

## EURAD-2 2nd wave Template #2

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Short Acronym and full Title	ASTRAD - Alternative strategies research and development		
Type of activity	<input checked="" type="checkbox"/> R&D	<input type="checkbox"/> Strategic Study	
Budget estimation (total budget in M€, i.e ~ 1.5 M€)	2 M€	Duration of the WP (in months)	36
Links with EURAD SRA / Roadmap Themes  (if multiple choices, indicate the primary link in bold – maximum 3)	<input checked="" type="checkbox"/> <b>Programme Management (Theme 1)</b> <input checked="" type="checkbox"/> Pre-disposal (Theme 2) <input type="checkbox"/> Engineered Barrier Systems (Theme 3) <input type="checkbox"/> Geoscience (Theme 4) <input checked="" type="checkbox"/> Disposal facility design and optimisation (Theme 5) <input type="checkbox"/> Siting and Licensing (Theme 6) <input type="checkbox"/> Safety Case (Theme 7)		
Links with EURAD SRA topics  (if multiple choices, indicate the primary link in bold – maximum 3)	- 1.5.1 (Integrated waste management routes and strategic options) - 2.2.4 (Storage) - 5.2.2 (Optimisation)		
SRA drivers (maximum 3)	<input type="checkbox"/> Implementation Safety	<input checked="" type="checkbox"/> Tailored Solutions	<input type="checkbox"/> Scientific Insight
	<input type="checkbox"/> Innovation for Optimisation	<input checked="" type="checkbox"/> Societal Engagement	<input checked="" type="checkbox"/> Knowledge Management
Objective (What) – 1 sentence	To generate and integrate a multi-disciplinary, evidence-based, socially accepted, and practically usable decision-support framework that enhances SIMS ability to evaluate long-term storage, DBD, and other alternative radioactive waste management strategies.		
Justification: impact / innovation / added-value	Across Europe, Small Inventory Member States (SIMS) continue to face a strategic challenge in managing radioactive waste. Many depend on interim storage facilities and waste packages that are now exceeding their original design lifetimes, requiring modelling tools and/or look-up tables to ensure		

<p>(Why) – bullet points or short paragraph (maximum quarter of a page)</p>	<p>ongoing safe storage and to assess options for final disposal under evolving climatic conditions. At the same time, they often lack financially viable routes to establish national geological disposal facilities. Alternative strategies such as Deep Borehole Disposal (DBD) remain conceptually attractive but are still underdeveloped, with limited safety-case structures, feasibility criteria, and practical tools to support decision-making.</p> <p>The tools and look-up tables developed through this work will support both SIMS and LIMS in selecting long-term waste management solutions that account for uncertainties in historical waste information, changing environmental conditions, and growing societal expectations around transparency, safety, and intergenerational responsibility.</p>
<p>List of planned tasks / subtasks with % of effort per task (5% increments)</p> <p>(Maximum 10 bullets)</p>	<p><b>Tasks 1. Management (5%) and</b></p> <p><b>Task 2. Knowledge Management (20%): 2.1 and 2.2 as required.</b></p> <p>2.3 Live Discussion Forum (LDF): Continuation of Live Discussion Forum (LDF) to support knowledge transfer expressed by SIMS and LIMS, offering a direct communication between both, building on the results from ASTRA Task 5.1.</p> <p>2.4: The SIMS–LIMS Demonstrator</p> <p>The SIMS–LIMS Demonstrator goal is to solve selected SIMS issues with the help of MS with more advanced programmes (MAP) by analysing solutions, identifying best practices (across the whole waste management lifecycle) through targeted, problem-focused exchanges.</p> <p><b>Task 3. Development of a Next-Generation Decision-Support Framework for End-of-Life Waste Management Storage Solutions and Disposal Options (30 %)</b></p> <p>3.1 Decision support database for end-of-life management of storage facilities and waste packages This work focuses on establishing a structured, consolidated, accessible repository of practices and challenges that supports end-of-life decision making for storage facilities and waste packages. It will include: understanding partners waste types, applied options on facilities and packages and create a look up table of long-term storage facilities.</p> <p>3.2 Predictive modelling for long-term package and barrier evolution This part aims to advance predictive modelling capabilities to enhance understanding and anticipate long-term waste package degradation, container alteration, and storage barrier performance to support long-term safety decisions. The task includes: develop digital twins to support end-of life considerations (a follow-up activity of PREDIS WP7), Extend modelling to changing environmental/degradation conditions, Developing and validating models and tools with available data on degradation processes to predict waste package degradation to assess and initiate necessary measures for safe long-term storage in advance and/or final disposal options requirements (near surface, DGR, DBD).</p> <p><b>Task 4 : Development of tools and methodologies to support progress towards a DBD prototype (35%)</b></p>

