EURAD-2 WP description Template #2

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

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Short Acronym and full Title	FORSAFF Waste Management **for S**MRs **a**nd **F**uture **F**uels		
Type of activity	☐R&D	☒Strategic Study	Knowledge Management – covered by a separate committee and template
Budget estimation (total budget in M€, i.e ~ 1.5 M€)	1M€	Duration of the WP (in months)	18
Links with EURAD SRA / Roadmap Themes (if multiple choices, indicate the primary link **in bold – maximum 3**)	☒**Programme Management (Theme 1)** ☒Pre-disposal (Theme 2) ☐Engineered Barrier Systems (Theme 3) ☐Geoscience (Theme 4) ☒Disposal facility design and optimisation (Theme 5) ☐Siting and Licensing (Theme 6) ☐Safety Case (Theme 7)		
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** 3.1.1 SNF	Assess possible strategies for SMR waste management and improve understanding for potential future quantities of waste arising from SMRs (and other new types of fuel), including the characteristics, location, ownership (responsible organisation) and amounts, in accordance with an appropriate classification scheme. Optimisation, safety and risk assessment of spent fuel (SF) management and disposal operations (including new upcoming designs e.g., ATF, SMR's), by characterising their physical and thermo-mechanical-chemical behaviour following state-of-the-art techniques (e.g., Machine Learning, AI).	

<table>
<tr><td></td><td colspan="3">1.1.3 Public information and participation

Ensure that public information on radioactive waste and spent fuel and a process for public participation are available.</td></tr>
<tr><td rowspan="2">SRA drivers (maximum 3)</td><td>☐Implementation Safety</td><td>☒Tailored Solutions</td><td>☐Scientific Insight</td></tr>
<tr><td>☒Innovation for Optimisation</td><td>☒Societal Engagement</td><td>☐Knowledge Management</td></tr>
<tr><td>Objective (What) – 1 sentence</td><td colspan="3">Provide outcome guidance for stakeholders to make informed decisions on SMR and advanced reactor deployment and supplier options, with respect to nuclear waste management. In particular, understanding the disposability of wastes arising from proposed SMRs and advanced reactors (relative to the potency of the underpinning knowledgebase) and the reprocessing of SMR spent fuels will be critical to inform deployment decisions.

As a strategic study, this WP aims at developing guidance and to analyse data gaps on SMR and advance reactors waste management.</td></tr>
<tr><td>Justification: impact / innovation / added-value (Why) – bullet points or short paragraph (maximum quarter of a page)</td><td colspan="3">To meet the world’s energy demands, small modular reactors (SMRs) and advanced reactor concepts are currently being developed. Despite their many perceived advantages, the deployment of SMRs and advanced reactors will require meeting numerous challenges. One of the biggest challenges is the management of spent fuel and radioactive waste generated from their operation and decommissioning. This challenge involves not only disposal but includes the possible reprocessing of spent fuels as well. There are a large variety of designs, technologies, and potential applications for SMRs and advanced reactors which will have profound effects on waste management strategies and technical pre-disposal and disposal solutions. These impacts need to be fully considered in the decision-making processes for incorporating these reactors into energy production networks. Socio-technical aspects as public engagement and technology acceptance need to be also included in this WP to optimize the outcome of the technical work within the WP.</td></tr>
<tr><td>List of planned tasks / subtasks with % of effort per task (5% increments)

(Maximum 10 bullets)</td><td colspan="3">• Task 1: Management/coordination of the WP, max 10%
• Task 2: Knowledge Management (incl. training materials development and State-of-the-Art for R&D WPs, etc.), at least 10%
• Task 3: Waste Generation (30%)

