EuradScience Position Paper on the selection of WP proposals for the EURAD-2 second-wave

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Disclaimer

This position paper is published with the aim of presenting EuradScience's process, activities and views in relation to the submission of RD&D and Strategic Study WP proposals for the EURAD-2 second wave. **The content of the position paper was reviewed and approved by the EuradScience General Assembly following the Steering Committee & GA review.**

Keywords

EuradScience; Research Entities (RE); second wave; EURAD-2; working groups; Work Package (WP) proposals; topics, RD&D, Strategic Study.

List of abbreviations

RE	Research Entity
WP	Work Package
TSO	Technical Scientific Organisation
WMO	Waste Management Organisation
EURAD-2	European Partnership on Radioactive Waste Management
EC	European Commission
EU	European Union
GA	General Assembly
KM	Knowledge Management
PMO	Programme Management Office
RD&D	Research & Development
RWM	Radioactive Waste Management
SRA	Strategic Research Agenda
WP CT	Work Package Coordination Team
EBS	Engineered Barrier Systems
THMC	Thermal-Hydraulic-Mechanical-Chemical (processes)

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1. Presentation of the second-wave selection process of EURAD-2

1.1 Quick introduction to EURAD-2

EURAD-2, the European Partnership on Radioactive Waste Management, is a continuation of the first EURAD programme under the European Union (EU)'s Horizon Europe framework. This five-year European Commission (EC) funded programme began in October 2024 and gathers European and International organisations categorised as Waste Management Organisations (WMOs), Technical Support Organisations (TSOs), and Research Entities (REs), which make for the three Colleges of the partnership.

The main goals of EURAD-2 are to ensure the safe and responsible management of radioactive waste through advancement in the development of disposal solutions, to support national programmes in their implementation, to foster collaborative research and innovation, and to preserve and transfer knowledge and competencies across generations, in the field of Radioactive Waste Management (RWM).

EURAD-2 gathers 18 Work Packages (WPs), which are split in two main categories: there are 10 Research & Development (RD&D) WPs and 6 Strategic Studies WPs. The two other WPs are the Knowledge Management (KM) WP and the Programme Management Office (PMO) WP. All EURAD-2 WPs address specific scientific and technical aspects of RWM and follow the priorities of research identified in the Strategic Research Agenda (SRA).

1.2 Introduction to the second wave process of EURAD-2

The second wave process of EURAD-2 follows the aims of the programme to be carried out on a needs-driven basis. In that sense, and as in EURAD-1, the programme is again deployed in a "two waves" format to ensure the possibility of integrating in the course of the programme new emerging needs from the EURAD-2 community (*EURAD-2 MS48 – Selection process for the second wave activities of EURAD-2: Terms of Reference from the Bureau*). Second wave WPs are to begin as of October 2026 and will last a maximum of two years for Strategic Studies WPs, and 3 years for RD&D WPs. The second wave WPs will benefit from the top-up budget planned by the EC, which will be known as of early 2026.

The EURAD-2 Bureau will act as Coordinator for the second wave process and selection of activities. This selection will be achieved following a consensus building process involving the 3 Colleges of EURAD-2, and the process developed by the Bureau for this matter is presented in Section 2 of the EURAD-2 MS48 on the Selection process for the second wave activities of EURAD-2.

The development of the second wave process started at the end of 2024 under the coordination of the Bureau and was approved by the EURAD-2 General Assembly (GA) and PMO. Each of the three Colleges must answer the call from the Bureau and propose a maximum of 4 topics for new RD&D WPs and 2 topics for new Strategic Studies WPs by 3 September 2025, through template #1 shared by the Bureau through the second wave Terms of Reference.

These proposals need to be eligible, and meet the criteria established by the Bureau, through the review of proposals by the PMO. The criteria to review the proposals, as well as the different stages of the second wave process at the EURAD-2 level – and for all WPs and organisations involved - are presented in the Bureau's milestone document.

2. Presentation of EuradScience's role & process in relation to the second wave of EURAD-2

2.1 Short presentation of EuradScience

EuradScience is the network of European Research Organisations, which comprises 30 organisations and represents 13 countries in the field of Radioactive Waste Management (RWM).

EuradScience aims at gathering the views of the Research Entities on European Radioactive Waste Management topics, representing the College of Research Entities in EURAD-2, fostering joint collaboration through exchanges and discussions, and preserving the interests of Research Entities at the EU level (in relation to EU projects).

EuradScience is an independent, cross-disciplinary, inclusive network with the aim of ensuring long-term scientific excellence and credibility in all aspects of radioactive waste management. EuradScience will provide, improve and further develop the scientific foundations for the sustainable and safe management of radioactive waste.

2.2 EuradScience's role in relation to the proposal of topics for the RE College

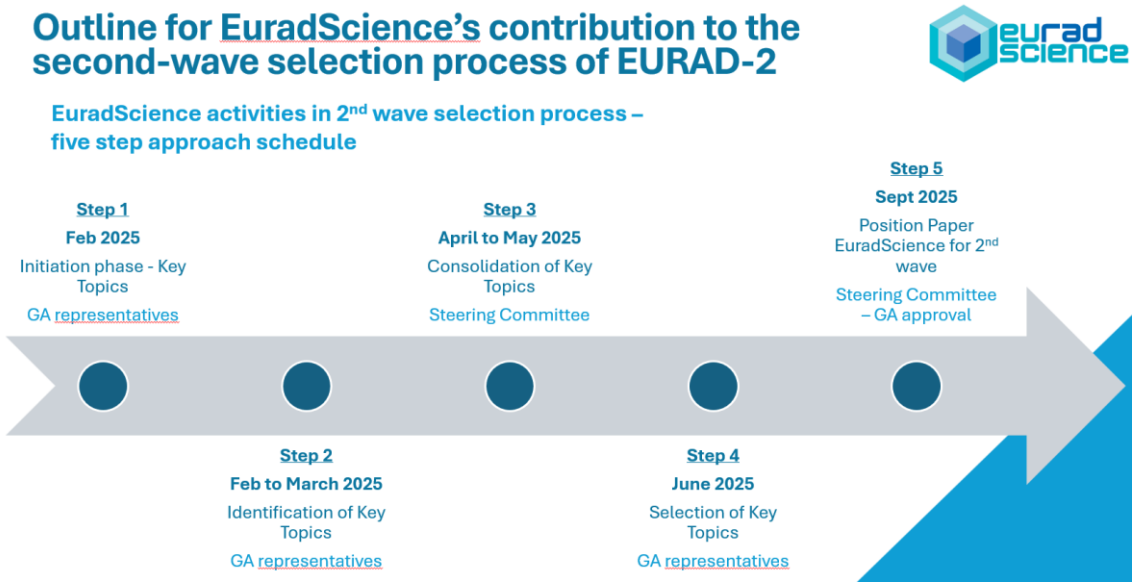
EuradScience plays a major role in representing the Research Entity (RE) College and its views in EURAD-2, as it has been assigned as the representative of the RE College within the Grant Agreement of the partnership. EuradScience was therefore responsible for gathering the consolidated view of all EURAD-2 REs on topics of interest for the second wave and made sure to guarantee inclusiveness regarding the second wave selection process of EURAD-2, since the network represents the whole RE College's views in the European Partnership. All inputs provided by REs for the second wave were therefore considered accordingly, whether these REs were part of EuradScience or not.

EuradScience was in that sense responsible for collecting and identifying the key topics (to be subsequently) prioritised for the second wave selection process of EURAD-2 for the RE College. EuradScience has provided its input on 1st September 2025, and sent its proposal for 4 RD&D WPs and 2 Strategic Studies to the EURAD-2 Bureau, Coordinator, and other Colleges – SITEX for TSOs and IGD-TP for WMOs.

2.3 EuradScience's process to identify topics of interest for EURAD-2 RE

The work of EuradScience to identify priority topics for the second wave began in January 2025, in order to ensure that all key topics identified by EURAD-2 REs could be collected and consolidated. This timeline was considered necessary since there are many more REs than WMOs and TSOs involved in EURAD-2. The intention was to allow sufficient time for the identification and consolidation of ideas via a bottom-up approach, as well as for the publication of this EuradScience position paper as an input to the Bureau's review of the topics proposed by each College.

A **five-step approach** was followed to determine the RE College's views on key topics to feed into the second wave selection process by September 2025. The outline and image presenting this five-step process, which was proposed by the EuradScience Steering Committee and approved by the EuradScience GA in February 2025, is shown here below:



2.3.1 Step 1 - Initiation phase: February 2025

In step 1, the overall five-step process of EuradScience was presented by the Steering Committee to the EuradScience General Assembly to initiate the process. The GA approved this five-step approach and its timeframe.

The importance of adopting a bottom-up approach for the identification of key topics was emphasised.

2.3.2 Step 2 - Identification of key topics: February / April 2025

In this second step, each EuradScience organisation was invited to submit up to five key topics of interest for the EURAD-2 second wave between February and March. To support their proposals, each key topic was accompanied by a short description of its scope, the type of WP (RD&D or Strategic Study), its link with the EURAD Strategic Research Agenda, and its potential links with current EURAD-2 WPs or previous & other EU projects.

2.3.3 Step 3 - Consolidation of key topics: May / June 2025

The key topics identified were then consolidated and merged through the elaboration of working groups, with the aim of combining topics of similar interest for the proposal of one key topic per working group, and through the approval of the EuradScience GA.

Participation in the working groups was held on a voluntary basis, both for EuradScience and non-EuradScience REs of EURAD-2. Each working group was composed of one EuradScience Steering Committee member acting as "contact person", responsible for gathering the participants of the working groups together. Nonetheless, the work of the working groups was carried out by the participants and not managed by the Steering Committee member, in continuation of the defined bottom-up approach for this process.

2.3.4 Step 4 - Selection of key topics: July 2025

The prioritisation phase was carried out by the EuradScience GA, through a ranking of the key topics consolidated through the working groups, based on transparent evaluation criteria matching the criteria outlined in the Bureau's Terms of Reference for the second wave selection process (through EURAD-2MS48). This prioritisation was approved by the EuradScience GA.

2.3.5 Step 5 - Submission of WP proposals: September 2025

The final step was the submission of the prioritised topics of interest for the RE College by the EuradScience GA through the completion of template #1 for each of the 4 RD&D and 2 Strategic Studies topics, by 3 September.

2.4 Inclusion of non-EuradScience REs views in the process

Although the Bureau had begun working on the second wave selection process in January of 2025 and had contacted EuradScience on this topic, the second wave selection process had not officially been launched at the EURAD-2 level when launched by EuradScience; it was hence not possible for EuradScience to gather the inputs of non-EuradScience REs, for EURAD-2 GDPR reasons.

Proposals from non-EuradScience REs were therefore gathered on a voluntary basis once the process was launched by the EURAD-2 Bureau & Coordinator, through the EURAD-2 Milestone 48 on the second wave process. This is one reason why a considerable effort has been dedicated to encouraging EURAD-2 REs to join EuradScience at the end of 2024 and in early 2025.

EURAD-2 REs not part of EuradScience were able to take part in EuradScience's second wave process to submit WP proposals for the RE College of EURAD-2, by proposing key topics of interest, which were then reviewed in relation to the working groups' consolidated topics, as well as by contributing to the consolidation of the key topics identified by taking part in the working groups in a voluntary approach.

