

Nuclear Waste Repository Monitoring MoDeRn 2020

Impressions of Work Packages 2, 3, and 4

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- *Modern2020 focuses on monitoring during the operational period to support decision making and to build further confidence in the post-closure safety case... (from D2.1).*
- Operational (confirmation) monitoring represents activities dedicated to affirming or challenging the basis of license application. Added perspectives to MoDeRn 2020 from:
 - ✓ Waste Isolation Pilot Plant compliance monitoring and
 - ✓ Performance confirmation for Yucca Mountain license application
- **MoDeRn 2020 helps illuminate a path toward developing, evaluating, and implementing the next generation of nuclear waste repository monitoring**

- Our assigned role as rapporteurs is “to ensure that the outcomes of the MoDeRn 2020 are clearly identified and in accordance with the proposal in 2014.”
 - ✓ Rapporteurs cannot ensure outcomes or how well the participants followed the proposal, but after reading the deliverables and interacting with leaders of MoDeRn 2020, it is my opinion that participants have done an impressive job in WPs 2, 3, and 4.
- My USA experience with like matters helps frame my comments here:
 - ✓ Operational-period monitoring results are intended to evaluate the adequacy of assumptions, data, and analyses that led to findings that permitted construction and subsequent emplacement of waste. Development of the most recent monitoring program (YMP) followed a three-step process:
 - Determine important parameters
 - Determine quantities that can be observed
 - Design observational program

- Strategies and screening are well understood and mature
- Mansueto Morosini (SKB) provided an excellent summary in his abstract and presentation
- Furthermore:
 - ✓ A rigorous treatment of this process was exemplified by Michael Jobmann on ANSICHT.
 - ✓ It is acknowledged that each entity is responsible for their own tranquility, but the process is mature.
- The example by Paul Smith (NAGRA) was similar to that used in YMP.

MAIN ACTIONS (Jose Luis Garcia-Sineriz)

- **Task 3.1:** Readiness level of monitoring technologies
- **Task 3.2:** Wireless data transmission systems
- **Task 3.3:** Alternative power supply sources



MAIN ACTIONS (Tasks)

- **Task 3.4: New sensors**
 - ✓ **Development/improvement** of new monitoring technology tailored to geological disposal.
 - **Task 3.5: Geophysical methods**
 - ✓ **Improve** the most promising methods to promote noninvasive monitoring technique.
 - **Task 3.6: Reliability and qualification of components**
 - ✓ **Development** of a qualification methodology.
- WP 3 is impressive, well integrated and thought out, including robust gauges, wireless transmission challenges and long-term power sources. This work shines light on the future. If MoDeRn 2020 did not have the vision to embark on this mission, who

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There is margin to perfect and still challenges to face:

- Long-range wireless transmission systems:
- Short-range wireless transmission systems:
- Follow-on activities:
 - ✓ Integration and verification of the energy sourcing parts;
 - ✓ Overall design of the monitoring systems with several wireless sensor nodes;
 - ✓ Improvement of wireless energy transfer;
 - ✓ Integration of the bi-directional data transfer.

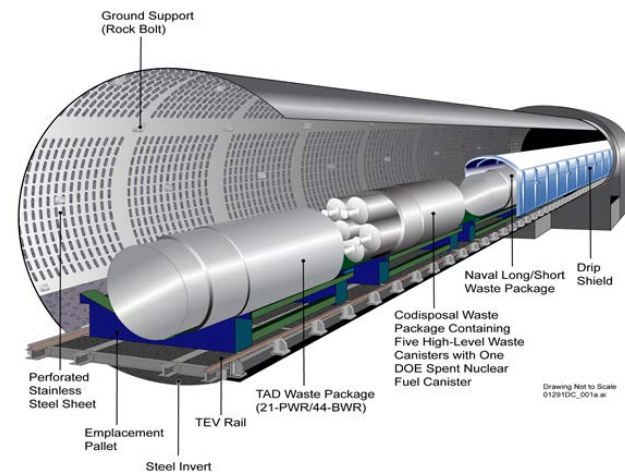
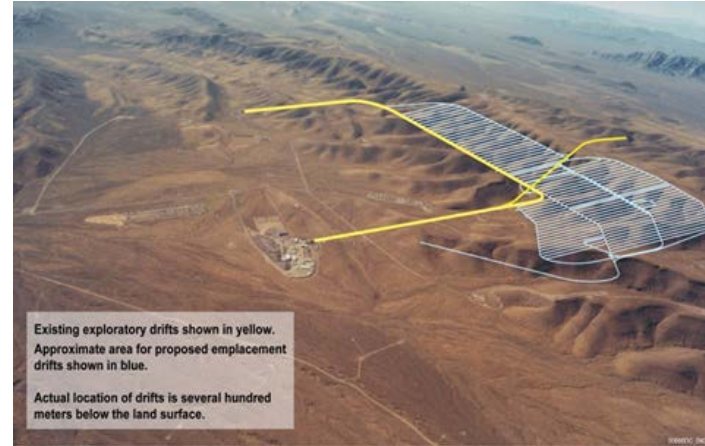
It seems WP3 would be a particularly good investment for future work.



