WP 18 - DEVELOPMENT AND IMPROVEMENT OF THERMODYNAMIC UNDERSTANDING FOR USE IN NUCLEAR WASTE DISPOSAL SAFETY CASE – LESSONS LEARNT

S. Brassinnes (ONDRAF/NIRAS), X. Gaona (KIT)

Co-funded by the European Union under Grant Agreement n° 101166718

OBJECTIVE

To assess current thermodynamic understanding in support of the Radioactive Waste Disposal Safety Case : data gaps analysis and identification of priorities for possible future R&D programmes

TECHNICAL INSIGHTS ON OUTCOMES (1/3)

- Thermodynamics is **foundational** to the Safety Case
  - To ensure scientific credibility and defensibility of long-term safety assessment
- Current approaches are **robust**
  - Existing Safety Cases remain valid and defensible.
  - Conservative assumptions / bounding scenarios / sensitivity analyses
- Requires **robust, transparent and consistent** TDBs
  - Multiple TDBs are complementary, not redundant
- **No "show-stopper"** gaps — but data limitations remain
  - Must be prioritized (Safety relevance / Impact on model predictions / Regulatory needs / Feasibility)
  - Repository conditions and national programmes needs strongly influence priorities of national TDB programs
  - Uncertainties / limited predictive capability / over-conservative results
- **Combined approaches** to fill data gaps
  - Experimental work: most reliable but resource-intensive
  - Estimations: necessary but uncertain
  - Artificial Intelligence/ Machine Learning: promising but requires validation

TECHNICAL INSIGHTS ON OUTCOMES (2/3)

- Strong need for **European/international coordination and harmonization**
  - Align priorities, pool resources and avoid duplication
- **EURAD-2** = facilitator (not to develop a new TDB)
  - Identify stakeholder needs
  - Foster collaboration
  - Support targeted R&D
  - Ensure knowledge transfer
- **Strong call to action** for the EURAD community (move from analysis to implementation)
- Pragmatic, **stepwise roadmaps** are proposed (short term and long term: should be incremental, coordinated, and impact-driven)
- **Six high-impact scientific priorities**
  - Cement topics, including new materials, interphase with zeolites and solid-solution formation,
  - Redox processes of key components,
  - Ternary and quaternary complexation (carbonate, silicate, organics),
  - Thermodynamic database methodologies,
  - High-salinity systems,
  - Temperature-dependent thermodynamics.

MORE DETAILS ARE TO FOUND IN PROJECT DELIVERABLES :