EURAD-2 WP description Template #2

Please see Instructions for Work Package Preparation Team, public document for guidance (available on EURAD and PREDIS websites)

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<table>
<tr><td>Short Acronym and full Title</td><td colspan="3">CSFD: Criticality Safety for Final Disposal</td></tr>
<tr><td>Type of activity</td><td>☒R&D</td><td>☐Strategic Study</td><td>Knowledge Management – covered by a separate committee and template</td></tr>
<tr><td>Budget estimation (total budget in M€, i.e ~ 1.5 M€)</td><td>3.8M€</td><td>Duration of the WP
(in months)</td><td>60</td></tr>
<tr><td>Links with EURAD SRA / Roadmap Themes
(if multiple choices, indicate the primary link in bold – maximum 3)</td><td colspan="3">☐Programme Management (Theme 1)
☒Pre-disposal (Theme 2)
☐Engineered Barrier Systems (Theme 3)
☐Geoscience (Theme 4)
☒Disposal facility design and optimisation (Theme 5)
☐Siting and Licensing (Theme 6)
☒Safety Case (Theme 7)</td></tr>
<tr><td>Links with EURAD SRA topics
(if multiple choices, indicate the primary link in bold – maximum 3)</td><td colspan="3">5.4.4 Criticality safety
7.3.3 Scenario development and FEP analysis
2.1.1 Inventory</td></tr>
<tr><td rowspan="2">SRA drivers (maximum 3)</td><td>☒Implementation Safety</td><td>☐Tailored Solutions</td><td>☒Scientific Insight</td></tr>
<tr><td>☒Innovation for Optimisation</td><td>☐Societal Engagement</td><td>☐Knowledge Management</td></tr>
<tr><td>Objective (What) – 1 sentence</td><td colspan="3">Attain an improved shared understanding regarding the methodological validation, experimental verification and consolidated technical basis of criticality safety argumentation for final disposal of fissile wastes.</td></tr>
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Justification: impact / innovation / added-value (Why) – bullet points or short paragraph **(maximum quarter of a page)**	Criticality safety assessments of geological disposal concepts are carried out for time scales which are typically orders or magnitude larger than in any other area of the fuel cycle. Understanding the evolution of fissile waste packages in the long-term, after disposal, and modelling their condition over the assessment time frame represent a challenge which requires additional research. While certain aspects of the post-closure criticality safety (PCCS) assessment are intrinsically related to the particularities of each individual disposal concept, leading to differences in the way organisations derive and present PCCS arguments, many organisations address similar challenges. Research leading to advances and innovative PCCS assessment methods will bring broad benefits to all project participants through activities focusing on: • Validation of long-term evolution scenarios for PCCS assessments; • Verification of calculation model implementation for PCCS assessments; • Validation of depletion and criticality codes for PCCS assessments; • Methodology for post-closure criticality consequences assessments; • Fissile waste package records for PCCS assessments; • PCCS communication and PCCS case digitisation.
List of planned tasks / subtasks with % of effort per task (5% increments) **(Maximum 10 bullets)**	• **Task 1**: Management/coordination of the WP, [10%] • **Task 2**: Knowledge Management (incl. training materials development and State-of-the-Art for R&D WPs, etc.), [10%] Subtask 2.1: Digitisation of PCCS cases to improve accessibility to criticality safety arguments and supporting evidence. • **Task 3**: **Validation of long-term evolution scenarios for post-closure criticality safety (PCCS) assessments** [10%] Research on waste package evolution to support definition of scenarios for PCCS assessments. Subtask 3.1: Identify features, events and processes (FEPs) relevant to PCCS in view of the long-term evolution of fissile waste packages (including spent fuel and fissile ILW, such as residues from spent fuel reprocessing) and the nearfield [2%]. Subtask 3.2: Evaluate FEPs identified as affecting fissile waste package evolution, drawing on experimental data and theoretical understanding to define a common basis for PCCS scenario definition and specification [3%]. Subtask 3.3: Develop scenario assessment and validation methodology [5%]. • **Task 4**: **Verification of model implementation for PCCS assessments** [12%] Develop models for PCCS scenario assessments. Develop new method(s) to verify PCCS models. Subtask 4.1: Review PCCS scenario modelling approaches, in terms of model parameter definitions, geometries, uncertainty treatment and simplifications, in view of the FEPs and scenarios identified in Task 3 for different fissile waste disposal concepts [2%]. Subtask 4.2: Develop technical understanding and modelling approach for assessing PCCS scenarios, including system evolution models and models for reactivity calculations [5%]. Subtask 4.3: Assess sensitivity to scenario uncertainties and model simplifications. Identify opportunities to optimise assessment approaches by refining modelling methods and uncertainty treatment, especially where model simplifications are overly conservative, and identify supporting justifications and evidence needed [5%]. • **Task 5: Development of PCCS methodology relevant to the derivation of spent fuel loading curves and fissile mass limits for ILW packages** [18%] For post-closure criticality safety, long-term phenomena such as waste package degradation, nuclide inventory evolution, etc. (as identified in Task 4) need to be taken into account in the derivation of spent fuel loading curves (i.e. burn-up

