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"><u>Ra</u>dionuclide <u>m</u>obility under <u>pe</u>rturbed <u>c</u>onditions
Acronym: RAMPEC</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>5 M€</td><td>60 months duration
- 6 month for initiation.
- 48 months experimental and modelling activities.
- 6 months finalization and reporting.</td><td></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</td><td colspan="3">- 4.2.1 Perturbations
- 4.4.1 Geo-datasets and conceptual models
- 7.3.1: Performance assessment and system models</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">Improved understanding and prediction of disposal system chemistry and radionuclide mobility under perturbed conditions, based on new experimental studies and tailored modelling approaches up to the cell scale.</td></tr>
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Justification: impact / innovation / added-value (Why) – bullet points or short paragraph **(maximum quarter of a page)**	Good understanding of radionuclide (RN) behaviour in argillaceous, crystalline and cementitious systems under equilibrium conditions has been derived from past experimental studies in simplified reference systems. RN and gas behaviour under perturbed conditions, however, are poorly constrained and up to date there is no integral model based description for perturbed systems. In addition, the chemical evolution of *in-situ* conditions in such systems has not yet reached a necessary level of maturity to deliver deterministic predictive reactive transport modelling of the nearfield. RAMPEC will provide improved methods and approaches both regarding mechanistic modelling and modelling radionuclide migration on the cell scale. This is realized by the use of existing data from previous projects (FUTURE, CORI, …) and targeted new experimental investigations. All R&D Tasks aim for both scientific excellence and high relevance in the applied context. The restriction of RAMPEC on three systems (Clay, Granite, Cement) with a limited number of specific perturbations to be investigated ensures a meaningful WP with a clear focus. It likewise ensures inclusiveness and opens new opportunities for coherent and forceful collaborations between the Tasks and Subtasks described below. RAMPEC will thus allow for a broad international cooperation throughout Europe with excellent opportunities for education and training as well as sharing of resources and expertise.
List of planned tasks / subtasks with % of effort per task (5% increments) **(Maximum 10 bullets)**	• **Task 1 (5%)**: Management/coordination of the WP. • **Task 2 (10%)**: Knowledge Management (including sorption database activity). • **Task 3 (45%)**: Experimental program (specific Subtasks on systems focusing on (i) clay, (ii) granite, (iii) cement. Radionuclides to be investigated in RAMPEC Task 3 need to reflect main uncertainties in the specific systems and perturbations defined in the following. o (Subtask 3.1): *Experimental studies in the clay system*. Perturbations to be investigated in RAMPEC Subtask 3.1 are limited to temperature (T < 90°C), complexing ligands, chemical plume and the saturation degree. o (Subtask 3.2): *Experimental studies in the granitic system*. Perturbations to be investigated in RAMPEC Subtask 3.2 are limited to the influence of secondary phases and changes in pore-water composition or pore structure (porosity). o (Subtask 3.3): *Experimental studies in the cement system*. Perturbations to be investigated in RAMPEC Subtask 3.3 are limited to ionic strength (sulphate, nitrate) and the impact of the saturation degree. • **Task 4 (20%)**: Development of macroscopic/mechanistic models. Macroscopic and mechanistic models will be developed to deal with both the physicochemical perturbations (including relevant chemical and/or microstructural data) and radionuclide transport. Expected coupled effects (specific of each considered perturbation) should be evidenced and analysed. According to the specific barrier and related perturbations, the bases of modelling - as well as the methodological procedures, which should be stated/discussed at the beginning of the project - are different and will be performed in the respective Subtasks: o (Subtask 4.1): *Modelling in the clay system*. o (Subtask 4.2): *Modelling in the granitic/crystalline rock system*. o (Subtask 4.3): *Modelling in the cements system*.

	• **Task 5 (20%)**: Upscaling of data and models Transfer to «cell» scale. Benchmarking of mechanistic models against simplified K_d approach. Upscaling methodologies for radionuclide retention/transport modelling in perturbed systems will be analysed to define the appropriate simplifications, to be done without losing fundamental information. Benchmarking activities, following definition and selection of relevant studies cases during the initial 6 months preparation phase, will allow improving input data constraints, based on mechanistic understanding, and boost the confidence in the modelling tools used for safety assessment calculations. RAMPEC has considerably limited the scope of work presented in the Template #2 regarding the systems to be investigated and also regarding the perturbations to be considered, relative to the initial merged proposals. A further focusing of RAMPEC is intended during the preparation of the Template #3, based upon the detailed individual proposals provided by the interested groups at that point. The aim is to derive consistent and strong experimental and modeling Tasks in RAMPEC which are building up on the strengths of the individual partners. Therefore at this point we have decided to restrict the numbers and kinds of perturbation but intend to select the radionuclides to be studied at a later stage in order to best assess the impact of the different perturbations on the investigated systems. Prioritizations will be made in view of contributing to safety.
List of expected outcomes linked to the identified SRA drivers **(Maximum 6 bullets)**	• The proposed R&D Tasks address the effects of chemical and physical perturbations on RN behaviour in selected systems, and elaborate a mechanistic description of these processes to provide input for Performance Assessment. The work in RAMPEC thus requires a close interaction between experimentalists and different modelling experts. The implementation of specific networking and collaborative research efforts (spanning from atomistic information via lab-scale experiments to modelling at cell scale with input to PA) is an important outcome in RAMPEC. (=> Knowledge Management). • RAMPEC prioritises the involvement of PhDs and young researcher in both the experimental Task 3 and the modelling Tasks 4 and 5. The required specific networking between the Tasks described above opens excellent training and education opportunities and enhances a “generalist” view on Waste Disposal research beyond individual technical specializations. (=> Knowledge Management). Technical outcome includes: • Targeted new experimental studies of RN retention and transport (sorption, diffusion) under perturbed conditions. Studies comprise necessary experimental work to allow process understanding in complex systems. Work must not be limited to ternary systems, but also provide a proper understanding and description of underlying binary systems. (=> Implementation Safety, Scientific Insight). • Development of mechanistic models for retention and transport of RNs in complex physico-chemical systems, based on accurate description of realistic systems and chemical speciation (Task 4). This is including model based description for *in-situ* conditions in the repository near field under external perturbations. (=> Implementation Safety, Scientific Insight). • Development of a “sorption database” focusing on the specific systems to be investigated in RAMPEC. This will support modelling activities and serve as a proof-of-concept for potential related