Work Package 4–Reported by Jan Verstricht

- Modern2020 created momentum for four demonstrators (T4.1 to T4.4)
 - ✓ EBS Monitoring Plan – POSIVA (FIN) (desk study)
 - ✓ High Activity Monitoring Cell – Bure, ANDRA (F)
 - ✓ Long-Term Rock and Buffer Monitoring – LTRBM – Tournemire, IRSN (F)
 - ✓ Full-Scale Emplacement (FE, Mt Terri) and Test and Evaluation of Test and Evaluation of Monitoring Systems (TEM, Grimsel) – NAGRA (CH)
- T4.5 (Best Practices *an ambitious goal*)
 - ✓ Synthesis of lessons learnt in four demonstrators

WIPP and Yucca Mountain



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- Operations
 - ✓ Engineering Systems Testing and Evaluation
 - ✓ Design, Construction, and Operations Testing
 - ✓ Health, Safety, and Effluents
 - ✓ Security and Emergency Testing
 - ✓ Licensing Specifications
- Long-term Science
 - ✓ Regulatory-Directed Testing
 - ✓ Elective Testing
 - ✓ Confirmation of the Licensing Basis—Our Principal Topic

- 1960s and 1970s
 - ✓ At first, it was believed that site characterization data and a technical performance demonstration would provide the answers needed to ensure all stakeholders that a repository would be safe to dispose radioactive waste. The project had no real plan for performance confirmation monitoring.
- 1980s
 - ✓ After failed attempt to site a facility at Lyons Kansas – loss of trust
 - ✓ Switch from DOE self-regulation to EPA disposal standards
 - ✓ Federal, state, and multiple stakeholders became involved
- Other “Assurances” needed beyond a technical performance demonstration
 - ✓ EPA regulations included performance confirmation elements
 - ✓ State of New Mexico agreement includes confirmation-related experiments and monitoring

- Multiphase program with different goals/objectives
 - ✓ Site Characterization Testing and Monitoring
 - To build a performance assessment (safety case)
 - ✓ Operational Phase Monitoring
 - To verify basis of performance assessment/results
 - ✓ Postclosure Monitoring
 - To enhance institutional controls and long-term stewardship