	credit) and ILW fissile mass limits. Understanding the factors that influence the calculation of fissile material limits can inform the optimisation of waste package and barrier designs. Subtask 5.1: Develop improved understanding and PCCS methods for spent fuel loading curve derivation and undertake model comparison exercises [8%] Subtask 5.2: Develop improved understanding and PCCS methods for deriving fissile mass limits for ILW packages (i.e. other than spent fuel) and undertake model comparison exercises [4%] Subtask 5.3: Research on how learning from derivation of waste package fissile material limits for PCCS can be used to inform optimisation of fissile waste package and engineered barrier design [6%] • **Task 6: Experimental basis for validation of depletion and criticality codes for PCCS** [7%] Identify experimental data needed to meet PCCS assessment needs. Subtask 6.1: Undertake a gap analysis to identify available experimental data and gaps where new data are needed to meet PCCS assessment needs [3%]. Subtask 6.2: Carry out survey on experience in obtaining experimental data (with focus on PCCS-relevant experiments), including lessons learned, communication with various stakeholders, boundary conditions, etc. [2%]. Subtask 6.3: Design a prioritised experimental programme to address the most significant data needs identified [2%]. • **Task 7: Methodology for consequence assessment in the post-closure phase** [13%]. Develop methodology, including models, for assessing the impact of hypothetical criticality events (informed by scenarios defined under Task 3) on repository barrier system and overall repository performance. This may be needed to meet a regulatory requirement or to support communication with stakeholders. Subtask 7.1: Research mechanisms and prerequisites for different types of postulated criticality events to occur in a repository [2%]. Subtask 7.2: Research approaches to assessing the impacts of a postulated criticality event on engineered and natural barriers [4%]. Subtask 7.3: Develop and apply models based on common principles/methodology to carry out post-closure criticality consequences assessments [7%]. • **Task 8**: **Fissile waste records for PCCS assessments** [10%] Identify information on fissile waste and disposal container properties needed for PCCS assessments. Development of effective technical implementation (e.g., in a database) beneficial to all organisations carrying out PCCS assessments. Subtask 8.1: Identify and categorise fissile waste and container information for PCCS assessments [4%]. Subtask 8.2: Research to develop a common approach to defining a database structure for fissile waste package records, including awareness of technical boundary conditions and handling of missing information [6%]. • **Task 9**: **PCCS communication** [10%] Improved knowledge and new strategies for communicating PCCS with stakeholders are to be developed, especially in view of the long assessment timeframes, to reduce risk of misinterpretation of PCCS case outcomes. Subtask 9.1: Identify stakeholders and develop a stakeholder-oriented PCCS communication strategy (e.g. to communicate different lines of qualitative and quantitative argument), consistent with programme needs [4%]. Subtask 9.2: Define common technical terms (e.g. a common PCCS glossary) and develop PCCS communication tools (e.g. graphical representations, etc.) [6%].
List of expected outcomes linked	• Improved understanding of long-term repository evolution processes relevant to PCCS and of the existing scientific data available to underpin the long-term evolution scenarios required for PCCS calculations. This will include the

