Deliverable 9.1: ROUTES - Training materials

Work Package 9

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Disclaimer

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	By	Date
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Approved (PMO)	Elisabeth Salat (IRSN)	24 May 2024
Submitted to EC (Coordinator)	Coordinating team (Andra)	24 May 2024

Executive Summary

EURAD (European Joint Programme on Radioactive Waste Management) and PREDIS (Pre-disposal management of radioactive waste) have organised a joint Summer School on Waste Acceptance Criteria (WAC) for radioactive waste. The training took place in September 4-8, 2023, in Prague, CZ. During five days, the objective was for participants to learn about the basics of WAC, WAC development and application, and examples of WAC in national programs. Theoretical lectures have been complemented with exercises and two technical visits.

The final presentations of the lecturers and the related reference papers are available on the PREDIS website (https://predis-h2020.eu/joint-summer-school-on-waste-acceptance-criteria/).

Table of content

1. Introduction

The Summer School on WAC for radioactive waste jointly organized by EURAD (WP 11 – Mobility and training) and PREDIS aimed at providing knowledge about fundamental aspects of WAC, its development, application, and explored instances of WAC integration within national programs. This training was targeting PhD students from the EURAD and PREDIS projects, as well as professionals working on WAC.

The task leads of ROUTES' Task 4, which is focused on the WAC topic, have been invited to give courses on WAC systems in their respective countries (Belgium and the UK).

1.1 Topics and target audience

The ROUTES WP (Waste management routes in Europe from cradle to grave) is one of two strategic studies within EURAD. This work package involves 36 organizations from 21 countries. Its primary goals are to facilitate the exchange of knowledge and experience among various member states, with different developmental stages of their respective programs and radioactive waste types and levels, to identify safety-related R&D needs as well as to promote the comparison of approaches and collaboration. To fulfill these objectives, the project is structured around several tasks, each dedicated to specific aspects (among which **WACs**) within the field of waste management.

- Task 1: Coordination, state-of-the-art and training materials.
- Task 2: Identification of challenging wastes to be collaboratively tackled within EURAD.
- Task 3: Description and comparison of radioactive waste characterization approaches.
- **Task 4: Identification of Waste Acceptance Criteria (WAC) used in EU Member-States for different disposal alternatives in order to inform development of WAC in countries without WAC disposal facilities.**
- Task 5: Radioactive Waste Management (RWM) solutions for small amounts of wastes (focusing on disposal strategies for small-inventory Member-States).
- Task 6: Description of the state-of-the-art of shared solutions in European countries for characterization, treatment, storage and disposal and planned sharing of facilities between Member-States, as well as identification of gaps and R&D requirements.
- Task 7: Interactions with Civil Society.
- Task 8: ROUTES Extension on the evaluation of the possible waste management solutions for Member States without WAC and with small inventories (SIMS).

The focus of this Summer School was on doctoral candidates enrolled in the EURAD and PREDIS programmes, along with professionals actively engaged on the WAC topic.

1.2 Learning outcomes

After finishing this Summer School, attendees ought to possess the ability to:

- Describe the waste management life cycle;
- Describe and explain waste acceptance systems and waste acceptance criteria elements;
- Discuss the WAC development process;
- Provide examples of types of WAC;
- Design WAC for a program without a disposal facility;
- Describe WAC for legacy, non-standard, and problematic radioactive waste;
- Discuss the treatment of non-conformances and departures from established WAC;
- List examples of WAC in existing national programs.

1.3 School program

Time	Monday	Tuesday	Wednesday	Thursday	Friday
09:00	Arrival to Prague	WAS development process	Generic (preliminary) WAC	Excursion to Richard repository	Exercise: Proposal of WAC for challenging waste forms
to		(S. Konopaskova – CVR)	(A. Baksay -TSE ENERCON)	Czech RWM system Waste acceptance process	(L. Nachmilner – CVR)
09:45			Examples of national WAC systems:	(M. Macelova – SURAO)	
			Belgium	Repository Richard (P. Pavlovic – SURAO)	
09:45			(Ch. De Bock – NIROND)		
to		Types of WAC	Hungary		
10:30		(L. Nachmilner – CVR)	(A. Baksay -TSE ENERCON)		
Break					
11:00		Responsibilities & requirement management (P. Zuidema – Zuidema Consult GmbH)	Spain	Excursion to Richard repository	Exercise: reporting about results
to	Registration in CVR		(J.-L. Leganes Nieto – ENRESA)		(L. Nachmilner)
11:45					
			UK		
			(L. Harvey – Galson Sciences Ltd)	Excursion follow-up discussion	
11:45		Examples of national WAC systems:	Discussion on national differences/commonalities (all)		Wrap-up discussion Evaluation of the event
to		Switzerland			Conclusions Closing
12:30		(P. Zuidema – Zuidema Consult GmbH)			
Lunch					
14:00	Introduction, goals of the course	WAC specifics	Excursion to UJV/CVR waste processing facilities		
to	(L. Nachmilner – CVR)	(J. Mertens – BelV)			
14:45					
14:45	RWM lifecycle	Acceptance of problematic waste			
to	(J. Faltejsek – UJV)	(J.-L. Leganes Nieto – ENRESA)			

15:30					
Break					
16:00	Description of WAS	Treatment of non-conformances			
to	(S. Konopaskova – CVR)	(J.-L. Leganes Nieto – ENRESA)			
16:45					
16:45	WAC in different stages of RWM	France			
to	(L. Nachmilner – CVR)	(V. Wasselin – ANDRA)			
17:30					

THE ACCEPTANCE SYSTEM FOR RADIOACTIVE WASTE IN BELGIUM

Chris De Bock – ONDRAF/NIRAS

These projects have received funding from the Euratom research and training programme 2019-2020 under grant agreements No. 847593 and 945098.

Structure of the lecture

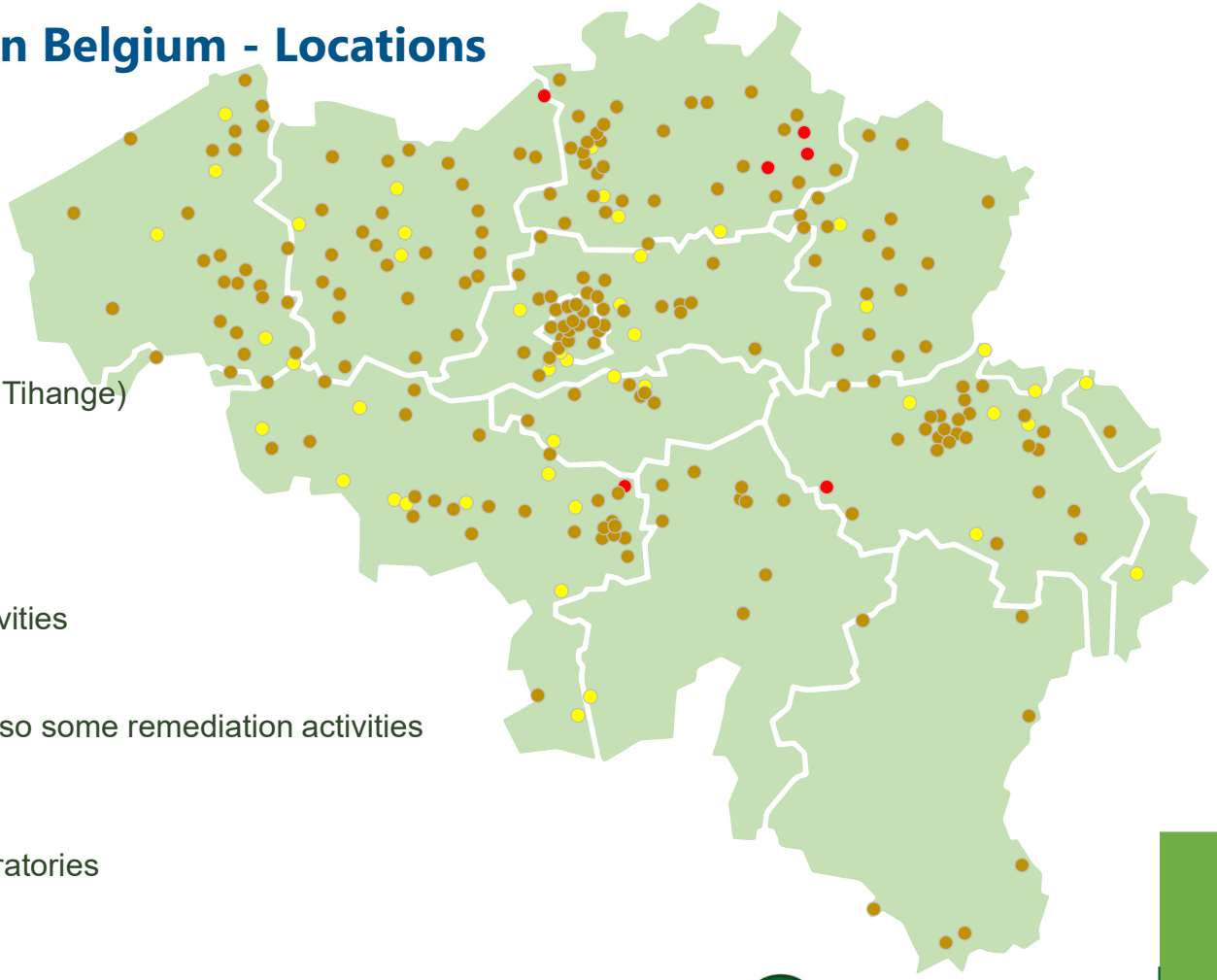
1. *Context: radioactive waste in Belgium – origins and main actors*
2. *Basis of the WAS*
3. *WAS in practice*
4. *'Potentially compliant' waste*

