EURAD-2 WP description Template #2

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

Short Acronym and full Title	Next generation **Di**gital **T**wins (DT) to support **O**ptimisation (including communication of safety), **C**onstruction and **O**peration of surface and subsurface radioactive waste management facilities - moving into the next decade (2030) – **DITOCO2030**		
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€)	Target 500kEuro	Duration of the WP (in months)	18 months
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**)	- 5.2.2 Optimisation (of the facility components and design) - **5.2.4 VR / Digital Twin** - 7.3.1 Performance assessment and system models		
SRA drivers (maximum 3) *these are drivers for the RD&D project resulting from the scientific study.	☒Implementation Safety*	☐Tailored Solutions	☒Scientific Insight
	☒Innovation for Optimisation*	☐Societal Engagement	☐Knowledge Management

Objective (What) – **1 sentence**	The objective is to lay-out the path on how to close the RD&D gap between the currently fragmented digital twins (DT) of individual disciplines, common data environments and decision-making platforms that the radioactive waste management community needs in order to *i)* optimize, construct, and safely operate the intermediate storage facilities as well as the surface and subsurface disposal facilities, and *ii)* facilitate and improve the communication of the scientific rationale behind decisions to all stakeholders, the general public and policy makers.
Justification: impact / innovation / added-value (Why) – bullet points or short paragraph **(maximum quarter of a page)**	The nuclear sector is now at the doorstep of adopting new technologies for its safety-critical and societally important endeavours. A DT of an intermediate storage facility, or a subsurface facility for radioactive waste disposal is a virtual replica of the physical facility that is created using carefully selected and appropriate results needed for decision-making. This information has its origin in different disciplines (*e.g.,* in waste management, engineering, geology, construction, operation, and many others). At present, differently structured data, heterogeneous transfer methods, and proprietary software applications prevent the digital continuity of this information from the appointed to the appointing party. The vision is to agree on what is needed from the individual disciplines in a DT, at what point in time and to what level of detail, in order to use the DT for effective decision-making during the planning, construction, operation and maintenance of radioactive waste management facilities, and for interactions with stakeholders. The study will identify the major challenges to tackle and set key performance indicators to identify the expertise and capacity that is needed to address the RD&D challenges. The added value lies in the evidence-based *i)* identification and management of risks, *ii)* performance assessment of safety margins, *iii)* optimization of design configurations, *iv)* calculation of costs to completion, *v)* engagement improvement with stakeholders. Even though the responsibility for implementing digital twins lies with the individual projects, it is the strength of internationally coordinated projects, such as EURAD-2, that allows the lessons-learned of disposal programmes with different levels of maturity to be taken into account by involving each stage in the development of one common standard, for *i)* safety and financial optimisation (early stage), *ii)* virtual design and construction (intermediate stage), *iii)* real-time monitoring during operations (advanced stage), and iv) providing guidance for less advanced programs. No such all-purpose DT exists as of today. It is anticipated that within EURAD-2 significant progress can be made to work towards this vision in terms of development of a uniform markup language and an open standard for nuclear waste management. This requires an international approach, and EURAD-2 is the optimal tool to foster such development.

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<td>List of planned tasks / subtasks with % of effort per task (5% increments)

(Maximum 10 bullets)</td>
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Task 1 (10%): Effort allocated to the management and coordination of the work package, including organisation of meetings.
Task 2 (10%): Effort allocated to the knowledge management, including documentation of the results.
Task 3 (15%): State of the art analysis to record and document normative requirements and their implementation today.

Compilation and review of regulatory requirements in order to derive requirements for a digital twin (5/15%).
Compilation of use cases in which digital twins are already being used today (5/15%).

Screening of the radioactive waste management community for pre-existing definitions of DT.
Outreach to other industries and other Horizon 2020 initiatives, such as carbon capture storage, geothermal, geotechnical, structural, civil, and nuclear engineering, industrial Internet of Things, and environmental monitoring, infrastructure.

Identification and comparison of international standards potentially relevant for nuclear waste management (5/15%).

Task 4 (20%): Gap analysis identifying the major challenges that need to be tackled to close the RD&D gap between currently fragmented single discipline DT and the emerging landscape of a unified cooperative platform.