A strong effort was also carried out by EuradScience to reach out to the non-EuradScience REs of EURAD-2. The goal was to assess whether these non-EuradScience REs would be interested in joining the network (as registration to a College of EURAD-2, entailing the payment of an associated fee, is not mandatory within the partnership), as well as for EuradScience to share the different stages of the second wave process with these organisations. Communication was also carried out to take part in the identification of key topics and consolidation of key topics during the working groups phases, through the EURAD-2 Coordinator, the EURAD-2 Beneficiaries for dissemination within their REs, and via the EuradScience website.

3. Identification and consolidation of key topics of interest

3.1 Identification of key topics of interest by EuradScience organisations

Following the approval by the EuradScience GA of the Steering Committee's five-step approach proposal to carry out the selection of priority topics of interest and gather the consolidated view of all EURAD-2 REs for the EURAD-2 second wave in February, key topics of interest for the second were identified by EuradScience organisations in a bottom-up approach, between February and April.

A Microsoft Forms document was sent to each technical contact of each EuradScience organisation, in order to propose up to 5 key topics of interest per organisation.

The Forms required, for each topic proposed:

- The key topic title
- The type of activity (RD&D or Strategic Study)
- The link(s) with EURAD SRA Themes
- A short presentation and scope of the topic identified
- Potential link(s) with current Strategic Studies WPs in EURAD-2

- Potential link(s) with current EURAD-2 RD&D WPs and/or previous WPs in EURAD-1 and/or other current or previous EU projects

As of mid-April, 56 key topics had been identified by 21 of the 30 EuradScience member organisations.

It is also important to notice that several EuradScience organisations expressed interest in topics which are currently developed as Strategic Studies WPs in EURAD-2. Nonetheless, it was jointly agreed not to further develop these topics of interest within the consolidation phase of EuradScience, as the Bureau's guidelines determined that these topics would be proposed as RD&D proposals by the Strategic Studies WPs (in consolidation with the views of the Colleges) at a later stage. In that sense, EuradScience decided it would be best to focus on topics identified of interest which are not linked to current EURAD-2 Strategic Studies WP activities.

3.2 Development of Working Groups based on similar key topics of interest

All the key topics identified through step 2 of EuradScience's second wave selection of WP proposals representing the views of the RE College were then consolidated into Working Groups. Working Groups are part of the EuradScience governance outlined in the network's Terms of Reference.

These key topics were consolidated into 12 Working Groups, proposed by the Steering Committee from the key topics identified by the EuradScience organisations in the previous stage and approved by the EuradScience GA in early May 2025. These Working Groups, focused on the consolidation phase of EuradScience's identification of priority topics for the EURAD-2 second wave process, were established to work on similar key topics of interest identified by EuradScience organisations, to propose one consolidated key topic per working group.

Two months were given for the Working Groups to consolidate the similar key topics, for presentation of the results during a Working Groups status update report online meeting on 3 July.

Here below are the twelve Working Groups topics which were identified and approved by the EuradScience GA:

- Bitumen
- Conditioning
- EBS Materials
- Glass
- Monitoring
- Natural Analogues
- Programme Management
- Radionuclide Migration
- Recycling
- Siting
- Spent Fuel
- THMC Host Rocks

The Working Groups were proposed from the key topics identified by the EuradScience Steering Committee, approved by the GA in early May, and developed during the same month. As a result, less than two months were given for each Working Group to consolidate similar topics of interest into one consolidated key topic. In this regard, a template was provided to each Working Group in order to have a harmonised set of guidelines, as well as a common basis for all Working Groups to carry out their work and provide outcomes of their discussions. The template gathered information which could serve as a basis for completion of template #1, in order to facilitate the evaluation of the outcomes of the Working Groups in relation to the submission of second wave proposals for the RE College.

More specifically, the guidelines provided through the template can be found here below:

- Summary of discussions and interests (related to the Working Group topic)
- Consolidated key topic short title
- Consolidated key topic short description
- Type of WP (RD&D or Strategic Study)
- Objectives of the WP proposal
- Added value for the national programmes and the EURAD-2 partners
- Link and potential links with current EURAD-2 WPs
- Alignment with EURAD-2 Strategic Research Agenda (SRA)
- Organisations part of the Working Group discussions

In order to facilitate the interactions within each Working Group, a Working Group representative was also appointed on a voluntary basis. Unlike the EuradScience Steering Committee member acting as contact person, the Working Group Representative would act as the spokesperson of the Working Group's technical exchanges and lead the group in the technical discussions and meetings, as well as carry out the presentation of the Working Group's outcomes during the Working Groups status report online meeting, held on 3 July 2025.

As the work carried out by the Working Groups occurred during the official launch of the second wave selection process at the EURAD-2 level, the key topics identified by non-EuradScience REs were reviewed in relation to the Working Groups' consolidated topics. All the organisations which proposed key topics were eventually included in at least one Working Group.

A total of 20 EuradScience organisations and 10 non-EuradScience REs were involved in at least one Working Group.

4. Prioritisation of the consolidated key topics

4.1 Consolidation of the key topics identified

The working groups consolidated their similar key topics of interest and presented their work and outcomes during a working groups status update report online meeting on 3 July, made open to all REs of EURAD-2 interested in attending.

Ten minutes were granted for each Working Group's technical representative to provide the outcomes of the Working Group's discussions, using the template previously provided. An additional five minutes were granted after each presentation for potential questions. This meeting was also made open to all the EURAD-2 Research Entities interested in attending, independently from their involvement in a Working Group, and through dissemination through the EURAD-2 Coordinator, Beneficiaries, and the EuradScience Secretariat.

Out of the twelve Working Groups agreed upon, the Working Group on Radionuclide Migration was eventually dropped, due to the unavailability of the members to lead the Working Group; discussions will nonetheless remain open for potential future ideas, although this topic will not make part of the final list of proposals from the RE College for the second wave of EURAD-2.

The presentations made by each Working Group representative enabled the EuradScience GA participants and meeting attendees to assess the 11 consolidated key topics, which would then be ranked from the EuradScience technical contacts via an EU Survey poll.

The content of the presentations carried out for each Working Group can be found in Annex 1, in a Table format, to harmonise the content presented through the common EuradScience template. In total, the 11 topic proposals gather 7 RD&D and 4 Strategic Studies WP proposals. The contact information of the Working Groups' technical representative(s) were also added in this regard.

4.2 Prioritisation poll results and ranking of consolidated topics

Following the consolidation phase of the key topics through the Working Groups' work, the EuradScience technical contacts were invited to carry out the prioritisation of the 11 WP proposals, through an EU Survey poll.

As EuradScience represents the RE College's views in EURAD-2, it was the network responsible for carrying out the prioritisation and proposal of WP topics for the second wave of EURAD-2. A considerable effort was carried out to ensure that the views of all the Research Entities of EURAD-2 which had identified topics of potential interest were taken into account. Nonetheless, the ranking of second wave topics (out of the 11 consolidated key topics identified through the Working Groups' work) for the proposal of the RE College's WP proposals was only carried out by the EuradScience organisations, through their technical contact.

A question on the agreement on the prioritisation process was included in the poll for the EuradScience GA to vote on the approval of the process. All organisations which completed the ranking through the poll approved the process outlined during the Working Groups status report online meeting.

The poll was sent to each EuradScience organisation's technical contact (one reply per EuradScience organisation) following the Working Groups' status report meeting, in order to rank the consolidated topics presented by each Working Group for submission of the 4 RD&D and 2 Strategic Studies WP proposals to the Bureau by 3 September.

The poll focused on the ranking of the proposals based on specific prioritisation criteria, defined by the EuradScience Steering Committee and approved by the EuradScience GA. Here below are the criteria:

- Scientific excellence
- Addressing relevant knowledge gaps
- Relevance to SRA
- Added value for the RE College
- Relevance for the National programme of my country
- Broader European relevance
- Potential involvement of young scientists (and younger generation of researchers)

One week was given to rank the topics through completion of the poll, in order to have sufficient time throughout the summer period to carry out the draft of template #1 for each of the 6 WP proposals selected.

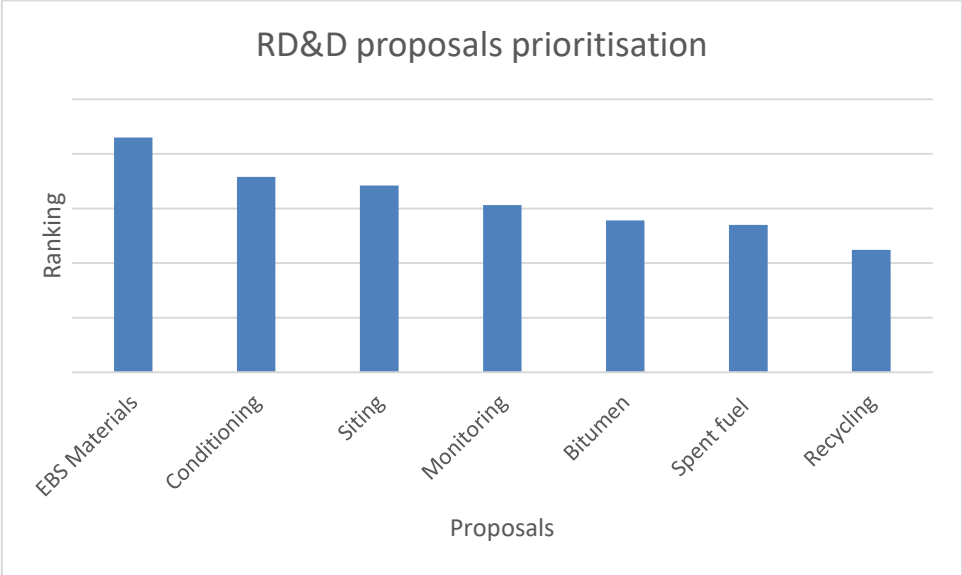
5. Outcomes of EuradScience's WP proposals ranking for the second wave

The results of the prioritisation of the key topics consolidated through the Working Groups were shared with the EuradScience organisations and participants involved in the Working Groups, as well as with the attendees of the Working Groups status report meeting, on 14 July 2025.