(1) Radioactive waste production in Belgium - origins

(1) Radioactive waste in Belgium - main actors

- **ONDRAF/NIRAS**
  - Waste Management organization
  - Current operator of a class II facility (remediation of a site of former nuclear activity)
  - Future operator of a class I disposal facility (surface disposal)
- **Belgoprocess**
  - Industrial subsidiary of ONDRAF/NIRAS
  - Located in Dessel (municipality)
- **AFCN/FANC**
  - Nuclear safety authority
- **BelV**
  - Nuclear inspectorate
  - Subsidiary of AFCN/FANC
- **Waste Producers**
  - See next slide

(1) Radioactive waste production in Belgium - Locations



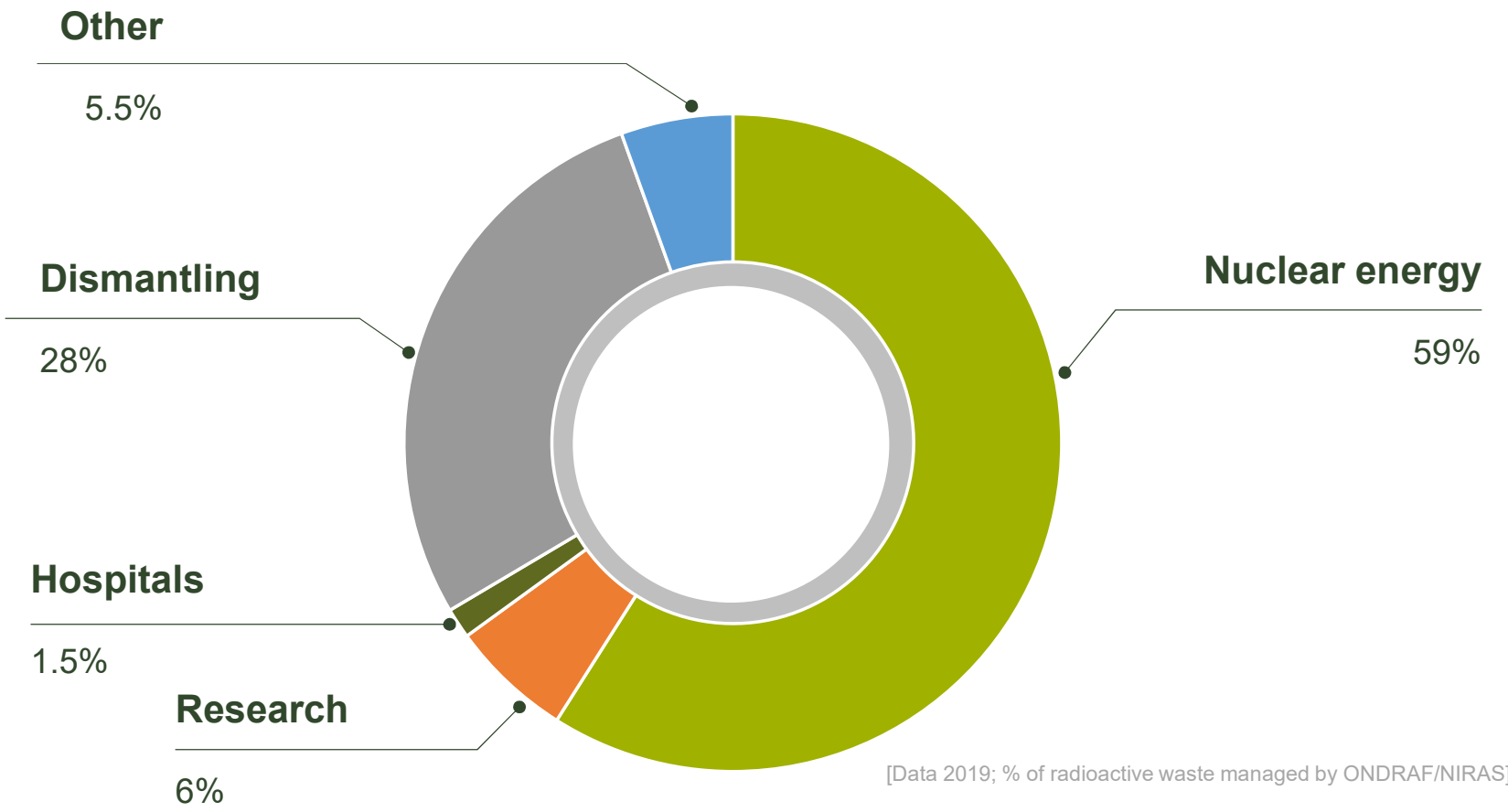
Class I:

- NPP's of Engie-Electrabel (units at Doel and Tihange)
- Belgoprocess
- SCK CEN (nuclear energy research)
- IRE (production of radioisotopes)
- EU JRC Geel
- Remediation of sites with former nuclear activities (FBFC, Belgonucleaire)

Class II: mainly medical and industrial applications, also some remediation activities

Class III: mainly non-nuclear industry actors and laboratories

(1) Radioactive waste production in Belgium – Relative quantities according to origin



[Data 2019; % of radioactive waste managed by ONDRAF/NIRAS]

(2) Basis of the WAS in Belgium

- *ONDRAF/NIRAS was founded by Law in 1980 and was entrusted with the management of all radioactive waste on Belgian territory*
- *For the management of certain waste to be transferred from the producer to ONDRAF/NIRAS, the waste must first be accepted*
- *The basis of the WAS is laid down in the Royal Decree of 1981 that gave ONDRAF/NIRAS its implementing power. The main elements of the WAS are:*
  - *Waste acceptance criteria*
  - *Qualifications*
  - *Waste acceptance*

(2) Waste acceptance criteria

- ***WAC are defined by ONDRAF/NIRAS based on General Rules.***
  - *These General Rules are laid down in formal legislation (Royal Decree)*
- ***AFCN/FANC has the legal competence to verify the compliance of the WAC with the General Rules (which includes verification of the compliance with nuclear licenses)***
- ***An ACRIA is the document (or documents) in which the complete set of WAC for one or more specific waste types is defined***
  - *The ACRIA's are supported by Technical Notes (which do not contain WAC but practical instructions for the producers, or conventions like codes)*
- ***Basically, WAC are defined with the aim to ensure the safety and feasibility of all management steps after the acceptance of the waste***
  - *This requires the definition of a management ROUTE for the involved waste type*
  - *The distinction should be made between ROUTES existing only of licensed activities and ROUTES in which one or more activities are not licensed*

