

EURAD-2 WP-17 «CSFD»

EURAD-2 Kick-Off Meeting, Ghent, Belgium
23rd – 24th October 2024

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

CRITICALITY SAFETY IN THE FINAL DISPOSAL OF RADIOACTIVE WASTE

- High-level radioactive waste (e.g. irradiated nuclear fuel) still contains certain amounts of fissile material.
- Under very specific circumstances, this could potentially lead to new fission chain reactions occurring in the deep geological repository (DGR).
- **Criticality safety of the DGR is a safety requirement in all national programmes that have to dispose of high-level waste.**
- Criticality safety - typically to be ensured and demonstrated both in the operational and in the post-closure phase of the DGR.



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CRITICALITY SAFETY IN THE FINAL DISPOSAL OF RADIOACTIVE WASTE - II

• **Criticality safety in the operational phase:**

- Limited time frame → direct controls/actions;
- Analogous to measures for criticality control implemented in nuclear facilities presently in operation.



• **Criticality safety in the post-closure phase:**

- Long time frames: orders of magnitude larger than in any other areas of the fuel cycle;
- Handling of uncertainties associated to the long-term evolution of the system.



- **The DGR post-closure phase requires a dedicated approach due to the long time frames.**

CRITICALITY SAFETY IN THE FINAL DISPOSAL OF RADIOACTIVE WASTE - III

- The R&D work in WP-17 addresses the challenges of ensuring and demonstrating post-closure criticality safety for long time scales.
- **Two key aspects of criticality safety for final disposal:**
 - Identifying, optimising and implementing **measures to ensure criticality safety** of DGR;
 - Developing methods to perform **criticality safety assessments**
→ basis for the criticality safety case for national final disposal concepts.

WP-17 «CSFD» - PARTICIPATING ORGANISATIONS

- WP-17 comprises contributions from 24 partner organisations from 13 different countries:

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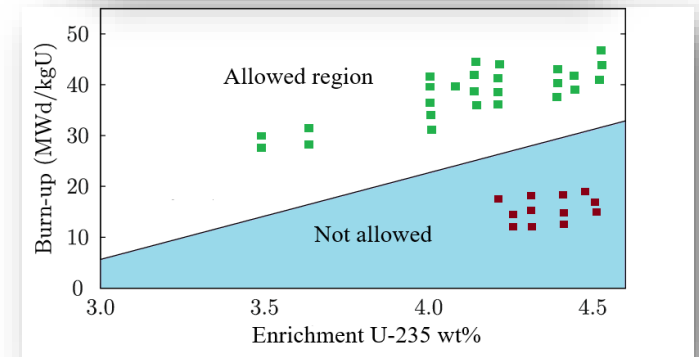
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WP-17 «CSFD» - OBJECTIVES

- Support national programmes in ensuring criticality safety for their DGR concepts and inventories;
- Consolidate the technical basis of the criticality safety argumentation for final disposal of fissile wastes:
 - Explore the optimisation potential of **measures for ensuring criticality** safety in final disposal – focus on post-closure phase:
 - Technical measures: e.g. optimising the design of final disposal containers for high-level waste;
 - Administrative measures: e.g. deriving fissile material limits per waste package (loading curves);
 - etc.
 - Further develop & improve understanding of **methodology to assess their effectiveness**
 - Validation and experimental verification of criticality safety assessments.



WP-17 – R&D ACTIONS' LANDSCAPE

Research measures to ensure criticality safety

Administrative measures:

- **Task 5:** Development of methodology for deriving fissile mass limits for spent fuel & ILW packages.
- **Task 2:** Fissile waste records for criticality safety assessments.

Technical measures:

- **Task 5:** Investigate factors that influence the derivation of fissile material limits with a view to optimise waste package & barrier design.

Communication to stakeholders

- **Task 2:** Develop an effective communication strategy to all relevant stakeholders (general public, national regulator, etc).

Develop methodology for post-closure criticality safety case

Evaluate performance of crit.-safety measures:

- **Task 3:** Validation of long-term evolution scenarios for post-closure criticality safety (PCCS) assessments
- **Task 4:** Verification of model implementation for PCCS assessments
- **Task 6:** Experimental basis for validation of depletion and criticality codes for PCCS

Criticality consequence assessments

- **Task 7:** Develop and consolidate methodology for assessing criticality in the DGR post-closure phase.

