FISA EURADWASTE 2025

SNETP Forum

Criticality Safety for Final Disposal EURAD-2 WP17 (CSFD)

eurad 2 European Partnership on Radioactive Waste Management

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Introduction

The final disposal of nuclear waste presents long-term safety challenges, one of the most critical being nuclear criticality safety (preventing an unintended chain reaction in stored fissile materials). While deep geological repositories are designed to contain and isolate waste for thousands to millions of years, factors such as water intrusion, material degradation, and neutron moderation must be carefully considered. Existing methodologies for assessing and mitigating these risks vary across different disposal concepts, leading to inconsistencies in safety case argumentation and optimisation potential.

Therefore, in 7 tasks, the aim of the research, development and demonstration Work Package 17 (WP17, CSFD) in EURAD-2 is to ensure and demonstrate criticality safety for final disposal concepts by improvement of understanding, development of advanced modeling approaches, experimental validation strategies, and optimisation of technical and administrative measures.

Towards post-closure criticality safety (PCCS) within 7 tasks of CSFD

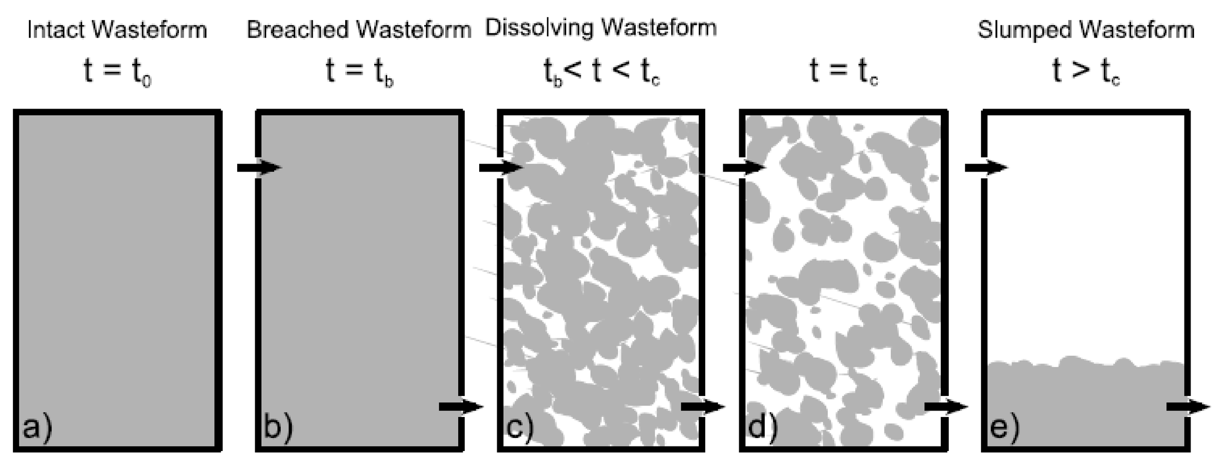
Task 1 (Management/Coordination of the Work Package) and Task 2 (Knowledge Management) are support tasks similar to all WPs in EURAD-2. For CSFD this includes ensuring smooth progress according to the Grant Agreement, development of an initial/final State-of-the-Art report, creating a structured database for fissile waste package records, and developing methodologies for clearly communicating post-closure criticality knowledge to stakeholders and civil society. The remaining tasks are key research areas of the CSFD work package:

Task 3: Validation of Long-Term Evolution Scenarios for PCCS Assessments

- Identify features, events, and processes (FEPs) that may impact long-term criticality safety.
- Evaluate FEPs using experimental data and theoretical models to define credible post-closure scenarios.
- Develop a systematic methodology for validating and selecting criticality scenarios.
- Conduct uncertainty analysis to assess long-term repository evolution.

Task 4: Verification of Model Implementation for PCCS Assessments

- Review existing approaches and develop methodologies for assessing PCCS scenarios for different fissile waste disposal concepts.



Conceptual model for dissolution, settling and slumping of a wasteform inside a disposal package..

Task 5: Development of Post-Closure Criticality Scenario Assessment Methodology

- Improve the modelling understanding for the development of
  - Loading Curves (LC) and
  - Intermediate Level Waste (ILW) fissile mass limits
- Study the optimization of canisters, ILW packages and engineered barrier designs, focusing on factors arising from aspects of criticality safety and decay heat.

Task 6: Experimental Basis for Validation of Depletion and Criticality Codes

- Conduct a gap analysis to identify missing experimental data.
- Review existing experimental datasets from sources like NEA SFCOMPO and ICSBEP.
- Propose new experimental programs to validate depletion and criticality codes.
- Survey and document experimental methods and best practices for PCCS assessments.

Task 7: Methodology for Consequence Assessment in the Post-Closure Phase

- Define types of potential criticality events and their prerequisites.
- Assess the impact of hypothetical criticality events on repository barriers.
- Develop computational models to evaluate energy release, temperature rise, and structural effects.
- Apply models to different disposal concepts to assess the robustness of safety measures.

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