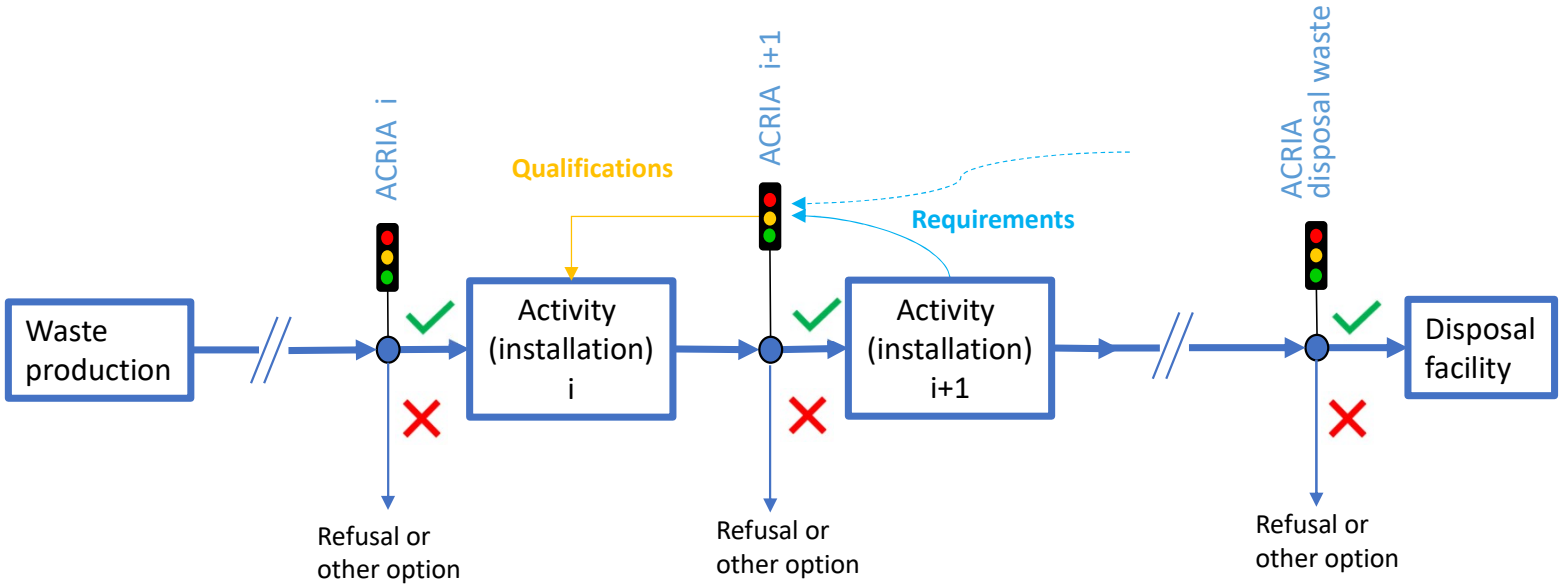
(2) Qualifications

- ***The Royal Decree of November 18th 2002 gave ONDRAF/NIRAS specific legal competences with respect to the Qualifications***
- ***The main objective of the Qualifications is to prepare the road for the acceptance of the waste***
  - *By judging the capability of a process/installation to produce/characterize radioactive waste that meets the WAC*
  - *By ensuring the adequacy of the methods put in place by the producer to meet these WAC*
- ***Six types of Qualifications exist*** *(type 1 only used for non-conditioned waste, 4 to 6 only for conditioned waste)*
  1. *Methods (ensuring conformity of non-radiological aspects)*
  2. *Radiological (ensuring conformity of radiological aspects)*
  3. *Radiological measuring apparatus used for final characterization*
  4. *Treatment and conditioning process*
  5. *Primary package for conditioned waste*
  6. *Storage facilities for conditioned waste operated by Belgoprocess*

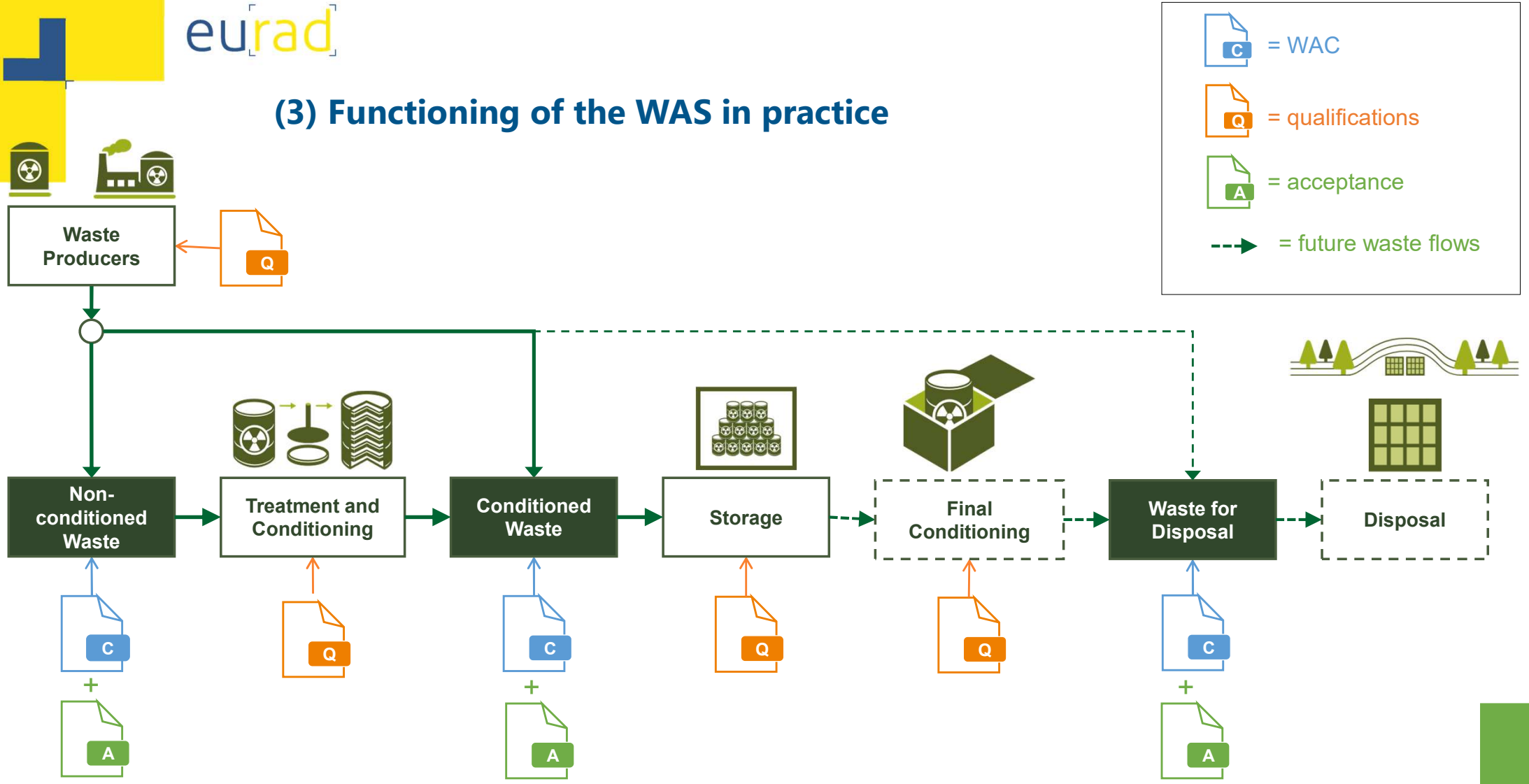
(2) Acceptance

- ***Objectives***
  - *Verify the compliance of the radioactive waste produced by a qualified process or installation with all WAC*
  - *Formalize the acceptance and the transfer of the responsibility of managing the radioactive waste to ONDRAF/NIRAS*
- ***Acceptance procedure comprises administrative verifications as well as inspections***
  - *Administrative verifications of waste documentation provided by the producer*
  - *Inspections on the sites of producers during and after waste production (non-conditioned and conditioned)*
- ***Formal transfer of the waste***
  - *Allows ONDRAF/NIRAS to fulfill its legal assignment as final manager of all radioactive waste on Belgian territory*
  - *Allows ONDRAF/NIRAS to collect the fee from the waste producer, to cover the expected costs associated with the further management of the transferred waste*
- ***ONDRAF/NIRAS arranges waste transportation if needed***

(2) Basic principle of how the WAS functions



(3) Functioning of the WAS in practice



(4) 'Potentially compliant' waste

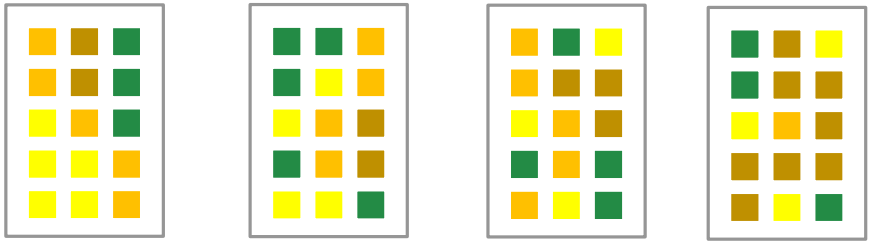
- ***The licensing process of the surface disposal facility involved conservative hypotheses regarding the long-term effect of certain chemical components in the waste.***
  - *This resulted in new WAC or tighter limit values that producers in general find hard to meet.*
    More specifically, these so-called 'critical' WAC are related to following waste characteristics:
    - *Alkali-Silica reaction in concrete waste (which leads to an expansion of the waste form)*
    - *Delayed Ettringite Formation in concrete waste (which leads to an expansion of the waste form)*
    - *Sulphate (SO_4^{-2}) content (which will attack the concrete in structures)*
    - *Mineral chloride ion (Cl^-) content (which will corrode steel reinforcements and facilitates migration of nuclides)*
    - *Cellulose content (of which the degeneration product ISA facilitates migration of nuclides)*
- ***ONDRAF/NIRAS has set up a program to:***
  - *Find techniques to modify waste characteristics and so meet the 'critical' WAC limit values*
  - *Relax the present limit values of the 'critical' WAC by*
    - *Finding final conditioning techniques to mitigate the adverse consequences of the chemical reactions*
    - *Demonstrating that the consequences of the chemical reactions are less adverse than presently assumed*

(4) 'Potentially compliant' waste

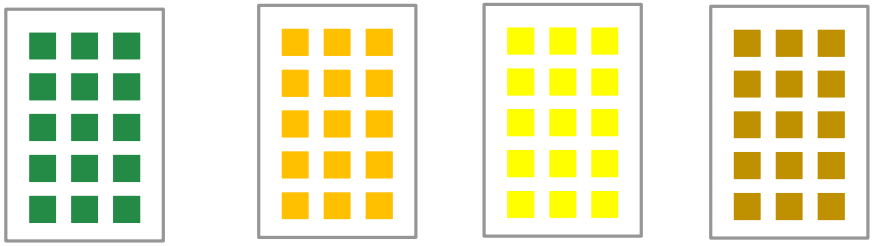
- ***Based on prospects provided by this program, ONDRAF/NIRAS can, on certain conditions, accept waste that currently does not comply with the 'critical' WAC. This is 'potentially compliant' waste***
  - *The acceptance of 'potentially compliant' waste is seen as special kind of deviation from the WAC*
  - *'Potentially compliant' waste cannot pursue its management route beyond the management step of 'storage'. The 'potentially compliant' waste remains in storage until it meets the relaxed licensing conditions of the surface disposal facility*
- ***ONDRAF/NIRAS will provide guidance to waste producers on sorting of raw waste***
  - *Objective: creation of 'mono-problematic' waste fluxes and 'problem-free' waste fluxes*
  - *Advantage: simplify the future demonstration of compliance to WAC*
  - *Illustration: see next slide*

(4) 'Potentially compliant' waste

= problem-free waste fraction
= problematic waste fraction with respect to certain critical criteria



NEW SORTING RULES



QUESTIONS?