The 4 RD&D topics selected to be submitted as EuradScience proposals for the second wave of EURAD-2 through template #1 were:

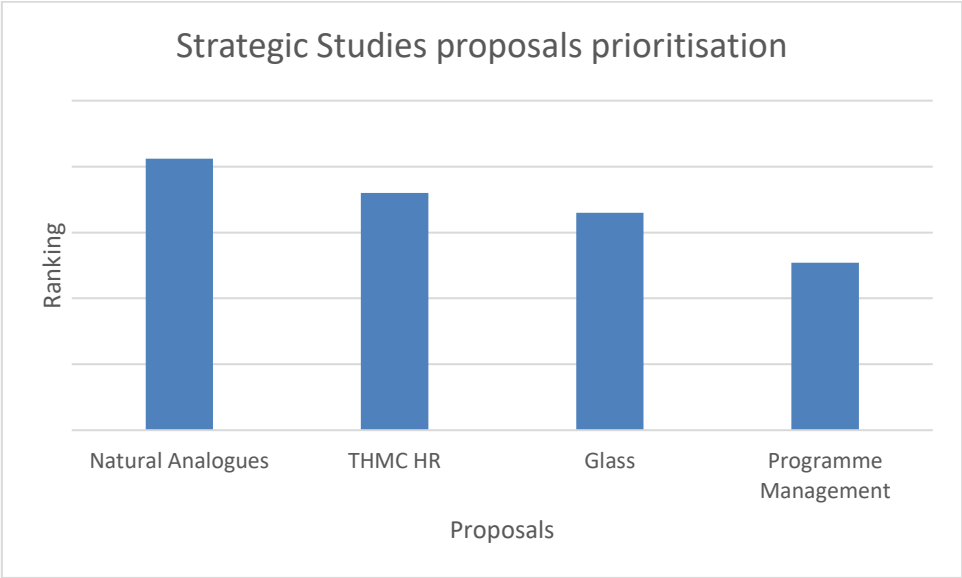
- **Materials (EBS):** ***Materials for enhancing passive safety and robustness of Engineered Barrier Systems***
- **Conditioning:** ***Development of robust and versatile conditioning matrices for challenging waste streams***
- **Monitoring:** ***Advanced Monitoring Systems and Data Management***

- **Siting:** ***Developing site screening strategies and procedures for integrated site descriptive models***



<u>The 2 Strategic Studies topics selected to be submitted as EuradScience proposals for the second wave of EURAD-2 through template #1 were:</u>

- **Natural Analogues:** ***Strategic review of holistic utilisation of NAs in radioactive waste disposal (NATSTRAT)***
- **THMC Host Rocks:** ***Assessing the end user gaps and needs on THMC(B) properties of HR – defining a common strategy***



All the organisations which completed the poll approved the process. A total of 27 out of the 30 EuradScience organisations completed the poll.

The technical representatives of the Working Groups which topics were selected in this prioritisation phase were then contacted for a member of the Working Group to carry out the completion of the template #1, in order to make the official topic proposal to the Bureau by 3

September. Completion of template #1 was to be carried out using the guidelines of the template and the outcomes of each Working Group's discussions presented in the previous Working Groups status report meeting.

Two weeks were given to complete the template for their topic proposal (until the end of July). These drafts of template #1 were then reviewed both by the EuradScience Secretariat and Steering Committee. The final versions of template #1 for each of the six WP proposals by the RE College were submitted to the EURAD-2 Bureau on 1 September 2025. The proposals can be found in Annex 2 of this position paper.

The completions of the templates were carried out as EuradScience proposals, to represent the consolidated view of the RE College, and not the view of the organisation(s) which completed the template or took part in the Working Group activities.

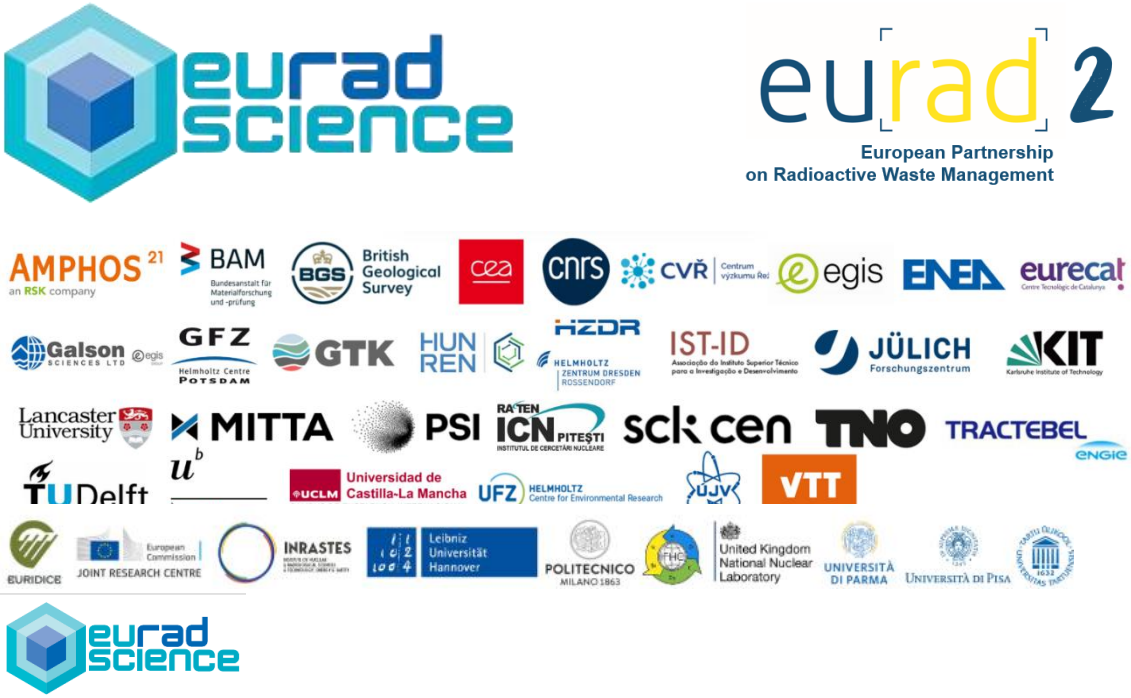
6. Acknowledgments

The authors would like to thank the involvement of all participating organisations in EuradScience's identification of WP proposals for the RE College as part of the EURAD-2 second wave process. The contributions of EuradScience organisations and involved EURAD-2 REs, throughout the identification, consolidation and prioritisation phases, enabled EuradScience to submit WP proposals aligned with the consolidated views of the RE College.

The coordination of the process to identify WP proposals by the EuradScience Steering Committee, as well as their review of the templates #1, is also greatly acknowledged.

We would additionally like to thank the Working Group Representatives for their involvement in the consolidation of their group's efforts and in the draft of the WP proposal templates for the RE College.

Finally, we would like to thank the EURAD-2 Bureau and Coordinator for their role in providing guidelines and their assistance in sharing our process with the REs of EURAD-2, as well as in the overall follow-up of this process.



7. Annexes

7.1 Template #1 documents submitted to the EURAD-2 Bureau as EuradScience WP proposals from the RE College

7.1.1 RD&D proposals

7.1.1.1 Conditioning

Topic	**Development of robust and versatile conditioning matrices for challenging waste streams using alkali-activated materials**		
College	☒RE	☐TSO	☐ WMO
Type of activity	☒R&D	☐Strategic Study	
Links with EURAD SRA / Themes (if multiple choices, indicate the primary link **in bold**)	☐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)		
Links with EURAD Roadmap Domain Insights (if multiple choices, indicate the primary link **in bold**)	- 2.1.1 Inventory - 2.1.2 WAC - **2.2.3 Conditioning**		
SRA drivers[1]	☐Implementation Safety	☒Tailored Solutions	☒Scientific Insight

	☒Innovation for Optimisation	☐Societal Engagement	☐Knowledge Management
Justification: impact / innovation / added-value (Why) – bullet points or short paragraph	**Innovation**: • Robust ready-mixed matrices based on alkali-activated materials (AAMs)/geopolymers, building on insights from WPs (5–7) while advancing towards higher technology readiness levels Able to handle uncertainty and a wide range of radioactive wastes, and to facilitate application and implementation at industrial scale • The optimized matrices will ensure long-term safety of the radioactive waste management **Added value for the national programmes and the EURAD-2 partners:** • Solutions for problematic waste streams, that remain incompatible with conventional cement-based approaches • Wider partner interest • Confidence on AAMs for waste management • Sustainable waste conditioning solution		
Objective (What) – 1 sentence	This project aims at advancing radioactive waste conditioning by developing and demonstrating AAM/geopolymer-based matrices that are robust, versatile, and sustainable, offering a pathway to safer, more efficient waste management.		
Short description: outcomes / tasks (How) – bullet points or short paragraph	**Expected outcomes:** • Achievement of robust and versatile geopolymer-based matrices for reliable waste immobilization across diverse waste streams • Matrices with superior chemical resistance, higher waste loading capacities, and enhanced long-term durability compared to traditional cemented waste forms • Understanding waste–matrix interactions and radionuclide binding mechanisms, addressing key knowledge gaps not covered in current WPs (5–7) or the PREDIS project. Establishment and validation of common/standardized testing protocols tailored for geopolymer-based waste forms to enable comparability and regulatory acceptance **Methodology:** • Waste inventory, classification and identification of waste streams compatible with AAMs: e.g. spent-ion exchange resins, pyrolysis ashes, SMR related waste (lead, salt…). • Development of a robust and widely applicable conditioning matrix for various waste streams (screening + optimization) using AAMs: Test different precursor materials (e.g., metakaolin, fly ash, slag) and activators to design formulations with optimal waste encapsulation properties. Assess the impact of waste loading levels on matrix stability and performance. • Robustness testing for variability in waste and precursor (physico-chemical) compositions to ensure the conditioning matrices are		

	versatile and reliable across diverse waste streams and environmental conditions. • Establishment of standardized protocols to evaluate the performance of conditioning matrices, ensuring reliable and comparable results across studies in collaboration with IAEA. • Modeling long-term performance under relevant disposal conditions. • Sustainability considerations – LCA/LCC.
(Optional - Explain what is out of the scope?)	• OPC based conditioning matrices • Bitumen
List of preliminary interested organisation in the College	15 organisations: SCK CEN (Belgium), Tractebel (Belgium), VTT (Finland), SIIEG NASU (Ukraine), PSI (Switzerland), UniPi (Italy), HZDR (Germany), PSI (Switzerland), KIPT (Ukraine), KhPI (Ukraine), INCT (Poland), UAM (Spain), CSIC (Spain), RATEN (Romania), CV REZ (Czech Republic)
Links with previous or ongoing projects / work packages	EURAD-2 WP6 STREAM and WP7 LOPERA; IAEA CRP geopolymers PREDIS WP5 and WP6
Main contact (name, email, phone number)	Quoc Tri Phung Quoc.tri.phung@sckcen.be +32495781656
Additional information	

7.1.1.2 EBS Materials

Topic	**Materials for enhancing passive safety and robustness of Engineered Barrier Systems**		
College	☒RE	☐TSO	☐ WMO
Type of activity	☒R&D	☐Strategic Study	
Links with EURAD SRA / Themes (if multiple choices, indicate the primary link **in bold**)	☐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)		
Links with EURAD Roadmap Domain Insights (if multiple choices, indicate the primary link **in bold**)	- **3.2.1 HLW and SF Containers** - **3.3.1 Buffers** - **3.3.2 Backfills**		
SRA drivers[2]	☐Implementation Safety	☒Tailored Solutions	☒Scientific Insight
	☒Innovation for Optimisation	☐Societal Engagement	☐Knowledge Management
Justification: impact / innovation / added-value (Why) – bullet points or short paragraph	**Innovation**: • Eco-friendly and innovative backfill materials, including cementitious composites to ensure passive safety, sustainability and robustness of individual EBS components. • Innovative industrial techniques (metallic protective coatings by high-performance build-up welding and research on non-metallic protective coatings) to enhance the durability and robustness of metallic disposal containers, improving the long-term safety of EBS. **Added value for the national programmes and the EURAD-2 partners:**		

	Finding innovative solutions that increase robustness and long-term safety of radioactive waste disposals and promote eco-friendly alternatives by
	• Optimization of production and conditioning processes for HLW disposal containers through:
	  ○ Use of alternative materials alongside advanced manufacturing techniques combined with appropriate welding technologies, to enhance safety.
	  ○ Integration of sustainable and cost-effective materials, complemented by ceramic coatings, to improve robustness and long-term durability.
	• Backfill material design to prevent mechanical damage of packages because of expansive reactions:
	  ○ Development of improved eco-friendly and innovative backfill material to offer practical solutions for managing expansive waste by allowing controlled expansion and minimizing water ingress into the waste, thereby reducing expansive reactions.
	• Identification and characterization of advanced closure and backfill materials
	  ○ to establish baseline configurations for optimizing repository sealing systems. These materials are evaluated for their geomechanical compatibility, chemical stability, and long-term performance under repository-specific conditions, thereby informing the design of more robust closure structures.
	  ○ Development of radiation-resistant concretes that can be used under conditions of simultaneous exposure to ionizing radiation and elevated temperatures.