Identify the full scope of waste generation (source terms, waste streams and inventories) relative to SMR and advanced reactor designs (e.g., light water reactors, high-temperature gas-cooled reactors, molten salt reactors, liquid metal cooled reactors, marine-based), operating conditions and fuel cycle options. Discussions with SMR/MAR designers will be integrated within this task, with the formation of an End-User group as a target to collect the maximum feedback from the designers side. Additionally, energy production scenarios (power generation, district heating, desalination, etc.) should be explored to evaluate future waste arisings.</td></tr>
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	• Task 4: Waste Management (including disposal and reprocessing options) (25%) Assess predisposal (treatment, conditioning, storage, transport) approaches and development needs (and sharing thereof) in terms of anticipated waste generation across SMR and advanced reactor designs and operating conditions including characterisation methods and needs. Explore spent fuel reprocessing options in the backend of the fuel cycle for SMRs and advanced reactors. Examine disposal routes for SMR and advanced reactor wastes across a range of end-user needs considering conventional as well as more novel concepts (shared facilities, deep borehole disposal) as well as harmonisation of waste schemes under IAEA and EC guidelines, disposability issues and evaluation of the SMR and advanced reactor waste within the current waste acceptance criteria. • Task 5: Policy and Regulatory Framework (5%) Determine the need to adjust national policies and regulatory frameworks to support SMR and advanced reactor fuel cycle and waste management. Although policy and regulation is not included within the SRA updated agenda as a primary topic, it is a relevant issue that cannot be neglected. Thus, we propose to include this task within the WP on a relatively low effort basis by taking full advantage of the work already performed by IAEA and others, i.e., ELSMOR project. • Task 6: Stakeholder Engagement (20%) Identify stakeholder perceptions and concerns related to SMR waste management and develop recommendations for transparent information exchange and dialogue. Foster the use of digital technologies for improving the communication with public. For each Task a milestone document will be prepared including the main conclusions and outcomes.
List of expected outcomes linked to the identified SRA drivers **(Maximum 6 bullets)**	• Descriptions of source terms, waste streams and inventories for SMRs and advanced modular reactors. • Specifications of backend considerations including waste management options, reprocessing and infrastructure needs. • Spent fuel and radioactive waste management cost estimates for SMR and advanced reactor design families.
Deliverables **(Maximum 6 – including the prescribed deliverables)**	• D1. State of the art (SoTA) review on the challenges in SMR and advanced reactor waste management and fuel cycle considerations. Delivery date: Month 6. • D2. Green paper - Guidance on SMR and advanced reactor implementation and deployment needs from the back end of the fuel cycle perspective; an overall vision from the 3 colleges. Delivery date: Month 15. • D3. White Paper - Identification of knowledge gaps for future RD activities. Delivery date: Month 18.

Critical input requirements & identified risks	• Engagement of SMR designers to already know the impact of the expected waste is an important plus for this this WP • Time frames of SMR deployment; not all possible designs are evolving at the same velocity • Lack of dedicated policy and regulatory framework • Lack of service data, i.e., no actual fuel or operational waste data available for proposed reactor designs. • Unproven benefits of SMR manufacturing, i.e., serial production. Which SMR vendor(s) will succeed?
Major achievements expected by end of Year 2 (Go/No Assessment)[1] **(Maximum 5 bullets)**	• Identification of relevant new waste streams, if any, based on the knowledge gathered during the SS execution • Identification of needs on SMR and advance reactors waste characterization for a proper management at pre-disposal and disposal scenarios • Identification of opportunities on the use of digital technologies to foster the interaction with stakeholders and the civil society.
(Optional - Explain what is out of the scope?)	Decommissioning
List of preliminary interested organisations as partners in the WP contributing effort; **% of effort (person months, by College)**	REs (50%): SCK-CEN (BE), GSL (UK), NNL (UK), UJV (CZ), Energorisk (UA), NAAREA (FR), UH (FI), RATEN (RO), CEA (FR), TU Sofia (BG), CV REZ (CZ), EK (HU), A21 (ES), CTU (CZ), KTH (SE), Orano (FR), LEI (LT), INCT (PO), UP (IT), SIIGNASU (UA), IFE (NO), POLIMI (IT), PSI (CH), Tractebel Engineering (BE), IDOM (ES), Studsvik (SE), JRC (BE) TSOs (30%): VTT (FI), IRSN (FR), SURO (CZ), EIMW (Slovenia), NTW (FR), BelV (BE), CEPN (FR), SSTC NRS (UA), NRG (NL), CIEMAT(ES) WMOs (20%): Andra (FR), Ondraf (BE), Posiva, TVO (FI), NWS (UK)
If applicable - links with previous projects / work packages	EU-ELSMOR (Towards European Licensing of Small Modular Reactors) EU-TANDEM (Small Modular Reactor for a European Safe and Decarbonised Energy Mix) EASI-SMR (Ensuring Assessment of Safety Innovations for SMR; under preparation for HORIZON-EURATOM-2023-NRT-01-02: Safety of light water small modular reactors) IAEA CRP on Challenges, Gaps and Opportunities for Managing Spent Fuel from SMRs

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

	Activities of the International Association for Environmentally Safe Disposal of Radioactive Materials (EDRAM) and the ERDO Association
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