Activities in the context of the characterization of legacy waste within the ERDO Association

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ERDO Association

ERDO is a multinational Association (www.erdo.org) working from the beginning of 2021, after a decade of preparatory work by the ERDO Working Group, involving founding members from several European countries. The Association aims to address the common challenges of safely managing the long-lived radioactive waste in the partner countries and carrying out the necessary groundwork to establish one or more operational, shared multinational waste management solutions.
Among the projects started by the ERDO-WG the **Legacy Waste Characterization** project is continuing under the ERDO Association.

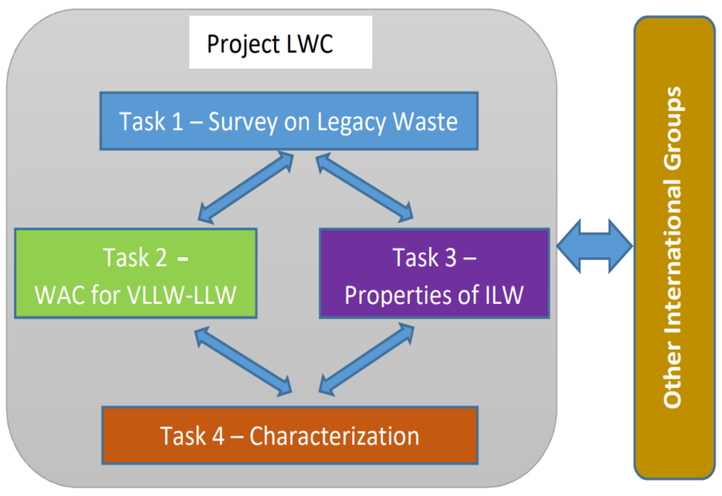
Introduction

Radioactive legacy waste: radioactive waste generated in past nuclear activities, treated and conditioned according to the rules in force at the time or simply stored pending a suitable management solution; such waste is often lacking sufficient physic-chemical and radiological characterization data (also for the lack of the associated documentation) for envisaging possible retreatment and reconditioning processes, in line with current regulatory requirements and checking compliance with current WAC of storage/disposal facilities.

Project goal: sharing information and methodologies to gain a **better knowledge of the current situation** of the main legacy waste, to permit its **better characterization**, in order to define the possible future management activities (re-treatment, treatment, conditioning) with a view to the storage or final disposal into national/multi-national facilities.

Organizations and countries involved

- NES (Austria)
- FOND-NEK (Croatia)
- DEKOM (Denmark)
- NCSRD (Greece)
- SOGIN – ENEA (Italy)
- COVRA (Netherlands)
- NND (Norway)
- ARAO (Slovenia)
- ENRESA (Spain)



Legacy waste survey (Task 1)

Exploration of the inventories of the main legacy waste streams in the interested countries (generated to date). **93 waste streams** have been gathered in **13 homogeneous groups**:

- Disused SRSs (WS1)
- Mixed solid waste (WS2)
- Powdery waste (WS3)
- Sludges (WS4)
- Ion Exchange Resins (WS5)
- Solid organic waste (WS6)
- Liquid organic waste (WS7)
- Graphite (WS8)
- Metals (WS9)
- α-bearing solid waste (WS10)
- Reactive metals (WS11)
- Chemotoxic materials (WS12)
- Liquid waste (WS13)

Commonalities and differences among legacy waste streams (Task 1)

- 8 over 13 groups are common to at least 4 out of 7 countries. Many **waste streams present similarities** among countries (possible synergies for sharing of knowledge and facilities);
- except in one country and for the Disused Sealed Radioactive Sources, the classification scheme is defined;
- in most cases, the waste is simply packaged in raw conditions, but the future treatment and conditioning activities are defined;
- the characterization methodology for more than 40% of the streams has yet to be defined, but many streams are going to be characterized during the sorting and treatment phases;
- in a few cases, the waste has been conditioned according to obsolete rules and will require re-treatment and re-conditioning for complying with WACs.

Waste Acceptance Criteria and relevant properties of waste (Task 2 & 3)

Objective of the task 2-3 : gathering information regarding WACs, for VLLW and LLW, and the main properties for disposability of ILW of the countries involved in the research, to determine a **minimum common set of WACs**. Information on WACs by survey performed among ERDO and non ERDO members, from EU projects (ROUTES and PREDIS) and from published documents. 4 groups of WACs: radiological, chemical, mechanical, physical/other. Table: **relevant properties** for each waste stream.

Property/WS	DSRSs	Mixed solid waste	Powdery waste	Sludges	IERs	Solid organic waste	Liquid organic waste	Graphite	Metals	α-bearing waste	Reactive metals	Chemotoxic materials	Liquid waste
Moisture content / free standing liquid				*	*		*					*	*
Low flash point liquids							*						
Combustible materials		*		*	*	*	*	*		*			
Ion exchange materials					*								
Explosive materials (incl. pressurized containers)													
Toxic materials	*	*	*	*		*	*		*		*	*	*
Corrosive materials		*	*	*	*		*						*
Complexing agents			*	*			*						*
Strong oxidizing agents		*											*
Pyrophoric materials	*	*	*						*	*	*		
Reactive materials		*	*				*		*	*	*		*
Notifiable waste such as asbestos, PCBs, lead, etc.		*	*				*		*	*		*	
Putrescible materials						*							

Radiological characterization. Destructive techniques (Task 4)

- Carried out in laboratory with chemical methods
- Accuracy and precision
- Long time required to perform measurements
- Loss of integrity of the sample
- Samples need to be representative of the waste to be characterized
- Contamination risk for the operators.

Radiological characterization. Non-destructive tech. (Task 4)

- Eliminates the need of sampling the orginal material (no specimen modification), but lower accuracy than destructive techniques
- Possible in-situ measurement
- Faster than destructive, yet robust and reliable
- No dissolution or chemical preparation
- Given an activity concentration, is the radionuclide detectable?
- If yes, how long does it take for its occurrence to be quantified?

Suitable characterization techniques for legacy waste (Task 4)

	Parameter	Characterization type	Applicability	Technique
Radiological characterization	Gamma-emitter radionuclides	Non destructive	All waste	ISOCS
	Gamma-emitter radionuclides	Non destructive	All small size waste	LabSOCS
	Pu and U isotopic ratios	Non destructive	All waste	MGA
	Gamma-emitter radionuclides	Non destructive	Drums	OG, SGS, TGS
	Fertile material	Non destructive	All waste	Passive neutron counting
	Fissile material	Non destructive	All waste	Active neutron counting
	α-emitter radionuclides	Destructive	All waste potentially contaminated by α-emitters; not applicable to SRSs	Alpha spectrometry
	α and β-emitter radionuclides	Destructive	All waste potentially contaminated by α and β-emitters; not applicable to SRSs	LSC
	X-ray emitters; EC-decaying radionuclides (e.g., ^{55}Fe, ^{59}Ni, ^{99}Mo)	Non destructive	All waste	X-ray spectrometry
Physical characterization	Density	Non destructive	All waste	Mass and volume
	Density distribution	Non destructive	All waste	Radiography, gammagraphy
	Density distribution	Non destructive	Drums	Transmission tomography
Chemical characterization	Water content	Destructive	All waste; not applicable to SRSs	Karl-Fisher
	Elements	Destructive	All waste; not applicable to SRSs	AES
	Isotopes	Destructive	All waste; not applicable to SRSs	MS
	Organic Compounds	Destructive	All waste; not applicable to SRSs	GC-MS