Objective (What) – 1 sentence	To develop innovative eco-friendly materials that enhance the robustness and passive safety of radioactive waste disposal systems through the use of advanced container materials and manufacturing techniques, innovative backfill materials and improved closure materials.
Short description: outcomes / tasks (How) – bullet points or short paragraph	**Expected outcomes:** • Innovative solutions and materials to enhance the EBS design, production, and conditioning, and especially the long-term durability of metallic disposal containers. • Sustainable innovative backfill materials for long-term safety of radioactive waste disposals. **Methodology:** • Applying and investigating advanced industrial techniques to improve the durability of metallic disposal containers: • Application of industrially available high-performance metal build-up welding processes (weld cladding and sealing)

	• Investigation of improved manufacturing techniques for producing non-metallic protective coatings (ceramics, enamel), including PVD method. • Develop sustainable innovative backfill materials to allow for waste matrix swelling and gas generation and passive protection of other engineered barriers from mechanical degradation. The development includes a multidisciplinary approach by • Numerical optimization of material in terms of hydraulic and mechanical properties • Experimental work aiming at finding the appropriate eco-friendly materials with numerically determined properties and to evaluate the overall performance • Optimization of closure/backfill materials to ensure their sealing properties under different THMCR conditions. Material options include clays, bentonite-aggregate mixtures, rock-based backfills, *radiation-resistant concrete,* and self-hardening materials with potential for low CO_2 solutions.
(Optional - Explain what is out of the scope?)	Bitumen
List of preliminary interested organisation in the College	13 organisations: GTK (Finland), BGS (United Kingdom), BAM (Germany), TU DELFT (Netherlands), SCK CEN (Belgium), LUH (Germany), HZDR (Germany), KIT (Germany), SIIEG NASU (Ukraine), KIPT: NTU KHPI (Ukraine), UKNNL (United Kingdom), UAM (Spain), VTT (Finland)
Links with previous or ongoing projects / work packages	EURAD-2 WP6 STREAM, WP9 InCoManD, WP10 ANCHORS and WP13 OPTI EURAD-1 WP7 HITEC
Main contact (name, email, phone number)	Janez Perko janez.perko@sckcen.be +32479854843
Additional information	

7.1.1.3 Monitoring

Topic	Self-Powered Monitoring Systems for Radioactive Waste Repositories		
College	☒RE	☐TSO	☐ WMO
Type of activity	☒R&D	☐Strategic Study	
Links with EURAD SRA / Themes (if multiple choices, indicate the primary link **in bold**)	☐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)		
links with EURAD Roadmap Domain Insights (if multiple choices, indicate the primary link **in bold**)	- 2.3.2 Optimisation - 3.4.1 EBS system - 5.4.2 Normal operations safety - **5.5.1 Baseline monitoring** - 5.5.2 Monitoring with regard to onsite investigation, construction and operations - 7.3.1 Performance assessment and system models		
SRA drivers[3]	☒Implementation Safety	☒Tailored Solutions	☐Scientific Insight
	☒Innovation for Optimisation	☐Societal Engagement	☐Knowledge Management
Justification: impact / innovation / added-value (Why) – bullet points or short paragraph	• **High impact risk reduction & safety assurance:** Provide continuous, truly autonomous, wireless and self-powered monitoring of radioactive waste facilities, through real-time indicators. Further impacts are expected in: • Minimization of energy consumption • Improvements in economic and environmental sustainability, • Reduction of battery waste. • Strengthening Safety • Cyber resilience • **Breakthrough:** Minimize hazardous battery waste throughout the repository life cycle, cut OPEX and enhance cyber-security • **Added value:** The implementation of monitoring programmes for disposal systems is often limited by technological constraints. A new technology based on wireless transmission, capable of connecting with conventional measurement instruments—including vibrating wire types—and supplying them with alternative nuclear battery technologies to replace conventional chemical batteries, will add significant value to monitoring systems, maximizing technology transfer, reducing costs and enhancing safety. • **Innovation:** Embed edge-AI for onboard cleaning, labelling, filtering and anomaly detection, ensuring high quality, decision ready data is		

	considered for national and EURAD knowledge management platforms.
Objective (What) – 1 sentence	Develop sustainable, cyber resilient, self-powered monitoring systems providing long-term RWs predisposal and repositories surveillance.
Short description: outcomes / tasks (How) – bullet points or short paragraph	The main outcomes expected are: 1)Reduction of high-impact risk and enhanced safety through long-term and non-intrusive monitoring with real-time metrics; 2) Elimination of hazardous battery waste through self-powered, energy-harvesting sensor nodes; 3) Enhanced cyber-resilience, data integrity and rapid anomaly detection via edge-AI analytics and secure wireless links. 4)Adaptive energy use – harvesting energy from radiation, heat, or geochemical gradients ensures long-term sustainability. 5)Regulatory and societal confidence – demonstrable long-term surveillance supports safety cases and public trust in repository performance. 6)Scalable and versatile applications – adaptable for deep geological repositories, near-surface facilities, and borehole systems. The activity will consist of (be organised in): Task-1 (AI, Data and Knowledge Management): Define data model, KPIs, and Data Management Plan. Task-2 (Sensor and Energy-Harvesting Hardware): power budget; select harvesting and power-management integrated circuit (PMIC); design sensors and ultra-low-power electronics; prototype and run environmental accelerated life testing (ALT). Task-3 (Wireless Communication and Power Delivery): perform link-budget/coexistence and security architecture studies; resilience verification (interference/jamming/penetration); assess wireless power transfer. Task-4 (System Integration and Demonstration): define reference architecture/interfaces; pilot deployments for continuous monitoring; TRL assessment. Task-5 (Dissemination): strategy for actively sharing the project's results and deliverables to maximize its impact and ensure its long-term sustainability The aim of this proposal is to develop an autonomous self-powered platform. A feasibility study of proposed system architecture will be provided. System design (TRL 5-7) for continuous, high-resolution and informed decision-making long term monitoring will be carried out.
(Optional - Explain what is out of the scope?)	All the activities not primarily focused on monitoring system and architecture are out of the scope of this proposal.
List of preliminary interested organisation in the College	7 organisations: University of Pisa (Italy); Amphos 21 (Spain); SCK CEN (Belgium); TNO (Netherlands); BAM (Germany); GRS (Germany); SIIEG NASU (Ukraine).
Links with previous or ongoing projects / work packages	EURAD-2 WP5 ICARUS PREDIS WP7; EURAD-1 WP17 MODATS; MoDeRn/ MoDeRn 2020
Main contact (name, email, phone number)	Salvatore Cancemi (University of Pisa); salvatore.cancemi@unipi.it; +390502218030 Susana Tuñón (Amphos 21); susana.tunon@amphos21.com; +34606261675

Additional information	

7.1.1.4 Siting

Topic	**Developing site screening strategies and procedures for integrated site descriptive models – SISTEMO**		
College	☒RE	☐TSO	☐ WMO
Type of activity	☒R&D	☐Strategic Study	
Links with EURAD SRA / Themes (if multiple choices, indicate the primary link **in bold**)	☒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)		
Links with EURAD Roadmap Domain Insights (if multiple choices, indicate the primary link **in bold**)	- 1.3.3 International Cooperation - **4.1.1 Site descriptive model** - 4.1.2 Aqueous transport and retention - 4.3.2 Climate change - 6.1.2 Area survey and site screening - 6.2.1 Site investigation - 6.2.2 Detailed site characterisation and site confirmation - 7.3.1 Performance assessment and system models - 7.3.3 Scenario development and FEP analysis		
SRA drivers[4]	☒Implementation Safety	☐Tailored Solutions	☒Scientific Insight
	☐Innovation for Optimisation	☒Societal Engagement	☒Knowledge Management

Justification: impact / innovation / added-value (Why) – bullet points or short paragraph	• Compilation and improvement of best practices for siting strategies, criteria and site descriptive models to ensure that state-of-the-art techniques are available to all stakeholders and member states (building upon IAEA report on 'Management of Site Investigations for Radioactive Waste Disposal Facilities' 2024). • Establishment of a reference framework with proposed workflows for progressive development of site descriptive models and long-term evolution models aligned with different siting stages. • Strengthening credibility of site-specific management of uncertainties, ensuring continuous improvement and adaptability to new data and/or interpretations.
Objective (What) – 1 sentence	Develop guidance on developing site descriptive models based on siting criteria catalogues, providing robust workflows that i) integrate various disciplines, ii) improve the models as the siting process progresses through its successive stages and iii) include the long-term evolution of a site.
Short description: outcomes / tasks (How) – bullet points or short paragraph	Task 1: Development of policies and best practices for site screening strategies, criteria and their communication strategy based on literature review/collection of expert knowledge and end user entities. Task 2: Progressive development of site descriptive models in connection to various siting stages and siting conditions, including the evaluation of prediction-outcome approaches, feedback loops and establishment of stepwise and iterative modelling approaches. Task 3: Define a comprehensive set of methods for fast and efficient evaluation of borehole data, based on existing and new data, using machine learning methods, statistical approaches and comparison with conventional data analysis methods. Task 4: Development of tools and workflows towards integrated models for the assessment of the long-term evolution of the disposal facility and the surrounding geosphere. Enhancement of numerical tools for coupling existing subsidiary models to build integrated geosphere models.
(Optional - Explain what is out of the scope?)	No aspects of proposal "THMC host rocks". No development of discipline specific numerical models e.g. for gas flow, transport, rock mechanics…
List of preliminary interested organisation in the College	10 organisations: Geological Survey of Finland (GTK) (Finland), University of Bern (Switzerland), GFZ Helmholtz Centre for Geosciences (Germany), SIIEG NASU (Ukraine), RATEN ICN (Romania), ENEA (Italy), Amphos21 (Spain), Helmholtz Centre for Environmental Research (UFZ) (Germany), Galson Sciences Limited (United Kingdom), UKNNL (United Kingdom)
Links with previous or ongoing projects / work packages	EURAD-2 WP2 KM, WP11 CLIMATE, WP15 DITOCO2030 and WP16 HERMES
Main contact (name, email, phone number)	Mirjam Kiczka (University of Bern), mirjam.kiczka@unibe.ch, +41 31 684 87 92 Jon Engström (GTK) (deputy), jon.engstrom@gtk.fi, +358 29 503 2624
Additional information	

7.1.2 Strategic Studies proposals

7.1.2.1 Natural Analogues

Topic	**Natural Analogues – Strategic review of holistic use of NAs in radioactive waste disposal (NATSTRAT)**		
College	☒RE	☐TSO	☐ WMO
Type of activity	☐R&D	☒Strategic Study	
Links with EURAD SRA / Themes (if multiple choices, indicate the primary link **in bold**)	☐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)**		
Links with EURAD Roadmap Domain Insights (if multiple choices, indicate the primary link **in bold**)	Examples: - 3.4 EBS system integration - 4.4 Geosynthesis - **7.1 Safety Strategy** - 7.2 Integration of Safety relevant information - 7.3 Safety Assessment and Tools		
SRA drivers[5]	☒Implementation Safety	☐Tailored Solutions	☒Scientific Insight
	☐Innovation for Optimisation	☒Societal Engagement	☒Knowledge Management
Justification: impact / innovation / added-value (Why) – bullet points or short paragraph	Recent reviews on the application of natural analogues (NA) in safety cases—such as those developed for the KBS-3 spent fuel repository and the near-surface LILW repository at Olkiluoto, as well as analyses across deep and near-surface disposal programmes in Finland, Switzerland, Sweden, Canada, USA, Japan, and Germany and UK —have identified several knowledge gaps within the fields of waste forms, EBS, geosphere, biosphere and external processes, that would serve as a starting point for this strategic work. There are several topical areas, particularly related to the safety strategy for LILW (surface or near surface), where the use of natural analogues remains largely unexplored. These include less-studied engineered barrier systems (e.g. earth covers), external processes (e.g., climate), biosphere, industrial analogues. However, exploring this underexposed topic of natural analogues will help strengthening safety cases and create broader social acceptance.		