Chris De Bock (c.debock@nirond.be)

These projects have received funding from the Euratom research and training programme 2019-2020 under grant agreements No. 847593 and 945098.

EXAMPLES OF NATIONAL WAC SYSTEMS: WAC IN THE UK

Dr Liz Harvey

Galson Sciences Ltd (UK)

These projects have received funding from the Euratom research and training programme 2019-2020 under grant agreements No. 847593 and 945098.

Outline

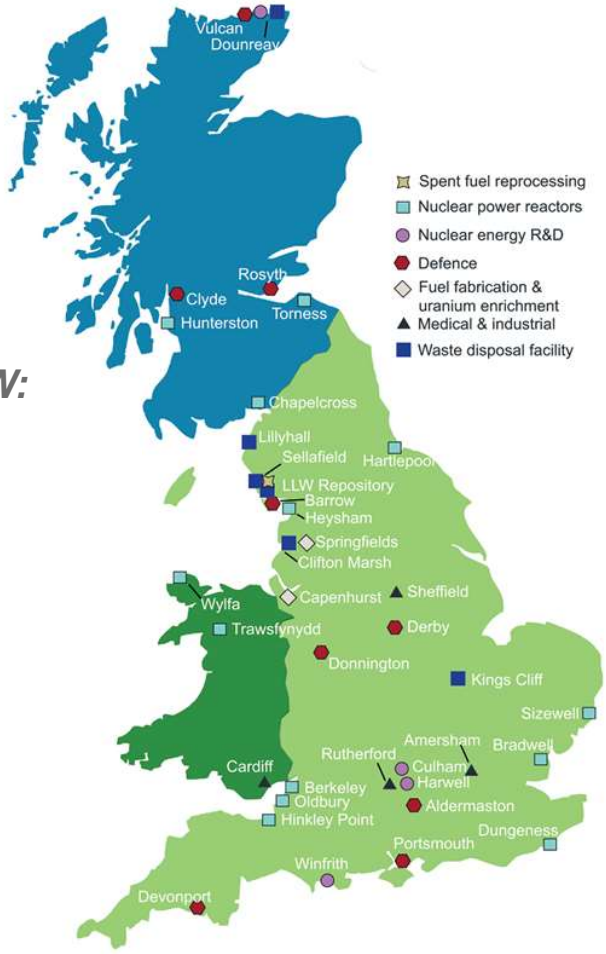
- ***Context***
  - *Waste classification in the UK and general requirements relevant to WAC*
  - *UK radioactive waste inventory and disposal routes (including VLLW disposal)*
- ***Disposal at the LLWR and associated WAC***
- ***D3100 LLW Disposal Facilities and associated WAC***
- ***Geological disposal and associated WAC***
- ***Summary***

01

SOME CONTEXT

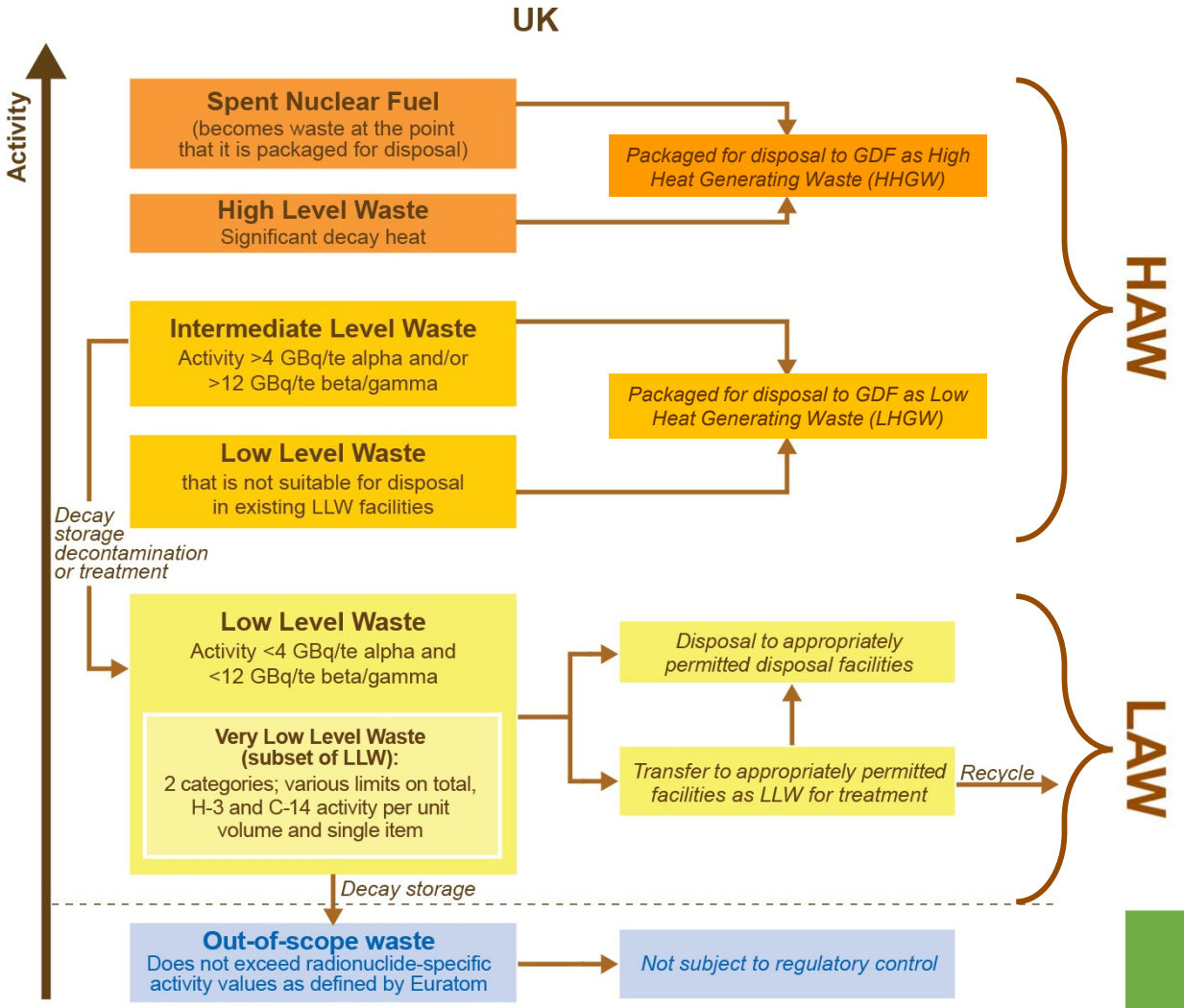
Radioactive Waste Disposal in the UK

- **Two LLW disposal facilities are in operation in the UK:**
  - The Low Level Waste Repository (LLWR) in Cumbria
  - The D3100 LLW Disposal Facilities at Dounreay
- ***Three landfill sites are permitted to receive VLLW or high volume VLLW:***
  - *East Northants Resource Management Facility (ENRMF), operated by Augean*
  - *Clifton Marsh, operated by Suez*
  - *Lillyhall, operated by FCC Environment*
- **A GDF is planned for the disposal of HLW, ILW and some LLW that is unsuitable for disposal to the LLWR (collectively referred to as Higher Activity Waste or HAW)**
- ***Facility-specific WAC in use for all facilities in operation, for all waste classifications, across the waste lifecycle***
  - *Not always referred to as 'WAC'*

