EURAD-2 WP-17 «CSFD»

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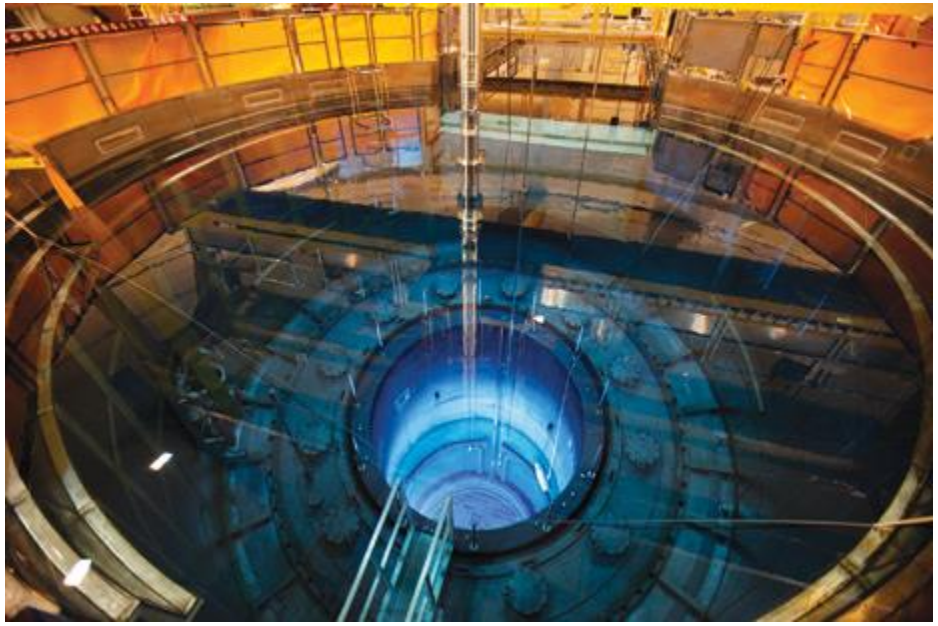
CRITICALITY SAFETY IN THE FINAL DISPOSAL OF RADIOACTIVE WASTE

- 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 ocurring 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.



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:**

WMO **TSO** **RE**

ANDRA, BGE BUNDESGESELLSCHAFT FÜR ENDLAGERUNG, enresa, amentum, Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, EIMV ELEKTROINŠTITUT MILAN VIDMAR, ČVUT ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE, EPFL, Galson SCIENCES LTD egis group

Nuclear Waste Services, nagra., Posiva, GRS, SSTC NRS STATE SCIENTIFIC AND TECHNICAL CENTER FOR NUCLEAR AND RADIATION SAFETY, Institut "Jožef Stefan", LITHUANIAN ENERGY INSTITUTE

PURAM, SKB, SÚRAO, TRACTEBEL ENGIE, VTT, Pacific Northwest NATIONAL LABORATORY, PSI, Sandia National Laboratories

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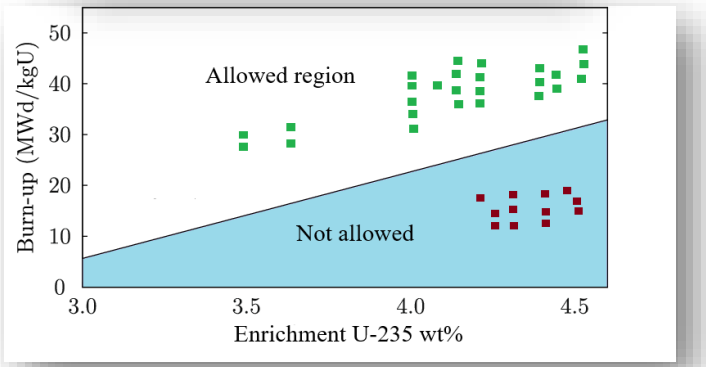
WP-17 «CSFD» - OBJECTIVES

- **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	Develop methodology for post-closure criticality safety case
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.	**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.
Communication to stakeholders • **Task 2**: Develop an effective communication strategy to all relevant stakeholders (general public, national regulator, etc).	

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

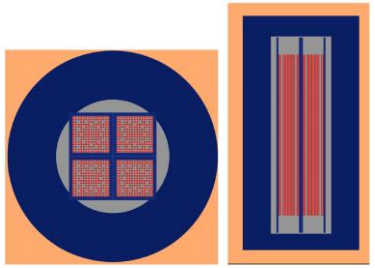
WP-17: TASK 3 – VALIDATION OF LONG-TERM EVOLUTION SCENARIOS

- **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

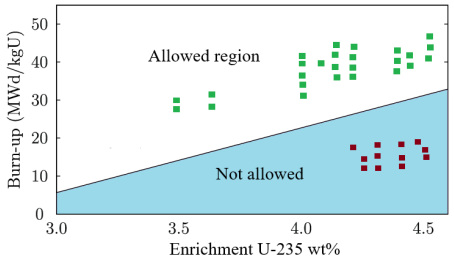


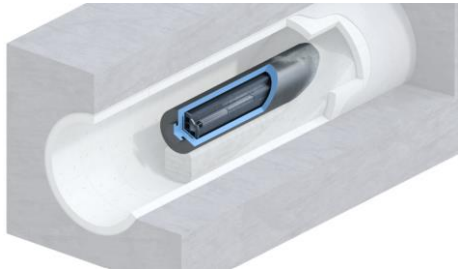
  - Develop method to evaluate scenarios & modelling approaches
  - Sensitivity analysis of scenario uncertainties & model simplifications

- **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).

We are looking forward to a fruitful cooperation!

THANK YOU

WP-17 TIME PLAN