	Enhancing understanding through the improved application of natural analogues to communicate the robustness of safety cases to civil society groups is seen as an underused asset.
Objective (What) – 1 sentence	The strategic study would focus on defining state of the art and critical gap analysis on NAs (including archaeological and industrial) for HLW and L/ILW concepts, as well as providing guidance for holistic use of NAs in disposal programmes (including safety cases and stakeholder communication)
Short description: outcomes / tasks (How) – bullet points or short paragraph	Task 1: FEP based gap analysis and state-of-the-art review on NA use in safety cases (utilizing existing literature) with aims to: - Revisit/redefine the use of analogues to support various stages of geological disposal programmes and components of the safety case; - Provide holistic understanding of the current status of NA research and a way forward for different repository concepts (guidance); - Identify NAs that are crucial to fill the knowledge gaps, provide evidence thus reducing key uncertainties in the safety cases, and/or aid optimization / robustness of the repository systems. Task 2: Knowledge management and training: Task 2.1: Implementation of the results of Task 1 to EURAD-2 KM Task 2.2: Training - Expert level training / workshop on NAs: Focused on how to effectively integrate NA data and insights into the development and justification of the safety case. - Expert level training / workshop on stakeholder communication: Exploring how to translate findings from NA studies into accessible, transparent and meaningful narratives to support stakeholder engagement and public trust. Task 3: Feasibility assessment for future NA studies - Based on Task 1 Gap Analysis, topics for future work will be provided including preliminary assessment of the sites / samples (accessibility, field work / sampling feasibility, sample quality if existing samples, etc.) including initial reconnaissance visits to relevant sites (Potential R&D for EURAD-3). - Structured and versatile assessment template for selecting future study topics accounting for feasibility, national needs, scientific gaps (especially NAs for upscaling over long time scales).

(Optional - Explain what is out of the scope?)	Research on natural analogues themselves is out of scope. The WP is intended as a meta-analysis.
List of preliminary interested organisation in the College	14 organisations: GTK (Finland), CEA (France), University of Bern (Switzerland), TUDelft (Netherlands), SCK CEN (Belgium), BGS (United Kingdom), TNO (Netherlands), Amphos21 (Spain), KIT (Germany), SIIEG NAS of Ukraine (Ukraine), UKNNL (United Kingdom), UFZ (Germany), EPFL (Switzerland), ÚJV Řež (Czech Republic)
Links with previous or ongoing projects / work packages	Ongoing[6]: EURAD-2 WP2 KM, WP9 InCoManD, WP10 ANCHORS, WP11 CLIMATE, WP13 OPTI and WP14 SUDOKU; NAWG (non-funded working group, not a project) Previous: EURAD-1 WP2 ACED; FP5-NANET (2003-2004)
Main contact	Heini Reijonen (heini.reijonen@gtk.fi, +358 50 3488 669)
Additional information	Posiva 2021. Safety Case for the Operating Licence Application - Complementary Considerations (CC). POSIVA 2021-02. Eurajoki, Finland: Posiva Oy. https://cms.posiva.fi/ King., F. 2021. "Natural Analogues and their Use in Supporting the Prediction of the Long-Term Corrosion Behaviour of Copper-coated UFC" NWMO TR-2021-19. https://www.nwmo.ca/-/media/Reports-MASTER/Technical-reports/NWMO-TR-2021-19-Natural-Analogues-and-their-Use-in-Supporting-the-Prediction-of-the-2021-11.ashx?sc_lang=en NWS review recent publications: Alexander W R, Reijonen H M, Norris S, 2024. Assessing the performance of a radioactive waste repository over geological timescales: past experience and the way forward. In *Sustainable geological disposal and containment of radioactive waste*, Norris, S and Cooke, A (eds). Geoenergy v2, https://doi.org/10.1144/geoenergy2023-046 See also full background report: NWS NA Catalogue update 131123 at: https://www.natural-analogues.com/nawg-library/na-overviews (Alexander & Reijonen 2023) Reijonen H M, Alexander W R, Norris S, 2023a. Resilience in knowledge management – the case of natural analogues in radioactive waste management. J. Process Safety Environ. Protection 180, 205–222. https://doi.org/10.1016/j.psep.2023.10.008 See also full background report: NWS NA Strategy report 170423 at: https://www.natural-analogues.com/nawg-library/na-overviews (Reijonen & Alexander 2023)

7.1.2.2 THMC Host Rocks

Topic	**Assessing the end user gaps and needs on THMC(B) properties of HR – defining a common strategy**		
College	☒RE	☐TSO	☐ WMO
Type of activity	☐R&D	☒Strategic Study	
Links with EURAD SRA / Themes (if multiple choices, indicate the primary link **in bold**)	☐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)		
Links with EURAD Roadmap Domain Insights (if multiple choices, indicate the primary link **in bold**)	- **4.2 Perturbations** - 4.4 Geosynthesis - 7.1 Safety strategy		
SRA drivers[7]	☐Implementation Safety	☐Tailored Solutions	☒Scientific Insight
	☐Innovation for Optimisation	☐Societal Engagement	☐Knowledge Management
Justification: impact / innovation / added-value (Why) – bullet points or short paragraph	The THMC(B) behaviour of clayey rock formation and clayey EBS materials formations has been studied extensively over the years, leading to a substantial body of knowledge. Recently, the EURAD-1 WP6 GAS and WP7 HITEC projects have advanced the understanding of gas transport mechanisms and the thermal effects on bentonite and natural clay barriers. Currently, the on-going EURAD-2 WP10 ANCHORS investigates the chemical effect on hydro-mechanical properties. While these studies contribute or have contributed to the overall knowledge base, they primarily address very specific aspects of THMC behaviour of clayey materials and are limited in scope. All these programmes investigate phenomena from small-scale (mm to cm) to in situ experiments (dm to dam), but ultimately, a systematic upscaling to repository-scale implementation is required. Key questions remain: How relevant is the existing knowledge for understanding the long-term performance of a geological disposal		

	facility (GDF)? What are the main uncertainties? Where does our understanding remain insufficient with respect to the different disposal concepts (clayey host rock/ clayey EBS materials)? How can we upscale THMC(B) properties from small-scale experiments to repository-scale applications? How can uncertainty reduction help improve the robustness of safety cases?
Objective (What) – 1 sentence	This study aims to systematically identify existing knowledge gaps and priority research needs concerning the THMC(B) and gas transport properties of clayey host formations and clayey EBS materials. To ensure mutual benefits across all programmes, engagement with end-users of national programmes will take place at all stages to incorporate the needs of both early-stage and advanced countries.
Short description: outcomes / tasks (How) – bullet points or short paragraph	**1. Task 1: Management of the Strategic Study** **Goals:** Oversee and coordinate all activities related to the strategic study. **2. Task 2: Knowledge Management** **Goals:** Develop a comprehensive and uniform synthesis of the state of the art of THMC(B) coupling in clayey host rocks/ clayey EBS materials by integrating previous projects (EC and national projects). **Activities**: the activity consists in workshops / working group with end-users to review former projects which often focus on individual aspects (either T, H, M, C or B) and to create an inventory (with data set) of current knowledge (with link to Knowledge Management WP). **3. Task 3: Identification of Knowledge Gaps in THMC(B) Behavior** **Goals:** Use the review process of task 2 to identify gaps and link findings with ongoing projects and national programme needs to maintain relevance. **Activities:** Workshops / working group with end-users to identify common challenges and gaps will be organised. This will be done by reviewing the inventory to give a better insight to experimental and modelling teams in what has been done in the past, to avoid duplication of experiments and modelling activities. Another aim of this review is to enhance collaboration between experimental and numerical teams. **4. Task 4: Proposal of a Common Perspective** **Goals:** Translate defined THMC(B) gaps into actions to define and develop a strategic framework from early-stage to more advanced research programmes. **Activities:** During these activities, workshops / working group with end users will elaborate experimental programmes and protocols, with particular focus on tailoring laboratory conditions - based on gap analysis (e.g., conditions representative of a GDF). Define modeling approaches - that couple processes across spatio-temporal scales and include strategy for sensitivity analysis. Identify upscaling approaches from lab scale to repository scale. The relevance of

	these actions is assessed by using e.g. importance/urgency or impact/effort matrices.
(Optional - Explain what is out of the scope?)	RD&D is out of scope. No experiments or modelling activities are planned.
List of preliminary interested organisation in the College	16 organisations: SCK CEN (Belgium), RATEN (Romania), University of Bern (Switzerland), GTK (Finland), BGS (United Kingdom), UPC/CIMNE (Spain), UFZ (Germany), EPFL (Switzerland), LEI (Lithuania), CNRS/ULorraine (France), ULiège (Belgium), CNRS/Navier (France), TU Delft (Netherlands), EURIDICE (Belgium), TU BAF (Germany), UKNNL (United Kingdom)
Links with previous or ongoing projects / work packages	EURAD-2 WP2 KM, WP10 ANCHORS, WP13 OPTI, WP15 DITOCO2030 and WP16 HERMES EURAD-1 WP6 GAS and WP7 HITEC
Main contact (name, email, phone number)	Arnaud Dizier (SCK CEN) arnaud.dizier@euridice.be Phone number: +32 14 332988
Additional information	