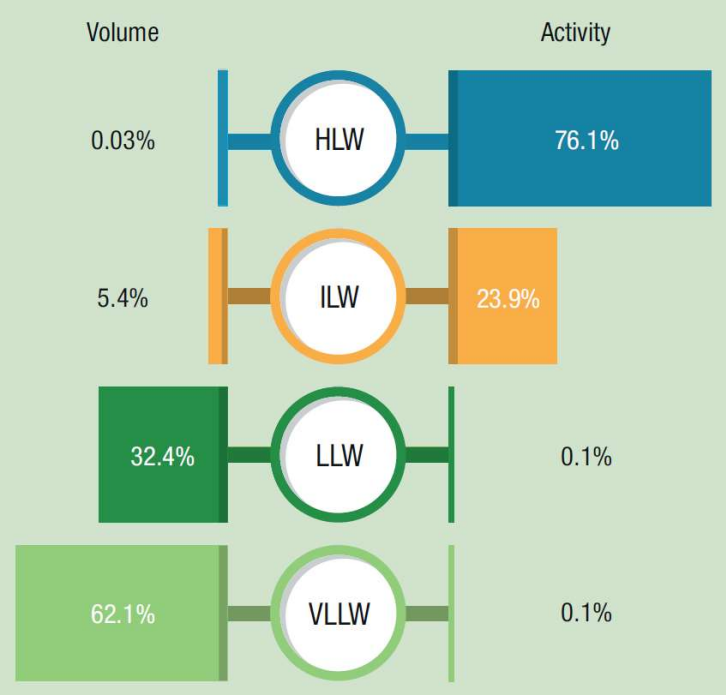


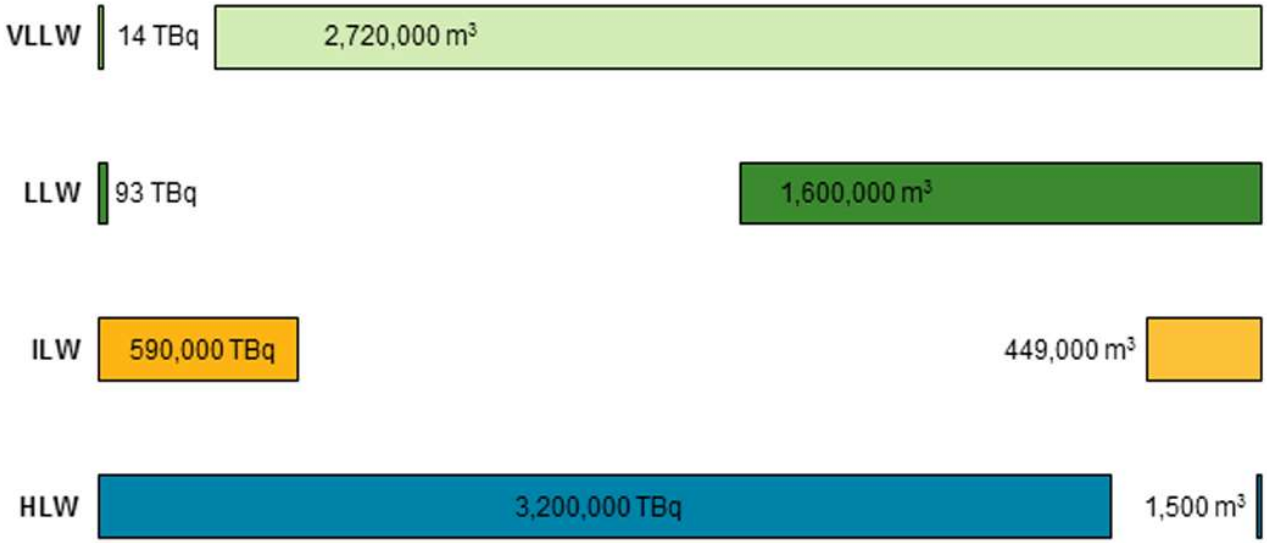
UK Waste Classification Approach

- ***UK RW is classified according to the type and quantity of radioactivity it contains and how much heat it produces***
  - *Does not distinguish between short-lived and long-lived wastes*
- ***LAW is consigned to LLWR / D3100 or disposal to landfill sites***
- ***HAW is destined for geological disposal***



UK Radioactive Waste Inventory (UK RWI)

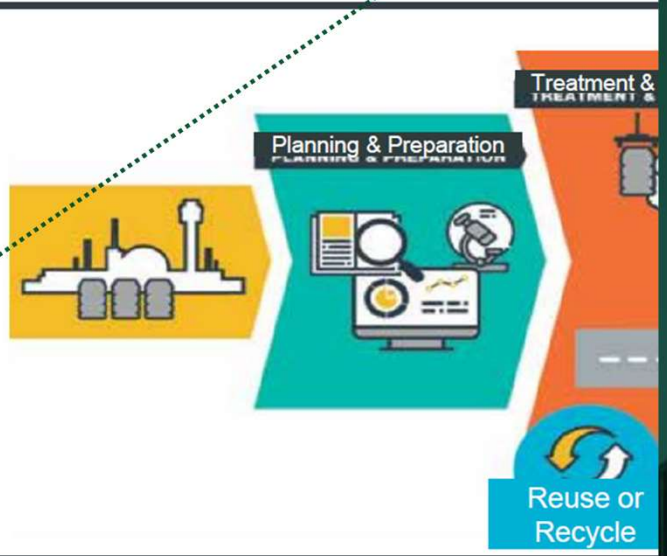




Organisational Structure for UK Radioactive Waste Management

NDA

Mission Statement:
To clean-up the UK's earliest nuclear sites safely, securely and cost-effectively with care for people and the environment



Nuclear Waste Services — **New single organisation responsible for UK's nuclear waste disposal and services**

NTS Nuclear Transport Solutions — Nuclear Transport Solutions manages transport services for NDA

Sellafield — 12 nuclear sites across the UK

Magnox

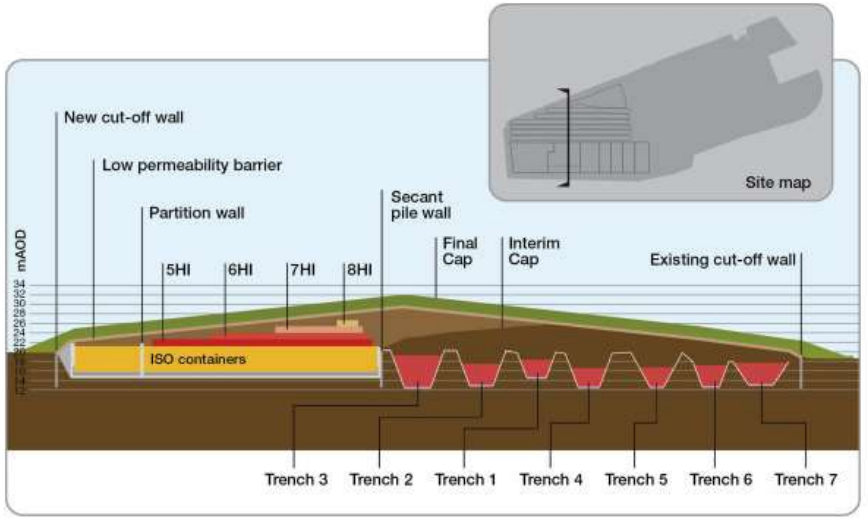
Dounreay — NDA decommissioning site in Scotland.

02

WAC FOR DISPOSAL AT THE LOW LEVEL WASTE REPOSITORY (LLWR)

Disposal at the LLWR

- *The UK's principal disposal facility for LLW*
- *110 ha site, situated on the west coast of Cumbria*
- *Most waste delivered to the site by rail*
- *On receipt at the LLWR, the containers are subjected to acceptance checks to ensure compliance with the LLWR WAC*
- *The LLW is then grouted into half-height ISO containers prior to disposal in engineered concrete vaults*



WAC for Disposal at the LLWR

- ***WAC are part of the authorisation requirements for the near-surface disposal of radioactive waste***
  - *WAC and associated control arrangements are an essential part of ensuring compliance with the Environmental Safety Case (ESC)*
- ***The current WAC were laid down in 2011 by the repository operator (LLW Repository Ltd)***
  - *Take account of the 2011 ESC and implementation of the 2015 permit for further disposals of radioactive waste at the LLWR*
  - *Updated as required by waste acceptance issues and technical work that helps to refine the position of the operator*
  - *Also updated every ten years alongside review of the ESC*
- ***Apply to specific treatment routes and to conditioning and packaging of all waste consigned for disposal at the LLWR***

WAC-related Responsibilities at the LLWR

- ***LLW Repository Ltd (now part of NWS), as operator of the LLWR is responsible for applying WAC and for compliance verification***
- ***LLW Repository Ltd also acts on behalf of the NDA to oversee the National Waste Programme (NWP), ensuring that LAW is managed effectively across the UK***
  - *The NWP team promotes the use of alternative waste management routes to disposal at the LLWR, consistent with the waste hierarchy*
- ***LLW Repository Ltd submits an annual review to the Environment Agency, the UK environmental regulator, covering matters that are relevant to the ESC, including any mis-consignments***
  - *Issues such as omissions from waste consignment information are resolved between the waste producer and LLW Repository Ltd and are not included in this reporting*
- ***For non-standard wastes, a disposability assessment is made against the WAC and this is reported to the Environment Agency by LLW Repository Ltd's ESC team***

