Strengthening Thermodynamic Foundations for Nuclear Waste Disposal Safety: The DITUSC Initiative

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eurad 2 European Partnership on Radioactive Waste Management

DITUSC

INTRODUCTION

Development and Improvement of Thermodynamic Understanding for use in nuclear waste disposal Safety Case (**DITUSC**) is a work package within the Eurad-2 project. This initiative has been designed as a **24-month strategic study** with the primary goal of consolidating and enhancing scientific knowledge to predict long-term safety-relevant processes in the disposal of radioactive waste. DITUSC is linked to the overall EURAD-2 roadmap, with a primary **focus on the Safety Case** and a secondary focus on knowledge related to Engineered Barrier Systems and Geoscience.

A total of **20 actors from 8 countries**, of which 4 are EC Member States, are involved in DITUSC. The European contribution is carried out by 12 partners, including 2 Waste Management Organizations, 2 Technical Safety Organizations and 8 Research Entities. The Non-European contribution is provided by 8 Associated Partners.

An **End-User Group** (i.e. waste owners, waste generators, waste management organizations, regulators) has been established to evaluate the scientific output of DITUSC, but also to ensure that future priorities are appropriately set.

OBJECTIVES

Assessment of current thermodynamic understanding in support of the Safety Case for radioactive waste disposal, with particular emphasis on a transversal understanding to allow identification of possible future improvements in knowledge and use.

- Identify, critically assess and prioritize data gaps of relevance to the **Safety Case;**
- Definition of technical approaches and scientific strategies to fill in the identified **thermodynamic data gaps;**
- **Complementarity/synergies** with on-going thermodynamic projects.

WORKSHOPS & TRAINING

Open to any interested parties

I. November 2024 – Spain
(i) Exchange with on-going TDB programs
(ii) Introduction to DITUSC Survey

II. November 2025 – France
(i) Feedback survey
(ii) Identification and prioritization of knowledge gaps and current limitations of use in the Safety Case

III. Spring 2026 – Belgium
(i) Thermodynamics and kinetics
(ii) Thermodynamics and OM
(iii) Thermodynamics of solid-solutions

IV. Workshops and Training Activities
(i) Joint NEA-TDB / DITUSC training course (September 2025)

DITUSC SURVEY

A **survey** (www.eusurvey.com) has been organized to capture the actual needs of the stakeholders, the underlying requirements and the related use of thermodynamics in the Safety Case. The survey also addresses related needs and key remaining underlying uncertainties.

I. **START** survey, focused on the use of the thermodynamic database **in support of research activities**
II. **SAFE** survey, focused on the **use of thermodynamics in the Safety Case.**

OUTCOMES

I. **Green Paper** framing the scope of interactions and take position on several topics relevant to use of thermodynamics in radioactive waste management;
II. **White paper** summarizing the outcomes of the integral assessment and promoting new valuable R&D actions to further support/improve the use of thermodynamics in the Safety Case.

WP BREAKDOWN

Task 1 – WP Management & Coordination – ONDRAF/NIRAS & KIT
T1.1. S/T coordination
T1.2. Dissemination / outreach / impact
T1.3. Quality control

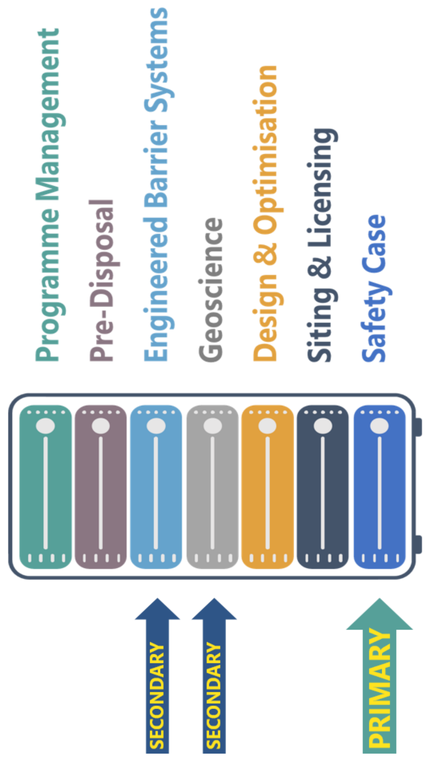
Task 2 – Knowledge Management – JFZ
T2.1. Knowledge capture
T2.2. Knowledge transfer

Task 3 – Thermodynamics: data gaps, solid-solutions, interlink with kinetics, and Safety Case – A21 & PSI
T3.1. Thermodynamic data gaps for RNs and organics
T3.2. Perturbed systems (high saline systems and high temperature)
T3.3. Thermodynamics of solid-solutions
T3.4. Interplay of thermodynamics and kinetics
T3.5. Thermodynamics and Safety Case

- The **collection of data gaps** is gathered from various sources, including scientific evaluation by the partners, technical discussions with ongoing thermodynamic database projects, scientific interactions with other EURAD-2 work packages, exchanges with the wide scientific community at dedicated open workshops and, direct input from interested end-users involved in the implementation of radioactive waste repositories.

- The **prioritisation of data gaps** is carried out in consultation with representatives from the three EURAD colleges, with the intention of adopting a common position on relevant strategic future needs.

EMPHASIS ON EURAD AND IGD-TP STRATEGIC RESEARCH AGENDAS



Topic 1: Post-closure Safety Case
- 1.1: Increase confidence in, testing and further refinement of the tools (concepts, definition of scenarios and computer codes) used in safety assessments.
- 1.7: Verification and validation of models for the simulation of the transport of radionuclides in the near-field of deep geological repositories.
- 1.8: Behaviour of I-129, Cl-36 and U-progeny in various repository compartments

Topic 2: Wasteforms and their Behaviour
- 2.2: Improved data and understanding of the release of radionuclides and chemical species from various long-lived ILW, including effects of organic materials with complexing ability.

Topic 3: Technical Feasibility and Long-term Performance of Disposal and Repository Components
- 3.7: Interaction of cement-based sealing and construction materials with clay-based buffer and clay host rocks.
- 3.9: New materials for engineered components.

WAVE 2 R&D PROPOSAL: THERMOGAP

- Development of thermodynamic data and understanding in support of radioactive waste disposal Safety Cases.
- Focus on **experimental and estimation approaches**
- Scope defined collectively on the basis of **data gap analysis and subsequent prioritization** (done with interested END-USERS and WPLs at the 2nd DITUSC workshop)

Relevant aspects:
- Focused: much narrower scope than DITUSC (3 years, priority-driven)
- Input from end-users (especially WMOs) is key to success
- Continued interest of TSOs and REs

Thermo GAP
THermodynamic Experimental Research and Methods to Overcome Gaps in Assessment Process

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