7.2 Working Groups presentations on the outcomes of their discussions

7.2.1 Working Group on Bitumen

Outputs of the discussion on the topic	- Bituminised Waste Product (BWP) has been produced in several countries - There is diversity in bitumen types/bitumen producers and waste composition across these countries - Localised knowledge and a lack of comparative research hinder broader understanding - It is necessary to verify and/or identify the key parameters and processes influencing BWP behaviour - Data/information about long term behaviour and interactions at repository conditions are required to improve predictive models for long term safety assessments
Consolidated topic short title	Behaviour of bituminised waste under storage and disposal conditions
Short description	This topic addresses the hydro-mechanical, radiolytic and physical-chemical behaviour of bituminised waste products (BWP) under storage and disposal conditions. It aims to minimise/close knowledge gaps related to water uptake, swelling, leaching, and degradation processes, which are critical for ensuring the long-term safety of radioactive waste disposal.
Type of WP	RD&D
Objectives of the WP proposal	- Swelling and leaching behaviour due to water uptake/interaction - Radiolytic and chemical degradation of bitumen - RN release - Legacy waste characterisation and possibilities of reprocessing - Operational safety – fire hazards and risks minimisation (working conditions, bituminised waste ignition temperature, etc. - Impact of increased ionic strength conditions
Added value for the national programmes and the EURAD-2 partners	- Address remaining knowledge gaps - Improvement of predictive models - Validation findings across different BWP types - Sharing of knowledge, expertise and methodologies
Potential links with current EURAD-2 WPs	WP7 L'OPERA – WP proposal as new WP or possible extension of WP7 L'OPERA
Alignment with EURAD-2 SRA	Pre-disposal (Theme 2) - 2.2.3 Conditioning Engineered Barrier Systems (Theme 3) - 3.1.4 Other wasteforms Disposal facility design and optimisation (Theme 5) - 5.4.2 Normal operations safety
Organisations involved	- Amphos 21 (Spain) - KIT-INE (Germany) - SCK CEN (Belgium) - UJV (Czech Republic)

Working Group representative	Petr Večernik (UJV) - petr.vecernik@ujv.cz

7.2.2 Working Group on Spent Fuel

Outputs of the discussion on the topic	Effect of temperature (80-90ºC) - Relevant for complementing the behaviour of SNF of planned work in SAREC WPs. Complementary to repository conditions, the studies will add value for the knowledge on early failure disposal scenarios and the interim storage conditions. - Knowledge Gaps identified for study within EURAD-2 by the SAREC SOTA Report and relevant to the work proposed here are as follows. For radionuclide release from the SNF matrix and grain boundary behaviour: - How dopants influence the UO2 surface with regards to the surface-mediated redox reactions involved in oxidative dissolution and the hydrogen effect need to better understood. - There are still some unresolved questions and discussions concerning what is behind the doping effect seen by 3-valent elements in the UO2 matrix. In addition, the observed effect of Th (4-valent) is not understood. - Results from model materials with highly mobile radionuclides (Cs, I) incorporated in the structure are also missing. - In general, there is a need to understand how grain boundaries participate in the dissolution process, such as the lattice mismatch or degree of non-stoichiometry. For spent fuel leaching experiments, novel methods to separate the grain boundary release from the gap and the matrix are needed.
Consolidated topic short title	Effect of Grain Boundary and Temperature on SNF behaviour
Short description	Task 1: Management/coordination of the WP Task 2: Knowledge Management Task 3: Effect of temperature on the Behaviour of Spent Nuclear PWR and SIMFUEL Fuels (Task 3 in SAREC) Experiments will be conducted under reducing conditions with High Burn-Up (HBU) SNF samples and by electrochemical studies on doped SIMFUELS at elevated temperatures (80-90°C). These studies will provide essential data on how temperature affects the leaching process in HBU SNF. Task 4: Study of Grain Boundary (Task 4 in SAREC) Role of grain boundary oxidation in FP release. Electrochemical corrosion/oxidation studies of three types of SIMFUELS to elucidate oxidation mechanisms, products and grain boundary and matrix dissolution rates under a range of conditions Task 5: Modelling (Task 6 in SAREC) The SERNIM model will be modified to introduce the effect of temperature.
Type of WP	RD&D
Objectives of the WP proposal	The proposal is presented as an extension of the SNF research studies presented in the SAREC WP, focussing on the characterisation of SNF and release studies under temperature and on release of key Radionuclides on HBU PWR and doped SIMFUELS specifically made for study of contribution from grain boundaries.

Added value for the national programmes and the EURAD-2 partners	- Work will be relevant to studies on dissolution behaviour during accident disposal scenarios, wet storage and DGR of different Fuel types. - Enresa (Spain) supports the study of the temperature effect on SNF leaching behaviour to complete relevant scenarios for the safety case - NWS (UK) need to dispose of a range of legacy high-burnup fuels in their inventory, and those planned for new-build nuclear. An increased understanding of the effect of higher temperatures on the dissolution behaviour of HBU SNFs will help them to optimise disposal concepts, container loadings etc.
Potential links with current EURAD-2 WPs	WP8 SAREC (tasks 3 to 6)
Alignment with EURAD-2 SRA	Disposal facility design and optimisation (Theme 5) Safety Case (Theme 7)
Organisations involved	- Eurecat (Spain) - JRC (EC) - KIT-INE (Germany) - Lancaster University (UK) - SCK CEN (Belgium) - UPC (Spain)
Working Group representative	Frederic Clarens Blanco (Eurecat) - frederic.clarens@eurecat.org

7.2.3 Working Group on Monitoring

Outputs of the discussion on the topic	- Energy harvesting for self-powered ***monitoring*** - Addition of new sensors, to wireless ***monitoring*** system & nuclear batteries as alternative to conventional chemical ones - Data management strategies (cleaning, labelling, and filtering) to extract high quality data from the ***monitoring*** systems System design of a ***monitoring*** system for ultra deep borehole disposal facilities
Consolidated topic short title	Advanced Monitoring Systems and Data Management
Short description	The works involve several technological developments aimed at advancing monitoring systems for demanded environments. The development of energy harvesting technologies to enable self-powered monitoring, reducing dependence on external energy sources and improving system autonomy and reliability over time. In addition, the upgrade of a wireless monitoring system with the integration of new sensors and the evaluation of battery alternatives to conventional chemical-based solutions. Another important task is the implementation of data management strategies, specifically data cleaning, labeling, and filtering, to ensure the generation of high-quality datasets suitable for accurate interpretation and informed decision-making. Finally, the project includes the system design of a monitoring solution for ultra-deep borehole disposal facilities, exploring the feasibility to address the technical and environmental requirements of these complex underground infrastructures.
Type of WP	RD&D
Objectives of the WP proposal	- Develop energy harvesting solutions that enable self-powered monitoring systems, minimising reliance on external power sources and ensuring long-term operational autonomy and reliability. - Integrate new sensors (vibrating wire) into a wireless communication system able to send the data though the EBS and hosting rock and investigate alternative nuclear battery technologies to replace conventional chemical ones, improving an existing innovative and non-invasive monitoring technology. - Design and apply effective data management strategies, including data cleaning, labeling, and filtering, to produce high-quality datasets that support accurate analysis and decision-making. - Implementing self-powered monitoring technology to design a robust monitoring system adapted for ultra-deep borehole disposal facilities, addressing their technical and environmental requirements to ensure effective and long-term monitoring.
Added value for the national programmes and the EURAD-2 partners	- Radioactive Waste is currently temporarily stored in different sites because due to the lack of availability of a National Repository (NR). The Italian National Strategy for RWM will consider a near-surface repository with four levels of engineered barrier systems (EBS), ensuring durability and safety for 300 years. So, integrating energy harvesting technologies into the NR will add significant value to the Italy National Programme. - The Spanish National Radioactive Waste Program (Seventh General Plan, 2023) outlines strategies for safe and responsible management of radioactive waste, including long-term storage

	solutions. With the improvements in wireless monitoring systems and longer battery autonomy, enhancing these technologies would add significant value by enabling continuous, efficient monitoring when the repository is to be closed. - Monitoring is one of the domains in the Private-Public Partnership between the waste agency (ONDRAF) and SCK CEN in Belgium. - The Dutch nuclear waste disposal research programme, coordinated by COVRA, explores various geological disposal options, including ultra-deep borehole disposal. Onsite monitoring during operations and long-term post-closure monitoring of the geological barrier are essential. Innovations in robust, reliable self-powered monitoring technology enhance the monitoring capabilities necessary for informed barrier integrity management.
Potential links with current EURAD-2 WPs	N.A.
Alignment with EURAD-2 SRA	Pre-disposal (Theme 2) Engineered Barrier Systems (Theme 3) Disposal facility design and optimization (Theme 5) Additional potential transversal links with Themes 4, 6 and 7
Organisations involved	- Amphos 21 (Spain) - ENEA (Italy) - SCK CEN (Belgium) - TNO (Netherlands)
Working Group representatives	Salvatore Angelo Cancemi (University of Pisa) - salvatore.cancemi@unipi.it Susana Tuñon Valladeres (Amphos 21) - susana.tunon@amphos21.com

7.2.4 Working Group on EBS Materials

Outputs of the discussion on the topic	Wide range of topics proposed - Ideas were discussed in Teams meetings - Finding common points - Which goals do we want to achieve - Scope of the project - Overlaps with other WP or previous projects Outcome keywords - EBS Materials - Robustness & passive safety - Innovative solutions - Sustainability
Consolidated topic short title	Materials for enhancing passive safety and robustness of Engineered Barrier Systems
Short description	The EBS is an essential part of any disposal system as a multibarrier system where each barrier provides its respective safety function. Enhancing passive safety and robustness of individual EBS components including waste form (primary package), container, backfill materials and sealing materials helps to optimize the entire disposal system. This work package we will focus on designing and improving material and manufacturing options.
Type of WP	RD&D
Objectives of the WP proposal	The current objective of the WP proposal is to develop EBS materials that improve robustness and passive safety of the overall system by: ➔ Materials and advanced industrial techniques to improve durability of metallic disposal containers - Application of industrially available high-performance build-up welding processes for different container materials - Investigation of improved manufacturing techniques for producing non-metallic protective coatings (ceramics, enamel) ➔ Develop sustainable innovative backfill materials to allow for waste matrix swelling and gas generation - Development of innovative cementitious composite backfill materials to accommodate for expansive processes including gas production and passive protection of other engineered barriers from mechanical degradation. ➔ Optimisation of closure/backfill material - Backfill/sealing materials should maintain their sealing properties under elevated temperature. By experimental laboratory studies the most suitable material can be determined. Material options include clays, bentonite-aggregate mixtures, rock-based backfills, and self-hardening materials with potential for low CO2 solutions.
Added value for the national programmes and the EURAD-2 partners	Finding innovative solutions that increase robustness and long-term safety of radioactive waste disposals by providing: ➔ Durable EBS materials and manufacturing options: - Welding technologies for optimisation of disposal containers to increase safety and robustness of the EBS. - Ceramic coatings ➔ Material design to prevent mechanical damage

	- Development of improved backfill material to offer practical solutions for managing expansive waste by allowing controlled expansion and minimizing water ingress into the waste, thereby reducing expansive reactions - Identification of improved closure/backfill materials to provide better starting points for optimizing closure practices and structures.
Potential links with current EURAD-2 WPs	WP9 InCoManD WP10 ANCHORS WP13 OPTI
Alignment with EURAD-2 SRA	Engineered Barrier Systems (Theme 3)
Organisations involved	- BAM (Germany) - BGS (UK) - GTK (Finland) - HZDR (Germany) - KIT-INE (Germany) - LUH (Germany) - SCK CEN (Belgium) - SIIEG NASU (Ukraine) - TU Delft (Netherlands) - UKNNL (UK)
Working Group representatives	Perko Janez (SCK CEN) - janez.perko@sckcen.be Heini Reijonen (GTK) - heini.reijonen@gtk.fi