WP-17: TASK 2 – KNOWLEDGE MANAGEMENT

- **Objectives:** Capture knowledge & transfer to community

- **Envisioned technical work:**

- Development of documentation material
- Knowledge transfer
- Fissile waste package records for criticality safety assessments
- Communication approach regarding criticality safety for final disposal



- **Task Lead:** EIMV

- **Participants:**

Andra, EIMV, CVUT, LEI, PURAM, SURAO, SSTC NRC, Posiva/TVO, BGE, NWS, GSL, Jacobs/Amentum, Nagra.

- **Deliverables:**

- D17.1 & D17.5: Two SoTA reports on demonstrating criticality safety
- D17.4: Report on communicating DGR post-closure criticality safety
- D17.6 Report to Member-States

WP-17: TASK 3 – VALIDATION OF LONG-TERM EVOLUTION SCENARIOS

- **Objectives:**

- research long-term waste package and DGR evolution to support the definition of scenarios for criticality assessments;
- demonstrate that there is a basis for confidence in the definition and selection of scenarios for criticality safety assessments.

- **Envisioned technical work:**

- Identify FEP relevant for post-closure criticality safety
- Evaluation of identified FEP
- Develop methodology for scenario validation



- **Task Leads:** Andra & SSTC NRC

- **Participants:**

Andra, VTT, GRS, CIEMAT, CVUT, JSI, LEI, SKB, SURAO, SSTC NRC, Posiva/TVO, GSL, Jacobs/Amentum, Sandia Lab., PNNL.

- **Deliverables:**

- Input to D17.7: report on repository post-closure criticality scenarios and their assessment.

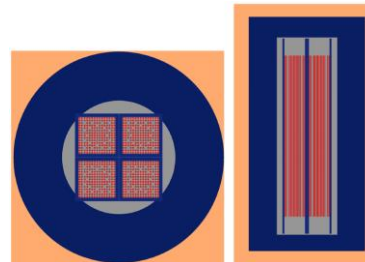
WP-17: TASK 4 – VERIFICATION OF CRIT-SAFETY MODEL IMPLEMENTATION

- **Objectives:**

- understand criticality scenario modelling approaches
- develop a methodology to evaluate scenarios
- verify whether the computational models appropriately represent the scenarios and include a suitable treatment of uncertainty and appropriate model simplifications.

- **Envisioned technical work:**

- Review post-closure criticality scenario modelling approaches
- Develop method to evaluate scenarios & modelling approaches
- Sensitivity analysis of scenario uncertainties & model simplifications



- **Task Leads:** VTT & GSL

- **Participants:**

Andra, VTT, GRS, CIEMAT, CVUT, JSI, LEI, SKB, Tractebel, SSTC NRC, GSL, Jacobs/Amentum, Sandia Lab., PNNL.

- **Deliverables:**

- Input to D17.7: report on repository post-closure criticality scenarios and their assessment.

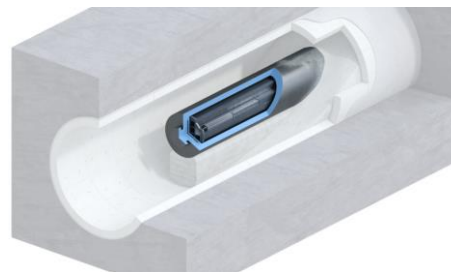
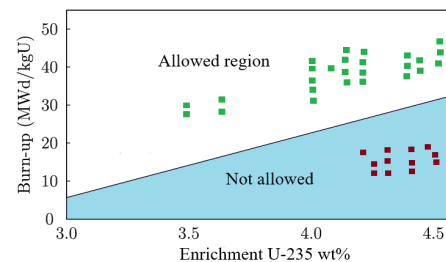
WP-17: TASK 5 – DEVELOPMENT OF METHODS FOR DERIVING FISSILE MASS LIMITS

- **Objectives:**

- improve understanding of modelling and technical approaches to deriving spent fuel loading curves & ILW fissile mass limits
- explore optimisation potential w.r.t. waste package and engineered barrier designs based on factors that influence the calculation of fissile material limits

- **Envisioned technical work:**

- Research spent fuel loading curve derivation approaches
- Research ILW fissile mass limits derivation approaches
- Explore optimisation potential for waste package & engineered barrier design



- **Task Leads:** PSI & PURAM

- **Participants:**

Andra, VTT, GRS, CIEMAT, CVUT, ENRESA, JSI, LEI, PURAM, SKB, Tractebel, SSTC NRC, BGE, NWS, GSL, Jacobs/Amentum, Nagra, PSI, Sandia Lab, PNNL.