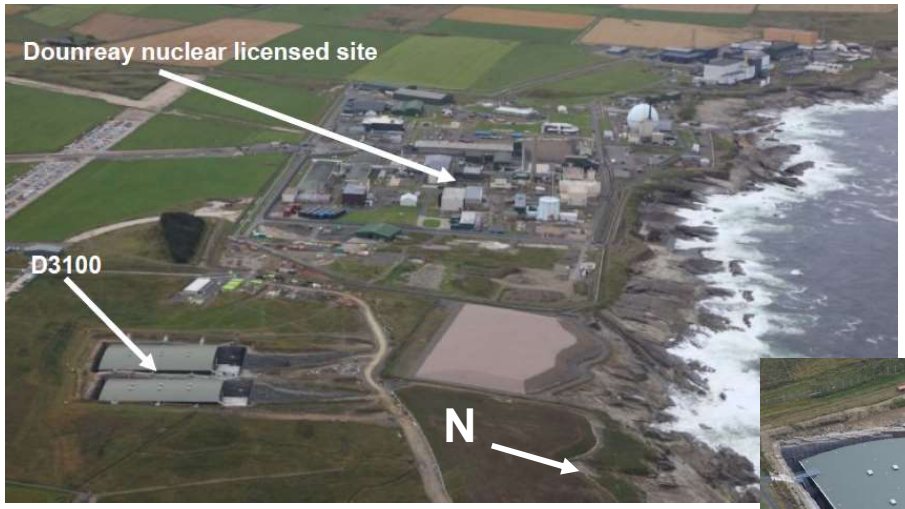
Scope of the LLWR WAC

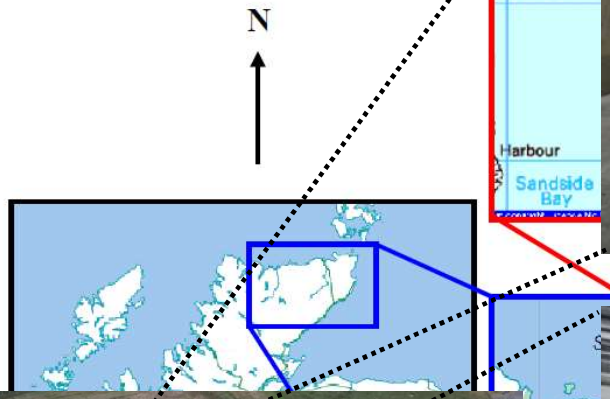
- **Constituents:**
  - Waste shall not contain materials that generate, or are capable of generating, toxic liquids, gases, vapours or harmful fumes
  - Liquid waste may be accepted for disposal, but only on a specific approval by the disposal operator, with justification provided
  - Additional categorisation requirements and management arrangements for waste containing complexing or chelating agents
  - Must report and/or control quantities of materials that would result in the waste being categorised as Hazardous Waste under European Council Directive 91/689/EEC if it were not deemed to be radioactive waste, as well as materials regarded as Hazardous Substances or Non-Hazardous Pollutants, as defined by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG)
  - The presence, physical form and quantity of asbestos and asbestos-containing products must be reported and limits on acceptance may be set
- **Radiology:**
  - Maximum limits per waste package exist for specific groups of nuclides
  - Also maximum limits per waste package for the total activity of α-emitters and the total activity of β-emitters
- **Waste form:**
  - Matrix: cementitious (through grouting) is standard
  - Leaching test is required to ensure solidity of the waste form
- **Waste package:**
  - Gas generation is controlled by limiting the surface area of reactive metals and the putrescible materials volume
  - Voidage is limited (<20 v%)
  - Chemical compatibility: waste should not include corrosive materials unless treated, prepared or made safe by a method approved by the disposal operator
- **Container:**
  - Stacking considerations are considered, but not explicitly addressed in the WAC
  - Impact and fire performance are not explicitly considered
- **QA/QC:**
  - Qualifications occur via the Waste Assurance Process

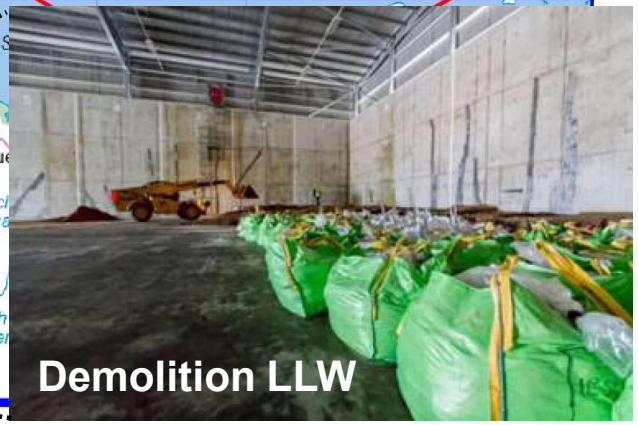
03

WAC FOR DISPOSAL AT THE D3100 LLW DISPOSAL FACILITIES AT DOUNREAY (LLWDF)

D3100 LLW Disposal Facilities at Dounreay (LLWDF)





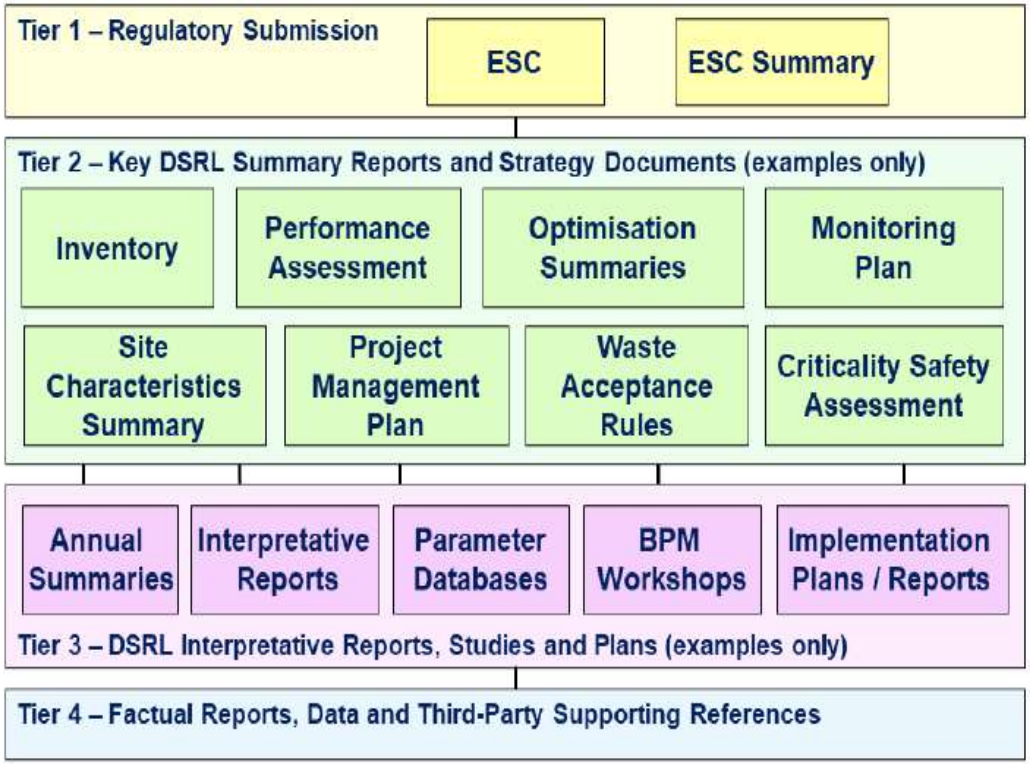


Shallow sub-surface disposal facilities operated by Dounreay, a division of Magnox Ltd

Upper limit of 175,000 m^3 packaged waste volume (234,000 tonnes)

WAC for Disposal at D3100

- *Radioactive waste disposal facilities in Scotland require a Permit under the Environmental Authorisations (Scotland) Regulations, 2018 (the "EASR")*
- *WAC are laid down by the regulator (SEPA) in the Permit for D3100*
- *The WAC are implemented by the operator as Waste Acceptance Rules, which underpin the Environmental Safety Case (ESC) for D3100*
- *Currently operating according to 2015 WA Rules*
- *Revised WA Rules (2020) linked to the 2020 ESC have been drafted for consistency with Dounreay's permit variation application (currently under review by SEPA). They cover eight areas:*
  1) *Compliance with the waste acceptance process*
  2) *Physical characteristics of the waste packages*
  3) *Chemical characteristics of the waste packages*
  4) *Biological characteristics of the waste packages*
  5) *Radiological characteristics of the waste packages*
  6) *Criticality safety controls*
  7) *Quality assurance*
  8) *Changes to the Waste Acceptance Rules*