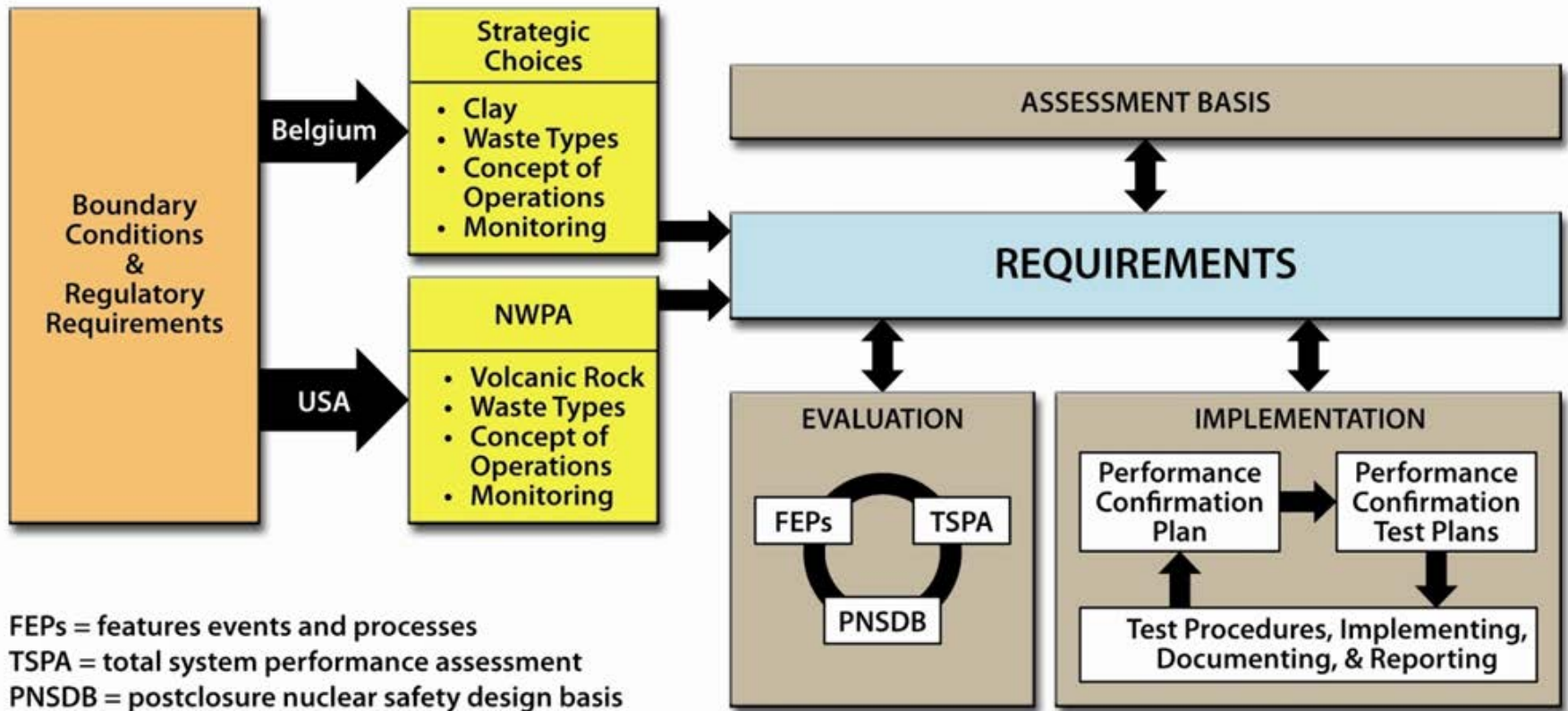
- Information was needed to build a defensible safety case
 - ✓ Site characterization investigated host rock, geologic structure, hydrology, seals/rock interactions, waste/brine chemistry, geochemistry, gas generation, Kds, and many other aspects of the system
- Resources and timelines limit the depth that scientific research can investigate a particular aspect of the system
 - ✓ What information is important or needed
 - ✓ What information can be developed
 - ✓ What is known

- EPA Regulations Govern Program
 - ✓ Monitoring is an assurance requirement
 - ✓ “The Department shall conduct an analysis of the effects of disposal system parameters on the containment of waste in the disposal system The results of the analysis shall be used in developing plans for preclosure and postclosure monitoring....”

