EURAD-2 WP description Template #2

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

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<table>
<tr><td>Short Acronym and full Title</td><td colspan="3">WP5 – ICARUS Innovative ChARacterization techniques for large volUmeS</td></tr>
<tr><td>Type of activity</td><td>☒R&D</td><td>☐Strategic Study</td><td>Knowledge Management – covered by a separate committee and template</td></tr>
<tr><td>Budget estimation (total budget in M€, i.e ~ 1.5 M€)</td><td>5 M€</td><td>Duration of the WP
(in months)</td><td>60</td></tr>
<tr><td>Links with EURAD SRA / Roadmap Themes
(if multiple choices, indicate the primary link in bold – maximum 3)</td><td colspan="3">☐Programme Management (Theme 1)
☒Pre-disposal (Theme 2)
☐Engineered Barrier Systems (Theme 3)
☐Geoscience (Theme 4)
☐Disposal facility design and optimisation (Theme 5)
☐Siting and Licensing (Theme 6)
☐Safety Case (Theme 7)</td></tr>
<tr><td>Links with EURAD SRA topics
(if multiple choices, indicate the primary link in bold – maximum 3)</td><td colspan="3">- 2.1.1 Inventory.
- 2.1.2 Waste Acceptance Criteria (WAC).
- 2.2.1 Characterisation.</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">Further development, optimization and when appropriate innovation of techniques for characterizing WAC, radiological, physical and chemical in LLW/ILW-mixed waste which could be critical for the safe implementation of radioactive waste management programmes, including destructive techniques</td></tr>
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	(DT) on laboratory scale and its relation to non-destructive techniques (NDT) at the raw waste and package scale use cases.
Justification: impact / innovation / added-value (Why) – bullet points or short paragraph **(maximum quarter of a page)**	There is need for faster and more reliable characterization techniques for classifying radioactive (incl. legacy/raw mixed) waste in large volume packages to reduce the volume of waste and optimize the waste route: • Identification of waste acceptance criteria and best available characterization techniques for large volume raw waste use-cases, in industrial level decommissioning situations. • Use-case on optimization for operative industrial use in decommission/ operation process of NDT for gamma activity distribution in complex large packages/components/buildings/soils by collimation, segmentation, passive mass distribution techniques (e.g. by gamma tomography). • Use-case on optimization for operative industrial use in decommission/ operation process of NDT neutron detectors for actinides in L&ILW packages to improve and simplify the quantification of alpha emitters compared to current destructive techniques and Scaling Factors method. • Development of sensitive radiochemical and radiometric/non-radiometric measuring DT for determining long-lived Difficult To Measure (DTM) radionuclides critical for the safe implementation of national programmes (e.g., C-14, Cl-36, Ca-41, Ni-59, Tc-99, Se-79, Zr-93, Mo-93, Pd-107, Sn-121, Cs-135, Sm-151, Np237, Am-243) in radioactive waste and environmental samples. • Characterization of disused sources, especially those classified as leaked and/or undocumented, and legacy waste. • Use case to implement the scaling factor approach and lower the uncertainties. For the same use case develop improvement of detection limits to meet ever stringent requirements set by national regulators on these large volume packages.
List of planned tasks / subtasks with % of effort per task (5% increments) **(Maximum 10 bullets)**	1. WP management and coordination. 5% 2. Knowledge management, incl. SOTA. 10% This task aims at compiling SOTA and GAP analysis of innovative non-destructive and destructive technics, scaling factor, WAC requirements for radiological, physical and chemicals characterization. It includes a database of characterization methods. 3. NDT design for industrial implementation. 40% This task is intended to develop innovative operative devices for large packages (metallic boxes, containers) characterization by NDT, radiological, chemical and physical, trying to determine values in standard volumes of 100-220 l inside a large volume the package. Including the detection of small hot spots like disused sources. 3.1 Gamma analysis based on multidetector/multilocation on large volume packages/metallic boxes/containers. 3.2 Alpha/Actinides detection on large volume metallic boxes/containers. 3.3 Physicals and Chemicals detection on large volume metallic boxes/containers. Including chemical processes like ASR or forming of acid, pressure etc. due to radiolysis.