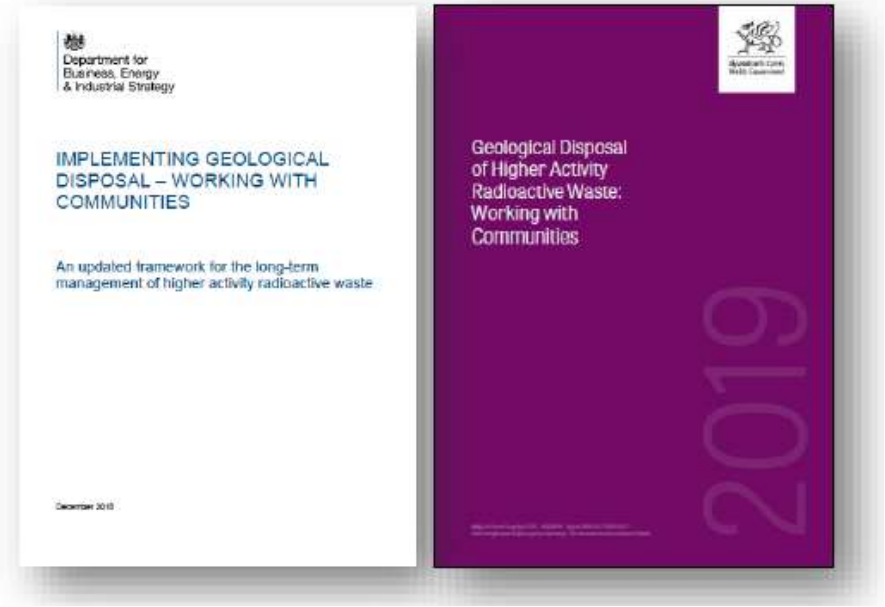
For more details, see Appendix A of: Dounreay, *D3100 LLW Disposal Facilities: Environmental Safety Case 2020*, D3100/4/REP/GAL/40137/IS/01, Issue 1, May 2021

04

WAC FOR GEOLOGICAL DISPOSAL

UK GDF Siting Process: Government Policy Finalised in 2018

Working with Communities Policy is a consent based process



A GDF will only be build where there is <u>both</u> a suitable site and a willing community

NWS has set out Community Guidance and the process for evaluating sites

It is proactively engaging on how it will operate the GDF and the processes it will use

Four Communities Currently Working in Community Partnerships

Likely GDF Sites will be inshore, under sea, accessed from land

- Cumbria – location of Sellafield
- Nuclear communities
- Coastal sites
- Focus is mudstone geology inshore

- Coastal, specific brownfield site, flood zone
- Non-nuclear community
- Focus is claystone geology inshore

WAC for Geological Disposal in the UK

Current packaging specifications for wastes destined for geological disposal are derived from generic safety cases

Host rock	Illustrative Geological Disposal Concept Examples[d]	
	LHGW	**HHGW**
Higher strength rocks[a]	UK ILW/LLW Concept *(NDA, UK)*	KBS-3V Concept *(SKB, Sweden)*
Lower strength sedimentary rock[b]	Opalinus Clay Concept *(Nagra, Switzerland)*	Opalinus Clay Concept *(Nagra, Switzerland)*
Evaporites[c]	WIPP Bedded Salt Concept *(US-DOE, USA)*	Gorleben Salt Dome Concept *(DBE-Technology, Germany)*

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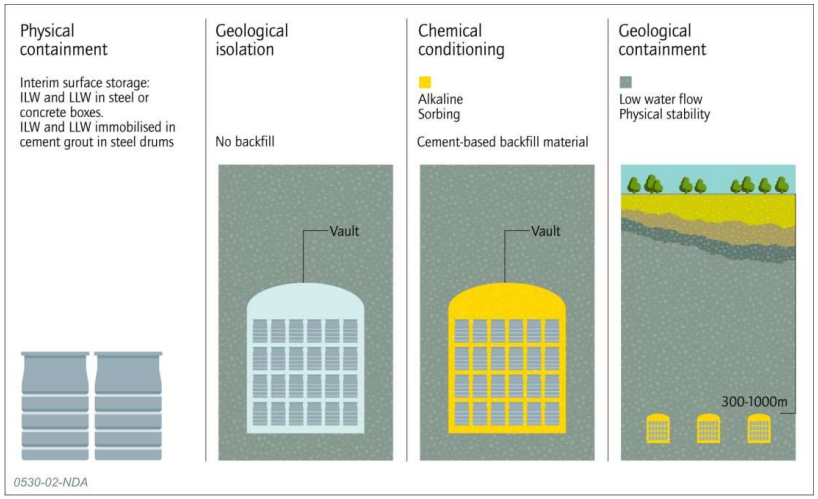
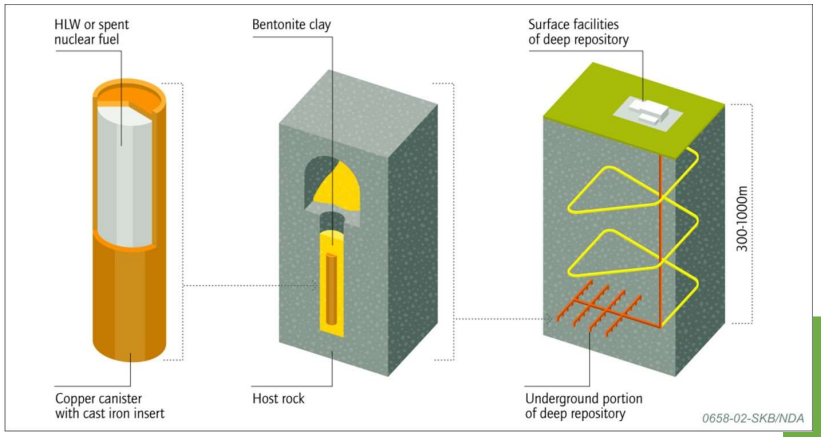
Multi-barrier disposal concept for LHGW



Multi-barrier disposal concept for HHGW

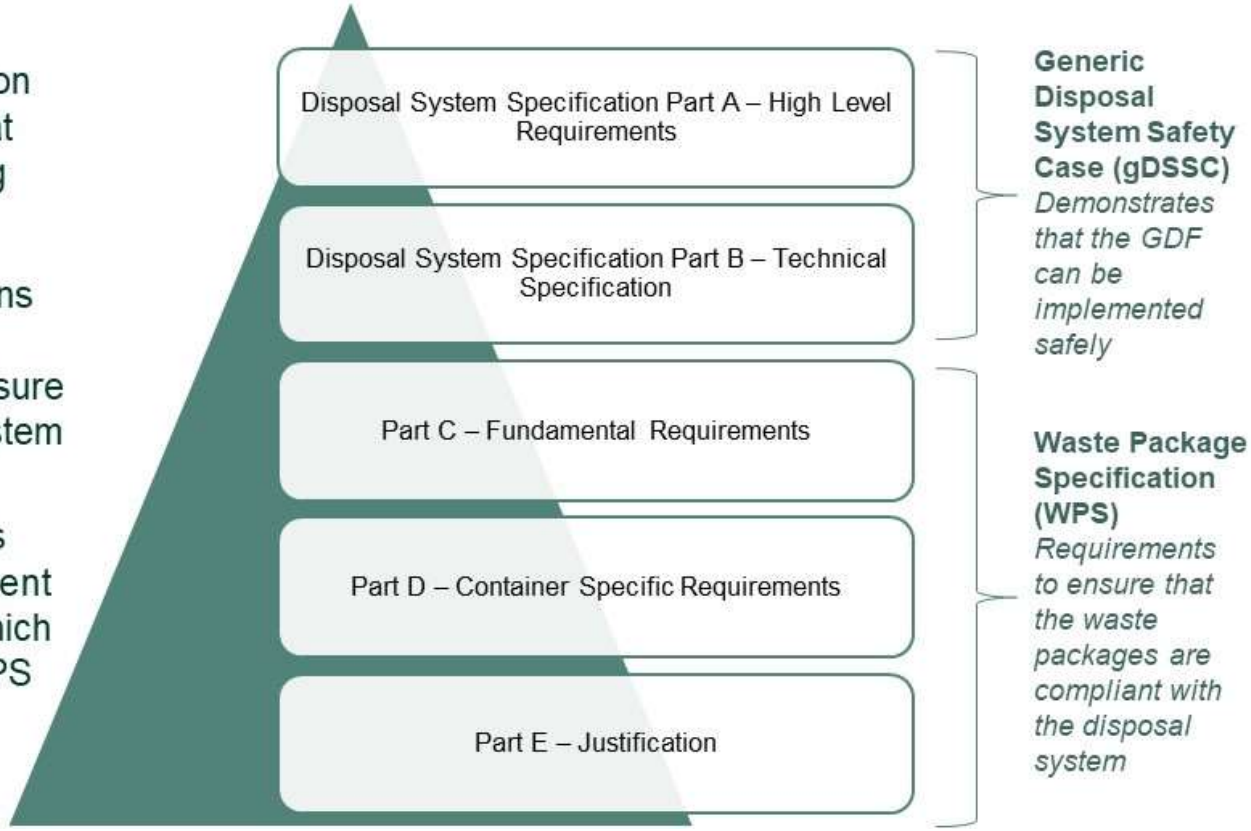


Hierarchy of generic Waste Package Specifications and Guidance

The Disposal System Specification (DSS) captures requirements that scope and bound the engineering design work