- **Deliverables:**

- Input to D17.7: report on repository post-closure criticality scenarios and their assessment.

WP-17: TASK 6 – EXPERIMENTAL BASIS FOR VALIDATING CRITICALITY CODES

- **Objectives:**

- Identify the experimental data required for post-closure criticality assessment needs
- Envision types of experimental programmes that could address any significant gaps and uncertainties.

- **Envisioned technical work:**

- Perform gap analysis to identify where new data is required
- Carry out survey on experience in obtaining experimental data



- **Task Lead:** SKB

- **Participants:**

GRS, CIEMAT, CVUT, JSI, SKB, Tractebel, GSL, Jacobs/Amentum, Nagra, EPFL, PSI, Sandia Lab, PNNL.

- **Deliverables:**

- D17.2: Report on experimental data needs to support post-closure criticality safety assessments.

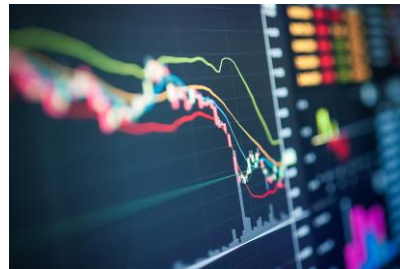
WP-17: TASK 7 – EXPERIMENTAL BASIS FOR VALIDATING CRITICALITY CODES

- **Objectives:**

- Develop methodology for assessing the impact of hypothetical, postulated criticality events on repository barrier system and overall repository performance.

- **Envisioned technical work:**

- Research mechanisms for different types of postulated criticality events in DGR
- Research approaches to assessing impacts of criticality on engineered and natural barriers
- Develop models and methods to do post-closure criticality consequence assessments



- **Task Leads:** NWS & JSI

- **Participants:**

Andra, VTT, CIEMAT, JSI, LEI, PURAM, SKB, Tractebel, SSTC NRC, Posiva/TVO, NWS, GSL, Jacobs/Amentum, EPFL, Sandia Lab, PNNL.

- **Deliverables:**

- D17.3: Report on methodology for assessing consequences of postulated DGR post-closure criticality.

WP-17 – INTERFACE & SYNERGIES WITH OTHER EURAD-2 WP

- **WP-8 SAREC:**

- Studies and tests on spent fuel leaching and matrix dissolution are relevant to understand the long-term behaviour of spent fuel → **Link to WP-17 Tasks 3 and 4.**

- **WP-9 InCoManD:**

- Studies on spent fuel container materials and their durability are relevant for:
 - The specification of long-term post-closure criticality scenarios → **Link to WP-17 Tasks 3 and Task 4**
 - The optimisation of spent fuel container designs to mitigate post-closure criticality safety concerns → **Link to WP-17 Task 5.**

SUMMARY

- Criticality safety of a DGR is a safety requirement in all national programmes that must dispose of high-level waste such as spent nuclear fuel.
- **WP-17 “CSFD” supports national final disposal programmes in ensuring criticality safety for their DGR concepts and inventories:**
 - Identifying, further developing and optimising measures for ensuring criticality safety in final disposal – focus on the DGR post-closure phase;
 - Further development & understanding of methodologies to assess the effectiveness of these methods.
- **WP-17 “CSFD” contributes by consolidating the technical basis of the criticality safety argumentation for final disposal of fissile wastes.**
- The planned R&D programme will be carried out in collaboration between 23 partner organisations from 13 different countries (10 Member-States and 3 Associated Partners).



24.10.2014



We are looking forward to a fruitful cooperation!

THANK YOU

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WP-17 TIME PLAN

