk-based responses	
Evaluate sensor performance	Re-checking of the raw data from sensors to check that the sensor readings are valid.
Check results	Re-checking the analysis of sensor readings to check that the interpretation of the raw data is valid.
Report results	Notifying stakeholders (including regulators) of results.
Root cause analysis	Evaluating the reasons behind particular monitoring results, focused on results that are not consistent with expectations. This might include, for example, literature review.
Revise models / safety assessment	Modifying THMC and safety assessment models to incorporate new process understanding and/or parameter values.
Update monitoring plan	Revising the monitoring programme, taking into account the results from the monitoring programme to date (and any other information generated during the period since the monitoring programme was last updated).
Monitoring Programme Responses	
Continue monitoring in the same way	Continuing the operation of the monitoring programme using the same method (e.g. using the same number and type of sensors, in the same locations, and with acquisition of data at the same frequency).
Change monitoring	Changes in the monitoring programme could relate to changes in the frequency of data acquisition using the current monitoring system, monitoring the same parameter(s) with additional sensors of the same type (additional redundancy), monitoring the same parameter(s) with different sensors (increased diversity), or monitoring of different parameters.
Disposal Programme Responses	
Change operations	The emplacement of waste could be altered by, for example, placing a temporary halt on emplacement operations, or only emplacing waste of a specific type. Monitoring can also support decisions to move from one phase of repository operations to the next.
Change design	Evaluation of the results from the monitoring programme may be used to underpin decisions to change the design of the repository.
Engineering intervention	Changing the properties of the repository near field through engineering measures such as grouting, in situ vitrification and construction of new barriers.
Reversal / retrieval	Reversal is removing the waste from the disposal location by reversing the original emplacement process (the term is also used to denote the ability to reverse decisions). Retrieval is removing the waste from the disposal location by any means.

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Interaction with public stakeholders

Engagment process

Engagement at project level: 1/2 «liaisons-officers »:

- ✓ Municipality of Eurajoki, Finland
- ✓ Municipality of Östhammar, Sweden
- ✓ Local partnerships in Mol and Dessel, Belgium
- ✓ Clis , France , Bure

participate in Modern2020 WP5

Specific Guidance for public stakeholders

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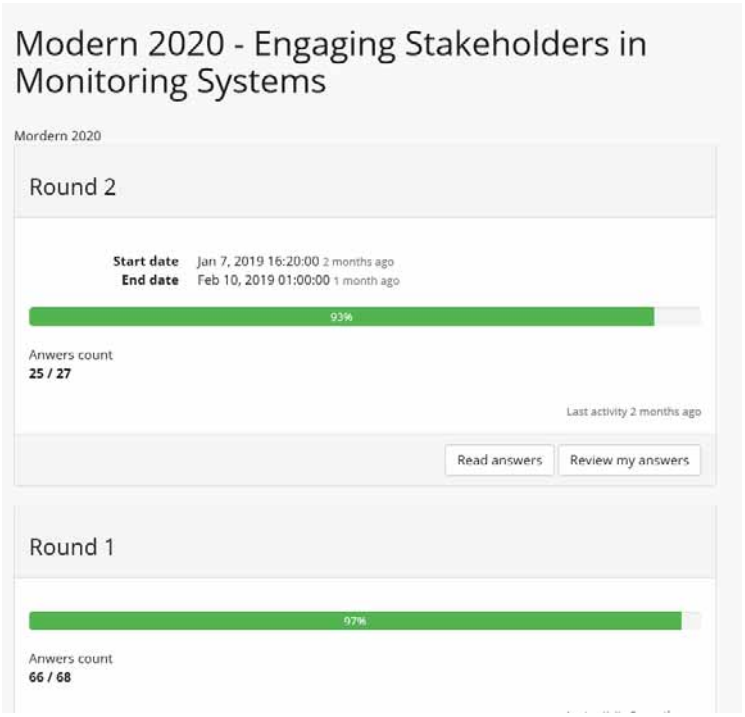
Analyses of the Stakeholders participation



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Monitoring training courses

Complete!!

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WWW.Modern2020.eu

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