7.2.5 Working Group on THMC Host Rocks

Outputs of the discussion on the topic	**Two main strategic directions emerged:** → Strategic Study to support the development of the next EURAD-3 programme RD&D focus on THMC (Thermal-Hydro-Mechanical-Chemical) coupling in the context of large-scale modelling and siting **Key Points:** - Modelling can help address knowledge gaps - Understanding heterogeneities and host rock behaviour is a shared challenge - Sensitivity analysis is important but may be limited by time or resources - Existing work (e.g., EURAD GAS) may inform future sensitivity analyses. - Funding limits must be considered — StSt can support modelling examples but not model development. **Conclusion:** The working group agrees to proceed with a Strategic Study (StSt) as a foundation for future R&D, recognising it as a more feasible and solid starting point.
Consolidated topic short title	Assessing the end user gaps and needs on THMC(B) properties of HR – defining a common strategy
Short description	Gap analysis: ➔ Based on current concepts, what do we know and what can be improved (insufficient knowledge)? What is the relevancy of the knowledge for understanding the functioning of a repository? What are the uncertainties associated and their impact on the GDF? How to upscale THMC(B) processes? ➔ How can these knowledge gaps be fulfilled? What effort is needed (impact /urgency matrix)? Gap analysis covering experiments, models, in situ monitoring data, etc. - Review of former EC projects (often focus on “single” aspects) to get a complete picture of the current state-of-knowledge and links with on-going projects. - Workshops with end-users – finding commonalities (form a firm basis for a next project). - What is important from national programmes (often goes beyond former EC projects) - Inventory of available datasets which may also uncover gaps. (link with KM WP) ➔ Propose research for a potential next RD&D programme - Propose strategy for early-stage programmes - Defining an experimental programme including protocols, with a special emphasis to tailor experimental conditions (lab) to the needs coming from gap analyses (specific conditions,…) - Defining constitutive laws/models upscaling approaches - Defining modelling approaches (coupling processes & spatio-temporal scales), sensitivity analyses Interactions with End users are crucial at each step.
Type of WP	Strategic Study
Objectives of the WP proposal	Exhaustive gap analysis to pinpoint the needs

	Define a targeted RD&D strategy based on the defined needs from early stage to more advanced programmes
Added value for the national programmes and the EURAD-2 partners	The aim of this Strategic Study is to map gaps and the needs of the national programmes related to THMC(B) properties of all relevant host rocks. By involving the end users at the early start of the Strategic Study, and even already during the preparation phase of this potential Strategic Study, there will be a clear focus on the national needs. By further processing the needs and ranking them (using for instance impact/urgency or other types of matrices), the priorities for the coming decade can be determined, which will be a solid foundation for future RD&D.
Potential links with current EURAD-2 WPs	WP2 KM WP10 ANCHORS WP13 OPTI WP15 DITOCO2030 WP16 HERMES
Alignment with EURAD-2 SRA	Engineered Barrier Systems (Theme 3) Geoscience (Theme 4) Disposal facility design and optimisation (Theme 5) Safety Case (Theme 7)
Organisations involved	- BGS (UK) - GTK (Finland) - RATEN (Romania) - SCK CEN (Belgium) - University of Bern (Switzerland)
Working Group representative	Arnaud Dizier (Euridice) - arnaud.dizier@euridice.be

7.2.6 Working Group on Recycling

Outputs of the discussion on the topic	**Scope in the initial phase**: - Broader than recycling (waste hierarchy) - Specific clearance & reuse in the nuclear industry - Current & future waste streams (incl. next generation facilities) Input **information is available** and/or in development (e.g. EURAD, HARPERS, IAEA) - We should effectively use it (not straightforward) - Collaborative RD&D **Potential activities**: inventory analysis and identification of recycling and reuse strategies; selection of case study(s); focus on metals & update RP89, addressing technical, environmental, economic and societal challenges; regulatory compliance, public engagement and transparency, etc. **Output**: Guidance supported by case study(s)
Consolidated topic short title	CLEARR (Circular Lifecycle Evaluation and Assessment for Reuse and Recycling)
Short description	**Analysis of the waste stream inventories** and identification of **reuse and recycling options**/strategies (e.g. large waste streams and/or complex waste streams) Implement **case studies** - Selection based on selection criteria to be developed - Detailed analysis of reuse and/or recycling process(es) necessary for dose impact study - Perform dose impact study (regulatory compliance, reliability, benchmarking, uncertainties, confidence levels/ levels of conservatism, mixing & heterogeneity factors, etc.) Address technical, environmental, economic and societal aspects (incl. public engagement and transparency). Output: **Guidance supported by case study(s), communication, dissemination, training**
Type of WP	RD&D
Objectives of the WP proposal	Advance circular practices in the nuclear industry through effective reuse and recycling, in line with the European Circular Economy Strategy
Added value for the national programmes and the EURAD-2 partners	Generally in line with circular economy strategy & sustainable waste management Economic benefit (including the need of small inventory member states)
Potential links with current EURAD-2 WPs	WP3 ASTRA WP4 FORSAFF WP5 ICARUS WP6 STREAM

Alignment with EURAD-2 SRA	Pre-disposal (Theme 2)
Organisations involved	- CNRS (France) - Lancaster University (UK) - NCSRD (Greece) - Politecnico di Milano (Italy) - SCK CEN (Belgium) - SIIEG NASU (Ukraine) - Tractebel (Belgium)
Working group representative	Sven Boden (SCK CEN) - sven.boden@sckcen.be

7.2.7 Working Group on Siting

Outputs of the discussion on the topic	Linked to the short description segment
Consolidated topic short title	Developing site screening strategies and procedures for integrated site descriptive models
Short description	**Developing site screening strategies and procedures for integrated site descriptive models** ➔ Task 1: Site screening strategies and communication - Reviewing existing literature and expert knowledge to compile experiences and best practices and validating site model workflows. - Geoscientific, environmental and socio-economic siting criteria, scoring and ranking procedures, and related GIS-based analysis processes including data quality management. - Development of policies and best practices for site screening processes. - Assessment of alternative sites, e.g. develop screening criteria applied for candidate sites of SMR including procedures for waste management. ➔ Task 2: Progressive development of Site Descriptive Models in connection of various siting stages - Description and flow model chart on the iteration and refinement of the model as investigations proceed. - Establishing a stepwise modeling approach with consideration of different objectives and models for the various siting stages. - Prediction-Outcome approach and feedback loop in the development and updates of site descriptive models at the various stages of investigations. - Guidelines for robust and transparent documentation to ensure open and representativeness of modelling steps. ➔ Task 3: Defining a comprehensive set of methods for fast and efficient evaluation of borehole data - Developing minimum parameter sets for provisional site assessment and extended parameter sets for subsequent in-depth site investigation, derivation of criteria to evaluate required spatial resolution (link to Task 2 and Task 4). - Using existing and new borehole data (core logging, chemistry, temperature, …) to test methods related to machine learning and compare them to conventional data analysis methods. - Developing tools for upscaling and sensitivity analysis, including machine learning (ML) and statistical methods, to contribute to the derivation of effective parameters (e.g. rock properties such as permeabilities, diffusion coefficients or radionuclide (RN) retention parameters). - Benchmarking exercises may be applied to build confidence in different approaches and models (link to Task 2). ➔ Task 4: Development of tools and workflows towards integrated models for the assessment of the long-term evolution of the disposal facility and the surrounding geosphere - Enhancement of numerical tools for coupling existing subsidiary models to build integrated geosphere models, to improve the understanding of large scale and long-term processes on repository safety in different geological settings.

	- Development of large-scale models will feed in the definition of parameters sets and processes to be investigated in different stages of the siting process (link to Task 2 and Task 3). - Novel model development and assessing representativeness for various test sites, with special emphasis on workflow management associated with different site characteristic data and models (link to Task 2). - Gathering data, knowledge and best practices from different test sites to benchmark procedures and the research needs in the future (link to Task 2).
Type of WP	RD&D
Objectives of the WP proposal	- Compilation of current best practices - Transparent and learned methods for Siting Criteria and Site Descriptive Models - Robust workflow for constructing Site Descriptive Models - Integration of various discipline-specific Site Descriptive Models
Added value for the national programmes and the EURAD-2 partners	- Ensure that state-of-the-art techniques are available to interpret and model site characterization information to all stakeholders - Progressive development of Site Descriptive Models with proposed workflows - Establishing a reference framework for Site Descriptive Modelling - Strengthening credibility of site descriptive models and management of uncertainties, ensuring continuous improvement and adaptability to new data and/or interpretations.
Potential links with current EURAD-2 WPs	WP2 KM WP11 CLIMATE WP15 DITOCO2030 WP16 HERMES
Alignment with EURAD-2 SRA	National Programme Management (Theme 1) Geosciences (Theme 4) **Siting and Licensing (Theme 6)** Safety Case (Theme 7)
Organisations involved	- ENEA (Italy) - GFZ (Germany) - GTK (Finland) - RATEN (Romania) - SIIEG NASU (Ukraine) - University of Bern (Switzerland)
Working Group representative	Mirjam Kiczka (University of Bern) - mirjam.kiczka@unibe.ch

7.2.8 Working Group on Glass

Outputs of the discussion on the topic	**The discussions were based on two proposals:** - R&D study on dissolution behaviour of vitrified waste in long-term conditions (link with EURAD-ACED) - Strategic study collecting national strategies related to HLW disposal research **There was agreement that the strategic study is required** - There is no clear international (European) research strategy on vitrified waste - No clear view on knowledge gaps - Need to preserve knowledge and thus to continue research - Priority given to strategic study, which can constitute basis for future R&D work on vitrified waste, including new formulations - Link with knowledge management **Involvement of the WMO is essential** **R&D on vitrified waste is still useful because glass is a key material for the conditioning of radioactive waste and knowing the behaviour of glasses in their disposal environment is essential** - Support the **safety case** for geological (and surface) disposal - Optimise (new) **glass formulations – also for Low Level Waste** - **Surface analytical techniques** have much improved in the last decennium - A **common concern** among European countries with vitrified waste for disposal, and beyond Europe
Consolidated topic short title	Strategic Study on the Long-Term Behaviour of Nuclear Waste Glasses in Disposal Conditions
Short description	**Comparison of national research strategies (WMO)**, resulting in a document highlighting the similarities and differences in the approach of the participating countries. Map the **Current Knowledge Base and Capabilities (RE)** - Conduct a state-of-the-art review of current understanding of glass behaviour in disposal environments: mechanisms and predictive modeling capabilities (last European state-of-the-art report on glass behaviour dates from 2008) - Inventory existing experimental facilities, databases, and simulation tools across Europe Identify **Knowledge Gaps** and **Strategic Priorities (WMO + RE)** - Identify gaps in fundamental understanding, modeling, and long-term experimental validation - Analyse uncertainties and limitations in the source term (glass + EBS) in the current safety assessments - Prioritise research questions (experiments + modelling) that have high impact on safety and feasibility of disposal - Suggest opportunities for shared infrastructure, joint experiments, or collaborative modeling platforms **Deliverables and Communication** - Publish a strategic report summarising findings, priorities, and the proposed roadmap - Establish a European network in research on vitrified waste