	<p><b>4.1 Models for Building A Generic Operational Safety Case</b></p> <p>This is a challenging area for the DBD concept as some aspects, e.g., the emplacement of waste packages into the borehole, has not been demonstrated, in particular for higher activity waste packages. Task will include: A method to identify wastes suitable for DBD disposal, Development of a conceptual approach to waste emplacement, Addressing potential operational hazards.</p> <p><b>4.2 Predictive modelling for long-term package and barrier evolution</b></p> <p>This work will focus on the post closure safety-case, emphasizing the key role that the host rock plays in isolating and containing the waste. It will: Use reactive transport models and thermochemical databases adapted to conditions expected at the significant depths envisioned for DBD, evaluate changes in groundwater flow, chemistry, and potential for radionuclide transport and establish long-term performance criteria for borehole seals and engineered barriers. Modelling in task 3 provides initial state for long-term modelling done here.</p> <p><b>4.3 Decisions pathways needed for DBFT implementation</b>The need for a Deep Borehole Field Test (DBFT) was repeatedly highlighted during Wave 1 as a necessary and urgent step in progressing the DBD concept. Previous experience in the USA, where a DBFT was halted, has demonstrated that clear communication and dissemination channels are required for a successful testing experiment. Task 4.3 will develop tools for Member States to foster the effective dialogue needed to reach consensual decisions for a DBFT.</p> <p><b>Task 5. Decision-making frameworks enhanced by civil society interactions (10 %)</b></p> <p>5.1: Structured dialogue of CS members with tasks 3 and 4 as contribution to the research processes, through joint tasks meeting, tailoring the decision-making framework to the tasks topics.</p> <p>5.2: Alternative strategies decision-making frameworks : contribution via documents and pluralistic workshops on transparency and public participation aspects of these frameworks, and elaboration of an alternative assessment tool via collective scenario assessment methodologies.</p> <p>5.3 : Building shared recommendations for trust-building processes on alternatives assessment, via transversal workshop in collaboration of tasks 3,4 and 5.</p>
<p>List of expected outcomes linked to the identified SRA drivers <b>(Maximum 6 bullets)</b></p>	<ul style="list-style-type: none"> <li>• Develop a harmonised, practical methodology for assessing risks and management needs of extended long-term storage in SIMS. (Tailored Solutions)</li> <li>• Produce a Generic European Safety Case Framework for DBD and a set of feasibility criteria allowing SIMS to compare DBD with other options. (Tailored Solutions)</li> <li>• By integrating technical assessment, safety-case logic, waste-stream strategies and governance considerations into one unified system, the project will deliver a <b>complete, actionable decision-support framework</b> enabling countries to make informed, responsible and</li> </ul>

	<p>transparent, publicly legitimate choices on their future radioactive waste management strategies.</p> <ul style="list-style-type: none"> <li>• Modelling tools and look-up tables for end-of-life considerations (Scientific insight)</li> <li>• LIMS-SIMS-demonstrator how to use tools, options for final disposal of different wastes (near-surface, DGR, DBD) (Tailored solutions/Innovation for Optimisation)</li> </ul>
<p>Deliverables (Maximum 6 – including the prescribed deliverables)</p>	<ul style="list-style-type: none"> <li>• Initial SOTA</li> <li>• Final SOTA</li> <li>• Impact to member states report</li> <li>• Task 3 Developed tools with application</li> <li>• Task 4 Report on Progress towards a DBD Safety Case</li> <li>• Task 5 Decision-making framework for alternative strategies assessment</li> </ul>
<p>Critical input requirements &amp; identified risks</p>	<p>Critical input:</p> <ul style="list-style-type: none"> <li>• SIMS participation to identify their needs.</li> <li>• LIMS participation to discuss solutions for these needs.</li> </ul> <p>Risks: there are varying needs of wide scope, so this WP must remain very focused on critical R&amp;D technical issues.</p>
<p>(Optional - Explain what is out of the scope?)</p>	
<p>List of preliminary interested organisations as partners in the WP contributing effort; % of effort (person months, by College)</p>	<p>WMO: ANDRA (FR), NES (AU), Sogin S.p.A (IT), COVRA (NL), ARAO (SL), DEKOM (DK)</p> <p>TSO: EIMV (SL), FTMC, NRG PALLAS (NL), NTW (EU), SSTC NRS (UA), SURO (CZ), VTT (FI)</p> <p>RE: AtkinsRealis (UK), Egis (FR), CVUT (CZ), GTK (FI), GSL(UK), IST-ID (PT), SCK CEN (BE), UNIPI (IT), Remondis (NL), SIIEG NASU (UA), TNO (NL), UTARTU (EE), POLIMI (IT), DMT (GE), PSI (CH)</p>
<p>If applicable - links with previous projects / work packages</p>	<p>EURAD-2 ASTRA, EURAD-1 ROUTES, EURAD-2 CLIMATE,</p>
<p>WP Preparation Team (1 member per College) contact (organisation + person, email)</p>	<p>ASTRA Board (M Vuorio, COVRA, marja.vuorio@covra.nl; J Begg, Egis, james.begg@egis-group.com, B Horvat, EIMV, barabra.horvat@eimv.si)</p>