	database projects beyond the scope of RAMPEC (Task 2). (=> Knowledge Management). • Upscaling and data transfer from small scale laboratory experiments to the cell scale in view of Performance Assessment requirements (Task 5). Including choice of « macroscopic » parameters and benchmarking. (=> Implementation Safety).
Deliverables **(Maximum 6 – including the prescribed deliverables)**	• SOTA report (initial at PM 6) • Final Report on results generated in RAMPEC on the clay systems. • Final Report on results generated in RAMPEC on the cement systems. • Final Report on results generated in RAMPEC on the crystalline systems. • Report on RAMPEC outcome/impacts specifically addressed to Member States and End Users. • SOTA report in RAMPEC updated (PM 54).
Critical input requirements & identified risks	Critical input: • Successful implementation of the experimental program at PM 7. • Knowledge transfer to Tasks 4 and 5 from previous projects (FUTURE, CORI) until PM 6. Critical risks: • Limited exchange between Tasks, especially regarding knowledge transfer. • Lack of effective collaboration between WP partners. • Poorly constrained scope of experimental program: duplications; gaps; standalone studies beyond the main project focus.
Major achievements expected by end of Year 2 (Go/No Assessment)[1] **(Maximum 5 bullets)**	• Full implementation of experimental program with preliminary data transfers (based upon milestone documents). Required data transfers from Task 3 to Task 4 and Task 5 at PM 12 and 24. Data transfer between Task 4 and Task 5 also at PM 12 and 24. • Definition and documentation of experimental and modelling protocols. • Data input from previous project completed. • Establishment of modelling approaches and methodology. Go/no-go criteria after year 2: • Inability to successfully establish the experimental program. • Inability to work together as a collaborative consortium.
(Optional - Explain what is	• Stand-alone research without adequate links and relevance to other RAMPEC Tasks.

[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.

out of the scope?)	• Pure K_d studies. Development of experimental methods. • Studies duplicating previous research in FUTURE and/or CORI.
List of preliminary interested organisations as partners in the WP contributing effort; **% of effort (person months, by College)**	This is a preliminary list of groups who have so far expressed interest in RAMPEC. We do not consider this list to be closed nor any preselection for a potential future involvement in RAMPEC. The % effort allocated to the 3 colleges are first rough estimates. REs (55%): Amphos21 (ES), BRGM (FR), CEA (FR), CNRS(IC2MP, IPHC, ISTerre Subatech, ISTO) (F), CTU (CZ), DTU (DK), EK (HU), ENEA (IT), FZJ (DE), GALSON (UK), GFZ (DE), HZDR (DE), IST-ID (PT), JRC (EU), JSI (SI), KIT (DE), LEI (LT), NNL (UK), POLIMI (IT), PSI (CH), RATEN (RO), SCK-CEN (BE), STUBA (SK), TNO (&UUtrecht) (NL), TNTU (UK), UGrenoble Alpes (FR), UHelsinki (FI), UJV (CZ), ULiberec (CZ), UManchester (UK), UPotsdam (DE), UWarsaw (PL). TSOs (30%): CIEMAT (ES), GRS (DE), IRSN (FR), NRG (NL), NTUA (GR), NTW, SSTC NRS (UA), VTT (FI). WMOs (15%): Andra (FR), BGE (DE), NAGRA (CH), NWS (UK), Ondraf/Niras (BE), POSIVA (FI), SKB (SE), SURAO (CZ).
If applicable - links with previous projects / work packages	EURAD-CORI, -FUTURE, -ACED, -GAS. CATCLAY, CEBAMA, ECOCLAY I&II, FORGE, NF-PRO, FUNMIG, RECOSY, (HITEC, TIMODAZ).
WP Preparation Team (1 member per College) contact (**organisation + person**, email)	RE: Marcus Altmaier (KIT, Germany), marcus.altmaier@kit.edu TSO : Tiziana Missana (CIEMAT, Spain), tiziana.missana@ciemat.es WMO : Jean-Charles Robinet (ANDRA, France), jean-charles.robinet@andra.fr CG observer : Nadja Zeleznik (EIMV, Slovenia), nadja.zeleznik@eimv.si