	➔ Objective: Strengthen and assure long-term cooperation in Europe and to implement the agreed strategic approach in EURAD-2
Type of WP	Strategic Study
Objectives of the WP proposal	- Create a basis for joint research programmes through the identification of key scientific challenges - Establish a European network of stakeholders (RE, WMO) for the implementation of an agreed strategic approach in EURAD-2 • Regular information exchanges on ongoing and planned research • Learn from each other's experience • Setup of complementary research programmes (possibly with harmonised procedures but using materials of national interest) • Optimise the use of national resources and of experimental, analytical and modeling capacity - Contribution to knowledge management documenting research strategy - Output to serve as basis for optimal RD&D proposals in EURAD-3
Added value for the national programmes and the EURAD-2 partners	- **Strengthen the common scientific foundation:** pool knowledge, data, and models; reduce uncertainties; identify key scientific challenges - **Unite expertise and resources:** promote the sharing of infrastructure; build a critical mass of researchers and support the training of young scientists - **Contribute to the robustness of geological disposal safety cases** and foster greater public confidence
Potential links with current EURAD-2 WPs	WP6 STREAM WP7 L'OPERA WP8 SAREC WP9 InCoManD WP13 OPTI
Alignment with EURAD-2 SRA	National Programme Management (Theme 1) - 1.1.1 National RWM Policy - 1.3.3 International collaboration Pre-disposal (Theme 2) - 2.2 Implementation - 2.2.3 Conditioning Engineered Barrier Systems (Theme 3) - 3.1 Wasteforms - 3.1.2 HLW Safety Case (Theme 7)
Organisations involved	- CEA (France) - HUN REN (Hungary) - IMT Atlantique – CNRS (France) - Juelich (Germany) - KIT-INE (Germany)

	- SCK CEN (Belgium)
Working Group representative	Karel Lemmens (SCK CEN) - karel.lemmens@sckcen.be

7.2.9 Working Group on Programme Management

Outputs of the discussion on the topic	- Strong agreement on the need for a holistic, robust long-term planning during all phases of geological disposal programmes. - Limited resources, data and experiences create gaps in requirement management, RD&D roadmap structuring, participatory and long-term governance. - Clear challenges in ensuring durable, long-term knowledge, skill and responsibility management. - Opportunities for consolidating lessons and good practices from various programmes and scientific and industrial fields, and transferring them in a structured, actionable way. → Developing practical templates, guides, and frameworks for robust requirement management and participatory governance → Tailoring outputs particularly to Early-Stage and Small Inventory Programmes, while also addressing experiences and challenges of more established programmes → Providing conceptual governance models for long programme lifecycles - Often-recurring limitations in financial, technical, and human resources, as well as incomplete site-specific data. - Existing guidance is often geared towards early stages of programme management — a gap exists for actionable tools tailored to constrained contexts and long-term governance. - Supports equitable access to best practice and knowledge, fostering safety, socially robust, and efficient programme management regardless of starting point. - Contribute to long-term safety, by improving knowledge transfer and maintaining vigilance. - While the future is unknown, planning and institutionalisation (emphasising both adaptability and continuity) contributes to future-proofing long-term governance.
Consolidated topic short title	**BRIDGE:** Best pRactice Integration for the Development of robust GEological disposal programme management
Short description	- Developing a **practical, holistic framework** for managing geological disposal programmes in **contexts with limited resources, data or operational experience** - By integrating **reflections, lessons and experiences** into **scalable tools and guidance** for requirements management, RD&D planning, governance, and stakeholder engagement - Emphasising the need for **long-term governance thinking and actions**, even (or especially) during early stages of programme management Scope: - Requirements management frameworks for environments with limited resources, data and/or experiences - RD&D roadmap methodologies responsive to these resource constraints - Best practices for meaningful long-term participatory governance - Approaches to intergenerational responsibilities and knowledge management - Governance structures capable of phase-specific adaptation over time

Type of WP	Strategic Study
Objectives of the WP proposal	- Develop a requirements and programme management framework for resource-constrained contexts. - Identify challenges and enabling factors for long-term participatory governance and knowledge management. - Produce scalable RD&D roadmap templates and frameworks for building and sustaining key competencies and practices.
Added value for the national programmes and the EURAD-2 partners	- Provides practical, scalable solutions for programmes operating under constrained conditions. - Promotes knowledge transfer between different national and international contexts, strengthening collective safety and implementation capacity. - Facilitates alignment with EURAD Roadmap and SRA objectives, across MS in various stages of programme development and implementation.
Potential links with current EURAD-2 WPs	WP2 KM WP11 CLIMATE WP13 OPTI
Alignment with EURAD-2 SRA	National Programme Management (Theme 1) Siting and Licensing (Theme 6) Safety Case (Theme 7)
Organisations involved	IST-ID (Portugal) KIT-INE (Germany) RATEN (Romania) SCK CEN (Belgium) University of Tartu (Estonia)
Working Group representative	Robbe Geysmans (SCK CEN) - robbe.geysmans@sckcen.be

7.2.10 Working Group on Natural Analogues

Outputs of the discussion on the topic	- Overall ideas for the NA topic were discussed by the participating working group members + additional REs that joined the discussion - The variety of topics was discussed based on initial proposals - Objectives included in the initial proposal by REs: • State of the art- review (all repository types, wastes and EBS combinations) • Glass analogues • Copper and steel corrosion analogues • Buffer – backfill – closure analogues • Earth (multi-layer) covers • Clay host rocks • Tracer analogues • Climate related analogues - The previous WP proposal was rejected as the topics were considered to be too broad for the WMO college mainly - Discussions regarding the NAs in general (is there something to change in the NA concept?) and their use in stakeholder communications (this was seen very important by many partners) - More in-depth discussions are needed – are NAs often misunderstood or misused? - After thorough discussions the working group agreed to propose a **Strategic Study** which would help obtain a holistic view what R&D is needed in this field to help closing knowledge gaps, reduce uncertainties or increase robustness.
Consolidated topic short title	Natural analogues – strategic review of holistic utilisation of NAs in radioactive waste disposal (NATSTRAT)
Short description	- In recent literature, **several gaps** have been identified where no NA work has been undertaken, despite identification of potential sites. In addition, there are **unexplored topics**, especially related to LILW and less studied EBSs (e.g. steel, earth covers), external processes, biosphere analogues, industrial analogues. - The strategic study would focus on **defining state of the art** and **critical gap analysis** on NAs (including archaeological and industrial) for HLW, LILW, and LLW concepts, as well as providing **guidance for holistic use of NAs in disposal programmes.** - The project would aim at identifying NAs that are crucial to informing the knowledge gaps, providing evidence thus reducing key uncertainties in the safety cases, and /or aid optimisation / robustness of the repository systems.
Type of WP	Strategic Study
Objectives of the WP proposal	- Revisiting/redefining the use of analogues to support various stages of geological disposal programmes and components of the safety case - Promoting mutual understanding through the co-interpretation of natural analogues in experts – civil society communication - Based on the national examples of recent NA reviews and expansion to cover currently missing repository concepts (e.g. surface) in EU (+UK and CH), an NEA iFEP based compilation of the exiting NAs and their use in safety cases will be collected

	- Structured gap analysis will be performed, and based on: ➢ Provided topics for future work, including a preliminary assessment of the sites / samples (accessibility, field of work / sampling feasibility, sample quality if existing samples etc.), leading to a need of reconnaissance visits. ➢ These can be ranked by national organisation regarding programme specific importance/urgency ➢ Assess where the need for model validation and extrapolation for longer time scales is most needed
Added value for the national programmes and the EURAD-2 partners	- Holistic understanding of the current status of NA research - Way forward for different repository concepts - Well established research plans for future work to provide data on processes repository relevant timescales - NAs are of interest also for countries outside EURAD-2 – potential for global collaboration - Natural Analogue Working Group (NAWG) is a scientific collaboration that is volunteer based (not funded) – new NA project funded by EURAD-2 would help to proceed overall scientific goals in the field of NAs (knowledge base from NAWG can be used)
Potential links with current EURAD-2 WPs	WP2 KM WP4 FORSAFF WP6 STREAM WP7 L'OPERA WP9 InCoManD WP10 ANCHORS WP11 CLIMATE WP12 RAMPEC WP13 OPTI WP14 SUDOKU
Alignment with EURAD-2 SRA	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)
Organisations involved	- Amphos 21 (Spain) - BGS (UK) - CEA (France) - GTK (Finland) - KIT-INE (Germany) - SCK CEN (Belgium) - SIIEG NASU (Ukraine) - TNO (Netherlands) - TU Delft (Netherlands) - UKNNL (UK) - University of Bern (Switzerland) - UFZ (Germany)
Working Group representative	Heini Reijonen (GTK) - heini.reijonen@gtk.fi

7.2.11 Working Group on Conditioning

Outputs of the discussion on the topic	Initial ideas: - LFR waste management - Conditioning of pyrolysis ashes/concentrates evaporator and sludge - Advancing characterisation of LILW - Development of robust and versatile conditioning matrices suitable for various waste streams Discussions: - SMR waste management - Incineration ashes were considered in WP6 STREAM - Characterisation & waste treatment would not be the focus of this proposal, as already part of the ICARUS and STREAM WP activities Consolidated principles: - Non-specific waste streams - Partners' interest to serve as common ground - Benefit from current WPs but advancing - Address the current challenges of robustness and versatility in waste conditioning.
Consolidated topic short title	Development of robust and versatile conditioning matrices for challenging waste streams
Short description	- Develop of a robust and widely applicable conditioning matrix for various waste streams (Screening + Optimisation) - Alkali-activated based matrices • Compatible with a wide range of waste types (organic, high salt, metallic, chemical conditions…) • Beneficial properties compared to cement-based materials (easy tailoring, low leachability, no problem of ASR and DEF, versatile to modifications of waste and precursor material, high loading capacity) • Sustainability (using by-products from industry) → LCA/LCC. - Identification of waste streams compatible with AAM: e.g. SIER, pyrolysis ashes, SMR related waste (lead, salt,…) - Robustness testing for variability in waste and precursor (physico-chemical) compositions • Basic Performance testing towards generic WAC - Modelling long-term performance
Type of WP	RD&D
Objectives of the WP proposal	Develop a robust and widely applicable conditioning matrix for different waste streams and demonstrate it. - Ready-mixed matrices: waste & matrix → stable wasteform - Easy to implement at the industrial scale - Benchmarking testing protocols for AAMs & demonstrate compliance with generic WAC → recommendations towards decision-makers.

Added value for the national programmes and the EURAD-2 partners	- Solutions for challenging waste streams - Wider partner interest
Potential links with current EURAD-2 WPs	WP4 FORSAFF WP5 ICARUS WP6 STREAM WP7 L'OPERA
Alignment with EURAD-2 SRA	Pre-disposal (Theme 2) - 2.1.1 Inventory - 2.1.2 WAC - 2.2.3 Conditioning
Organisations involved	- ENEA (Italy) - SCK CEN (Belgium) - SIIEG NASU (Ukraine) - Tractebel (Belgium) - VTT (Finland)
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