	3.4 Passive Mass/NDT distribution detection on large volume/metallic boxes/containers. 3.5 Non-destructive Prototype devices (Gamma prototypes, Neutron for Actinides/Alpha prototypes, Physical, Chemicals prototypes, Mass prototypes) Including NDT techniques with external activation(gamma/neutron). 4. Design of DT for DTM radionuclides 25% This task focuses on the development of sensitive and accurate technics for completing the radiological inventory of waste and packages by the quantification of long-lived DTM radionuclides usually present in low activity concentrations. The aim is developing simplified/quick DT to improve the detection limits and the normally expensive and time-consuming radiochemical analysis. The impact of radiochemical treatment and processes will be limited by preferring non-radiometric techniques to radiometric techniques. 4.1 Development of new radiochemical methods 4.2 Development of new measurement methods 4.3 Implementation of destructive technics on real waste 5 Scaling Factor optimization 15% This task is created to investigate the way of improving the Scaling Factor Accuracy, trueness and precision and their impacts in activity packages and inventory. 5.1 Theoretical analysis of waste streams 5.2 identification of conducive parameters, 5.3 Sampling design for accuracy improvement: trueness/precision, 5.4 Package-Disposal-Storage activity accuracy 5.5 Analysis of optimized scaling factors on real waste 6. Dissemination 5%
List of expected outcomes linked to the identified SRA drivers **(Maximum 6 bullets)**	• Identification of the most relevant radionuclides and WAC limits, including possible limitations/difficulties that remain for their proper characterisation to improve waste management. • Improved NDA methods for radiological characterization (including in-situ and remote characterization, gamma and neutron analyses) to safely implement the subsequent stages of the waste management lifecycle strategy. • Improved NDA methods for characterisation of physical-chemical properties and chemicals inventory (e.g. complexants and organics) to optimize waste segregation, treatment and conditioning of and enhance pre-disposal safety. • Development/optimisation/innovation of DA methodologies to characterise DTM radionuclides identified as critical and for which limitations/difficulties remain in the available characterisation techniques, improving the Minimum Detectable Activity to obtain a comprehensive radiological inventory and a better quality of the data. • Development of innovative methods for the optimization and validation of scaling factors methodology to improve accuracy and reliability of DTM radionuclides characterization. • Development of characterization methodologies for mixed wastes as heterogeneous legacy waste including DSRS and orphan sources, especially those classified as leaked and/or undocumented, to

	acquire accurate radiological and chemical inventory necessary for defining appropriate final disposal.
Deliverables **(Maximum 6 – including the prescribed deliverables)**	D1 (T2.1, T2.2, T2.3, T2.4) State of the art on innovative NDT and DT, Scaling Factors, and WAC for waste characterization D2 (T3.1, T3.2, T3.3, T3.4) Advances on Non-Destructive Techniques: Gamma analysis, actinides detection, chemicals and mass distribution devices D3 (T3.5) New Non-Destructive Prototype devices D4 (T4.1, T4.2) New Destructive Technics for Difficult to Measure RN D5 (T4.3) Implementation of Destructive Technics on real waste D6 (T5.1, T5.2, T5.3, T5.4, T5.5) Scaling Factors optimization and implementation on real waste
Critical input requirements & identified risks	• Availability of real wastes to test developed methods. • Availability of certified standard materials to validate the developed methods, especially for some DTM radionuclides. • During the project the collaboration and sharing of needs, discussions is needed to prevent the results are not maximized to all partners. • Complementarity and interaction with other WP (e.g. WP6, WP7, and WP8) to avoid repetitions and provide required data and information.
Major achievements expected by end of Year 2 (Go/No Assessment)[1] **(Maximum 5 bullets)**	• List of the most relevant radionuclides and related WAC limits. • New NDA methods and prototypes for physical-chemical-radiological characterization of materials with complex geometry and composition. • New DA methodologies for DTM radionuclides in complex matrices and improvement of Minimum Detectable Activity. • Validation of scaling factors methodology. • New characterization methodologies for mixed/legacy wastes, DSRS and orphan sources.
(Optional - Explain what is out of the scope?)	Decommissioning-related activities, such as in-situ characterization, and studies aimed at determining the physical-chemical-mechanical properties to implement retrieval and dismantling operations. No development on drum monitoring, drum measurements solutions are already developed in previous EU-projects and the scope of this WP is on large volumes packages in a 'fast' industrial approach.
List of preliminary interested organisations as partners in the WP contributing effort; **% of effort (person**	REs (40%): SCK CEN, IMT Atlantique, ENEA, RATEN, CAEN, CEA, CSIC, CVUT, DMT, DTU, INFN, Isotoptech, JSI, LEI, ORANO, SCK CEN, SORC, TUoD, POLIMI TSOs (30%): VTT, TS Enercon, NCSRD, NRG, CIEMAT and LTPs, FTMC, NTW, SSTC NRS, IRSN, BELV, NUCLECO, NTUA WMOs (30%): NIPNE, SKB, ONDRAF/NIRAS, NES, IAE, ARAO, ANDRA, LLWRSITE, NAGRA, TVO, ENRESA

[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.

months, by College)	
If applicable - links with previous projects / work packages	ROUTES, PREDIS, CHANCE, MICADO, EURAD,
WP Preparation Team (1 member per College) contact (**organisation + person**, email)	RE: POLIMI, Eros Mossini, eros.mossini@polimi.it TSO: NRG, Bas Janssen, b.janssen@nrg.eu WMO: ENRESA, José Luis Leganés Nieto, jlen@enresa.es CG observer: SCK CEN, Christophe Bruggeman, christophe.bruggeman@sckcen.be