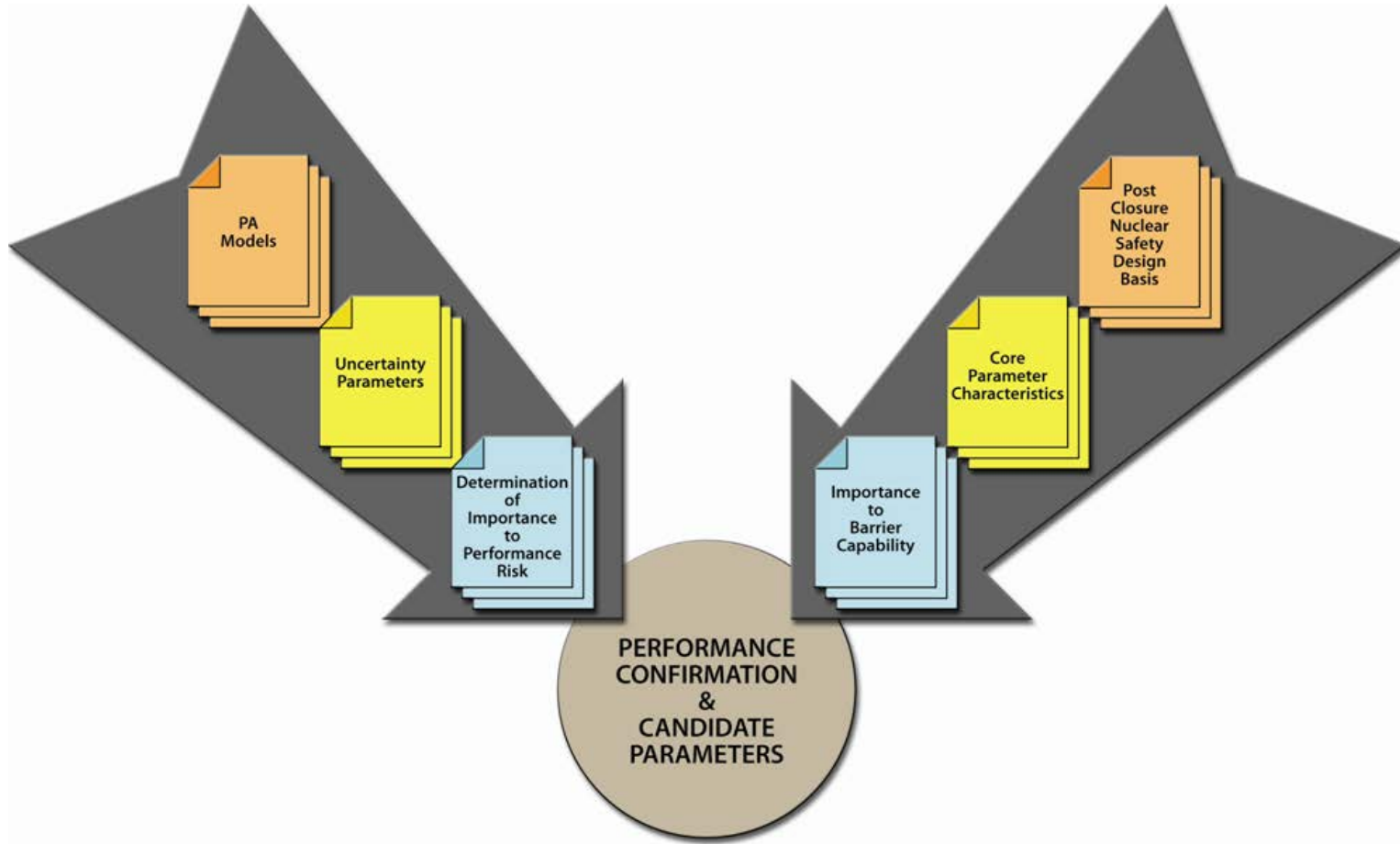
- Analysis Addressed Significant Disposal System Parameters Defined by Their
 - ✓ Effect on the system's ability to contain waste.
 - ✓ Effect on the ability to verify predictions about the performance of the disposal system.
- Addressed an Important Disposal System Concern
- Obtained Meaningful Data in a Short Time Period
- Will Not Violate Disposal System Integrity
- Complemented Existing Monitoring Programs