to the identified SRA drivers **(Maximum 6 bullets)**	development of new methods and techniques to assess the suitability of models, uncertainty treatment, and the impact of inherent modelling simplifications. This will lead to a significant reduction in overly conservative assumptions in PCCS assessments, supporting optimisation of waste packaging and disposal concept designs. *(Scientific Insight, Implementation Safety, Innovation for Optimisation)* • Improved understanding of data needs for PCCS assessments, in particular for validation (e.g., against experimental benchmarks) and verification of depletion and criticality codes. Attain insight into experimental gaps and define a new experimental programme focusing on PCCS and the needs of burn-up credit applications. This will provide benefits in addressing regulatory requirements, where applicable, and further consolidating trust in PCCS case results, thus, also enhancing communication to various stakeholders. *(Scientific Insight, Implementation Safety)* • Innovative methodology to derive fissile material limits, accounting for PCCS considerations. While methods for establishing fissile material limits for waste packages (e.g., derivation of spent fuel loading curves) are an individual implementor's choice/decision, there is benefit in researching and developing a new mechanism that enables a direct comparison of assumptions, common procedures, results, etc., thus, consolidating confidence in the individual approaches and supporting optimisation of waste packaging design. *(Implementation Safety, Innovation for Optimisation)* • New methods to perform post-closure criticality consequences assessments. While assessing the impact of postulated criticality excursions in the post-closure phase is not a regulatory requirement for all implementors, there is benefit in establishing a scientific understanding of the assessment methodology and model definition. This strengthens the confidence in the PCCS case, by providing new scientific insight in to how the repository barrier system can minimise the impacts of hypothetical criticality events. *(Scientific Insight, Implementation Safety, Innovation for Optimisation)* • Improved understanding of the information (data) needs concerning fissile waste and container properties for PCCS assessments. Develop a novel data architecture concept as a basis for a waste package records database. PCCS cases rely on evidence in the form of information about waste properties and disposal container descriptions. Ensuring focus on capturing the information relevant to PCCS assessments will reduce the risk of lack of information and, ultimately, will help to optimise the waste acceptance process for disposal. *(Implementation Safety, Innovation for Optimisation)* • Innovative methods of scientific communication to express and present key aspects of PCCS cases, such as long-term scenario definitions, models, results, comparisons and qualitative arguments (wherever appropriate). Identify common PCCS communication strategies. Develop novel approach to PCCS case digitisation, e.g., by establishing a digital database for PCCS modelling assumptions, scenario definitions, etc. This will provide benefits in communication with all stakeholders, enhancing confidence, support and acceptance of the PCCS case. *(Scientific Insight, Implementation Safety)*
Deliverables **(Maximum 6 – including the prescribed deliverables)**	• Report on PCCS long-term evolution scenario definition and modelling, experimental and theoretical basis, and fissile mass limit derivation. • Report on PCCS experimental needs. • Report on post-closure criticality consequence assessment. • PCCS case communication strategy report. • Initial and final SOTA reports • Outcome/impact report to Member States and End-Users

Critical input requirements & identified risks	• Critical input: knowledge, tools and needs for assessing repository evolution and its effects on nuclear reactivity and consequences of postulated criticality.
Major achievements expected by end of Year 2 (Go/No Assessment)[1] **(Maximum 5 bullets)**	• PCCS state-of-knowledge report complete. • Understanding of FEPs relevant to PCCS scenarios and how to model them. • Gaining insight into PCCS methods for deriving fissile material limits for spent fuel and ILW packages and optimising packaging designs. • Key components of PCCS communication strategy identified.
(Optional - Explain what is out of the scope?)	• The (comparative) evaluation of benefits and drawbacks of different disposal and PCCS strategies followed by implementors. • Criticality safety assessments for stages other than the post-closure phase of a geological repository. • Undertaking validation experiments. Experimental needs will be identified and prioritised, but uncertainties in availability and cost of laboratories and materials for experiments are too great to warrant inclusion of experiments at this stage of proposal preparation. However, at least two interested organisations have indicated that they have samples and facilities available for validation experiments.
List of preliminary interested organisations as partners in the WP contributing effort; **% of effort (person months, by College)**	**REs** [50%] : Galson Sciences/UK, PSI/Switzerland, LEI/Lithuania, CTU/Czech Republic, JSI/Slovenia, CNRS-Subatech/France, JRC Karlsruhe/Germany; EPFL/Switzerland **TSOs** [20%] : VTT/Finland, CIEMAT/Spain, SSTC NRS/Ukraine, GRS/Germany, SURO/Czech Republic; **WMOs** [30%] : BGE/Germany, TVO/Posiva/Finland, NWS/UK, PURAM/Hungary, Andra/France, Nagra/Switzerland, SKB/Sweden, ENRESA/Spain.
If applicable - links with previous projects / work packages	
WP Preparation Team (1 member per College) contact (**organisation + person**, email)	RE: Galson Sciences Ltd, Tim Hicks, twh@galson-sciences.co.uk TSO: GRS gGmbH, Robert Kilger, robert.kilger@grs.de WMO: Nagra, Madalina Wittel, madalina.wittel@nagra.ch CG observer: BGE, Astrid Göbel, Astrid.Goebel@bge.de

[1] EC budget being only allocated for the first 2 years, each work package progress will be reviewed at the end of Year 2, to assess its continuation based on the total budget that EURAD-2 will be granted.