Clarify the needs and opportunities (taking into account the SoTA results), perform an analysis assessing drivers and barriers towards a standardized DT set objectives, and capture the end-user needs and requirements on the final product in detailed descriptions of use-cases (5/20%).
Compile ideas on how the envisioned digital twin supports the argumentation of a safety case, the implementation and maintenance of the waste disposal facilities, including the generation of possible improvements, and stakeholders communication (5/20%).
Develop qualitative and quantitative performance indicators to distinguish functional digital twins from dysfunctional ones in the long term (5/20%).
Description of the human and technical competences required for the development, operation, and maintenance of digital twins (5/20%).

Task 5 (20%): Achieving consensus on the above-mentioned topics (Tasks 3 and 4) for a strategic recommendation on the standardised design of digital twins for radioactive waste management, documented in a position paper.

Harmonisation of data collection/ processing,
Harmonisation of databases/information exchange,
Harmonisation of methods/workflows/processes with definition of data exchange requirements.

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	o Task 6 (25%): **Community engagement** with surveys, pluralistic workshops and webinars, including the documentation of results.
List of expected outcomes linked to the identified SRA drivers **(Maximum 6 bullets)**	As the outcomes are high level, given that this is a strategic study, the expected outcomes serve all three drivers identified above equally: • A common language is established in form of a glossary defining digital twins to be used for nuclear waste management, also with reference to other industrial sectors. • It is clearly defined which goals are to be achieved with digital twins. • Use cases elucidate how DT support the evaluation, implementation, maintenance and optimisation of the facility design by benefiting from unified and structured information and the assessment of selected results from the individual disciplines shared via a common coordination platform. • Key requirements for DT are derived from the goals and use cases and are made measurable with qualitative and quantitative performance targets. • Consensus has been reached and documented in a position paper on what is needed from the individual disciplines in a digital twin to support for effective decision-making during the planning, construction, and operation of radioactive waste management facilities, and for communication with stakeholders. • Recommendations on international standards, methods, and markup-languages provide guidance for the implementing of such DT.

Deliverables
 	
(Maximum 6 – including the prescribed deliverables)
	• State of the art analysis report by month 5
	• Gap analysis report by month 10
	• Continuous documentation of community engagement
	• Position paper on DT for radioactive waste management by month 16
	    o Documentation of the achieved consensus (tasks 3 to 5).
	    o Documentation of the community feedback (task 6).

Critical input requirements & identified risks	The risk towards not reaching the deliverables is deemed low. However, the topic at hand is rapidly developing and key players need to be identified and involved such that the proposed work is not obsolete by the time the results are published as a position paper.
Major achievements expected by end of Year 2 (Go/No Assessment)[1]	A well-documented and traceable information posture enables *i)* to intensify cooperation between disciplines, *ii)* to clearly define processes and procedures for effective information exchange supporting the_decision-making, *iii)* transparent and trust-building interactions with stakeholders and policy makers, *iv)* the linkage of existing information (document or model based), and

[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.

(Maximum 5 bullets)	*v)* the linkage of existing systems (live-monitoring, etc.) to make relevant information findable, accessible, interoperable, and reusable (FAIR principles). **By 2029, the radioactive waste community will be able to profit from the next generation digital twins.**
(Optional - Explain what is out of the scope?)	Research and development, monitoring data management, multiphysical simulations, software development, international standardisation, databases, development of commercial products, services or business models.
List of preliminary interested organisations as partners in the WP contributing effort; **% of effort (person months, by College)**	REs (50%): IFE (Norway), PSI (Switzerland), SCK CEN (Belgium), UDC (Spain), ENEA (Italy), Amphos 21 (Spain), UFZ (Germany), UCLM (Spain), CEA (France), BRGM (France), NNL (UK), TUS (Bulgaria), MIITA (Finland), UniPi (Italy), Egis (France) TSOs (25%): VTT (Finland), TSENERCON (Hungary), GRS (Germany), IRSN (France), CIEMAT (Spain), TSE, FTMC (Lithuania) WMOs (25%): Nagra (Switzerland), SURO (Czech Republic), NWS (UK), SKB (Sweden), ENRESA (Spain), ANDRA (France), POSIVA (Finland) CS: NTW
If applicable - links with previous projects / work packages	EURAD MODATS, UMAN, iCROSS, HITEC, SFC, FUTURE PREDIS: WP7 EURATOM HARPERS (WP5 and WP6), SHARE, PLEIADES HORIZON- EURATOM OPERA HPC (WP6)
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