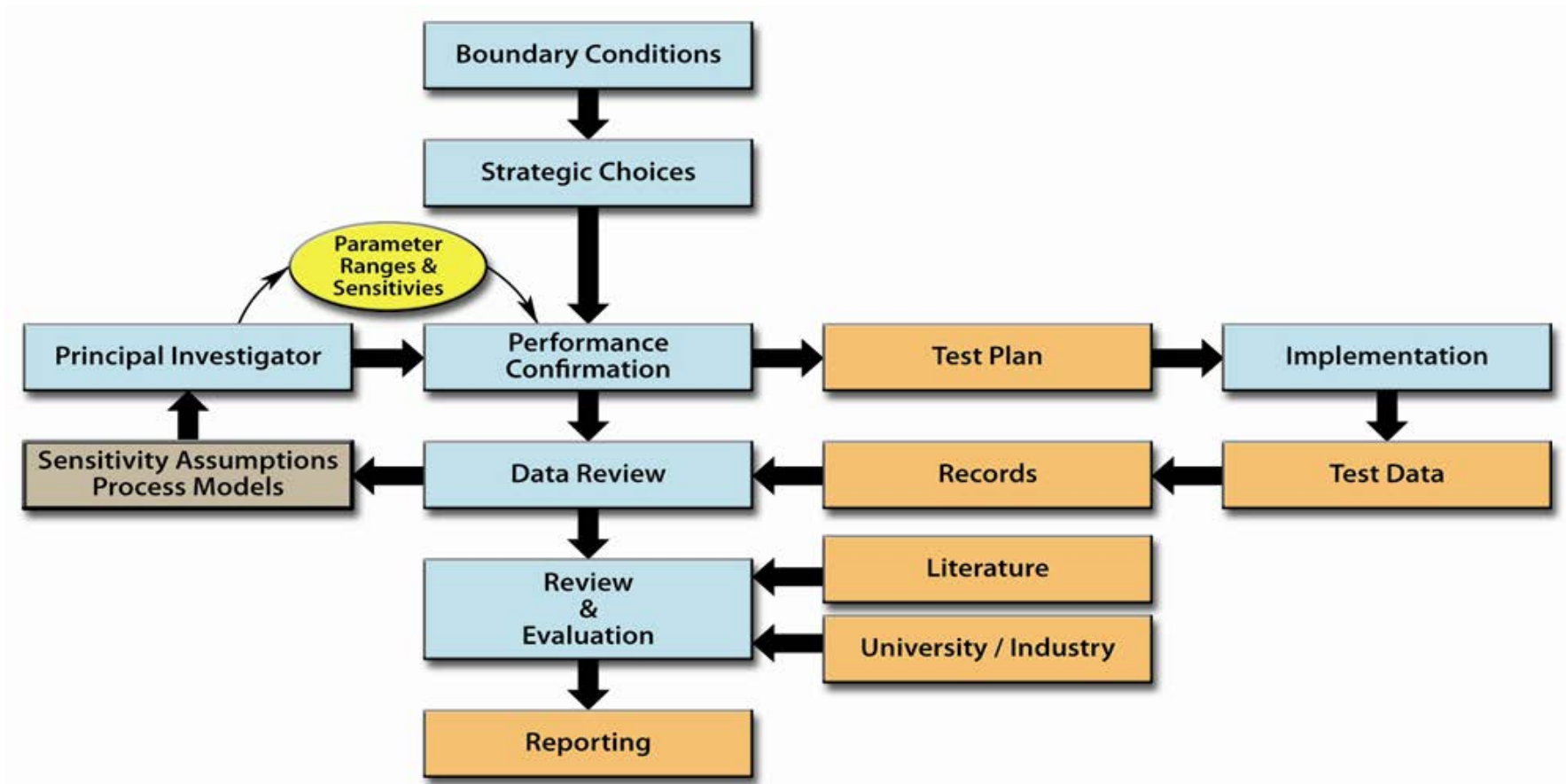
- ✓ Creep Closure and Stresses
- ✓ Change in Culebra Ground Water Flow
- ✓ Extent of Deformation
- ✓ Drilling Rate
- ✓ Initiation of Brittle Deformation
- ✓ Probability of Encountering a Castile Brine Reservoir
- ✓ Displacement of Deformation Features
- ✓ Subsidence Measurements
- ✓ Culebra Groundwater Compositions
- ✓ Waste Activity

Developing and Assessing Performance Confirmation



Confirmation Parameter Sources





In September 2011 NRC released its findings on the performance confirmation section of the Safety Analysis Report (SAR)

“

The NRC finds that the performance confirmation program is consistent with the NRC's Yucca Mountain Review Plan (YMRP).

The SAR includes a description of the Performance Confirmation Program, which evaluates the adequacy of the supporting assumptions, data, and analyses in the SAR...On the basis of the NRC staff's review of the SAR and other information submitted in support of the SAR, the NRC staff notes that DOE has provided a reasonable description of its Performance Confirmation Program that is consistent with the guidance in the YMRP.

Concluding Remarks

- Performance confirmation parameters should be demonstrably linked to the safety assessment
- In some manner, performance confirmation begins during site characterization but formally becomes a commitment when it is included in a license submittal
- Monitoring requires detail including acceptable ranges and relevance to performance assessment.
- **MoDeRn 2020 embraces these principles and has advanced international awareness of monitoring development and commitment**



- What is important to monitoring depends on regulatory requirements such as dose and release.
- Safety-by-design concepts—minimize risk, minimize exposed real estate.
- Monitoring must be observable, interpretable, and actionable.
- Monitoring is monitoring, science is science, R&D is R&D, separate, parallel and related
- Can we develop a Monitoring Primer?