The Waste Package Specifications (WPS) set out the requirements placed on waste packages to ensure compliance with the disposal system

The Thematic Guidance supports waste producers in the development of waste packaging proposals which meet the requirements of the WPS

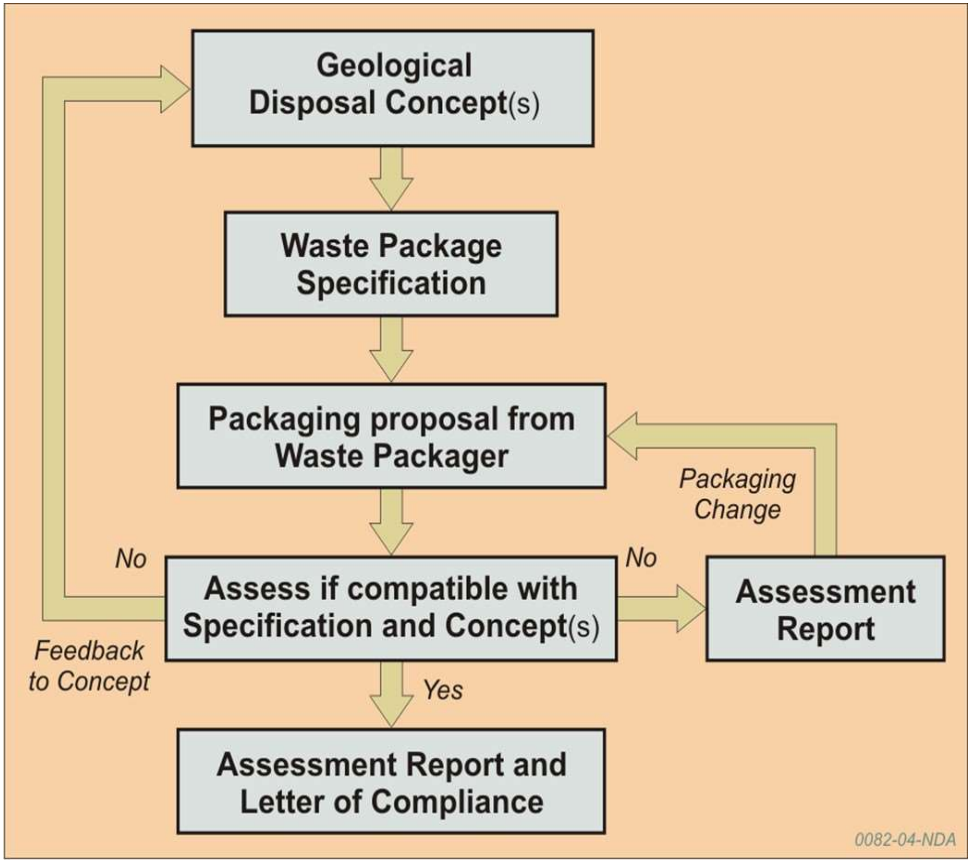


Evolution to Waste Acceptance

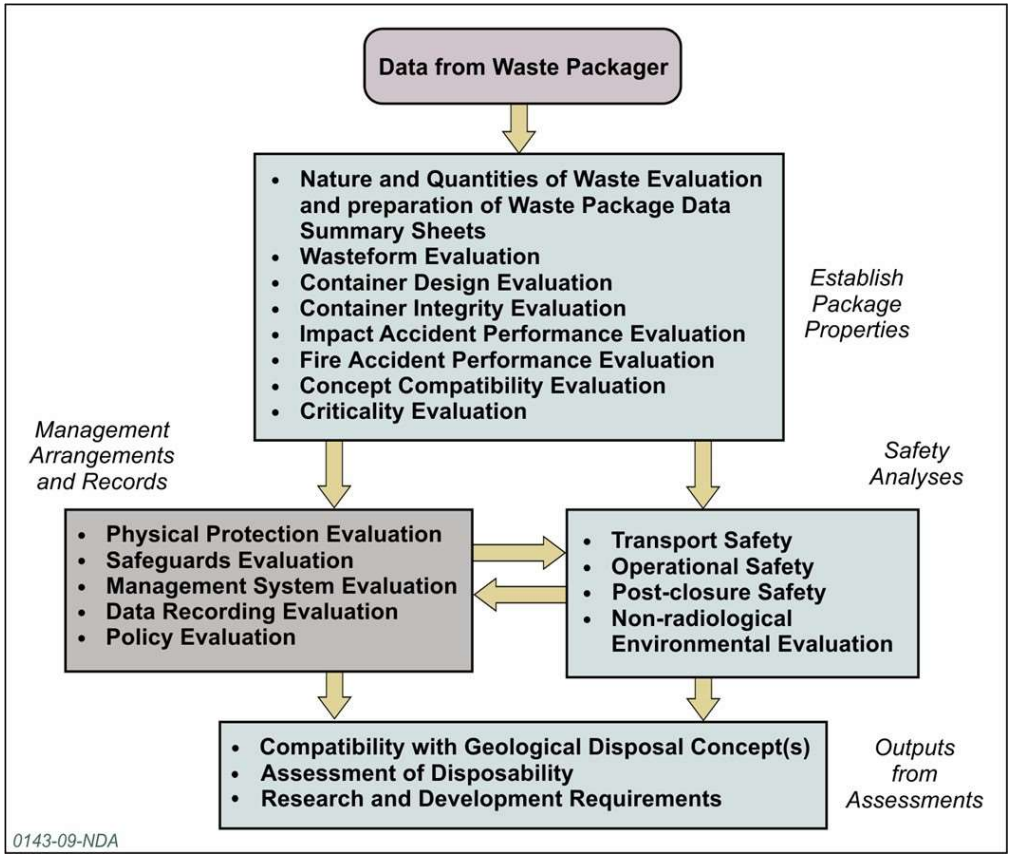
- **Definition of WAC for a disposal facility has two strands:**
  - The definition of the WAC themselves
  - Procedures by which the acceptability of individual waste package can be judged; the acceptance process
- **WAC ultimately will be derived from the safety case submissions for an operational GDF, based on evolution of packaging requirements**
- **Extended period before disposal allows progressive increase in confidence in the acceptability and early action if deviations are recognised**
- **Development of WAC, and waste acceptance, is an evolutionary process over an extended period, enabled through:**
  - Increasing clarity of the criteria that ultimately would become WAC
  - Maintenance of clear and sufficient records
  - Building confidence in the condition of waste packages

Assessing Disposability

- ***NWS's Disposability Assessment process systematically tests the compatibility of waste packaging proposals by evaluating them against the generic WPS***
  - *Commenced in late 1980s*
  - *~1000 assessments completed*
  - *Programme determined by waste custodians*
- ***It also serves to test the completeness of safety cases / requirements for real wastes***
- ***Packaging proposals are endorsed through issue of a Letter of Compliance (LoC)***



Assessing Disposability



- **Inventory challenge:**
  - Origin of waste, fissile content, variability, uncertainty
- **Package design and properties:**
  - Container type, immobilisation matrix (if any), accident performance
- **Compliance with disposal system:**
  - Disposal concept and design, package specifications
- **Fulfilment of management requirements:**
  - Records, Management System, criticality compliance
- **Compatibility with safety cases:**
  - Transport, operations, environmental (post-closure)

Maintaining the generic WPS and managing non-compliance

- ***NWS's assurance approach provides for continuing maintenance and management of the validity of waste packaging endorsements (and packages produced under them)***
  - *Gives confidence in the disposability of both waste packages currently being produced and existing waste packages in interim storage*
- ***Continuous management of acceptability of wastes, providing gradual waste acceptance and confidence in future disposal, primarily through:***
  - *Annual review of endorsements to identify any requirement for update responding to e.g. evolution of the DSSC; acquisition of new knowledge / operational experience, changes in regulatory expectations, …*
  - *Periodic Review Disposability Assessments (~every ten years)*
  - *Consolidation of LoCs for related wastes / packaging processes*
  - *Cross-cutting reviews and technical audits*
- ***These mechanisms provide for early recognition of an emerging non-compliance and/or recognition that an existing endorsement is in some way no longer valid***
  - *Allows timely intervention and/or risk management*

05

SUMMARY

Summary

- ***In the UK, facility specific WAC are established for the LLWR and D3100 at Dounreay (and also for VLLW disposal)***
  - *All are derived based on the requirements of the respective safety cases*

- ***Generic waste package specifications (preliminary WAC) for a UK GDF (at a site TBD)***
  - *Used as the basis for evaluating waste packaging proposals via a structured, long-established process*
  - *Bounding (conservative) requirements, accounting for safety cases applicable in three geological environments*
  - *Will evolve into site-specific WAC when site-specific conditions are known*

QUESTIONS?

Liz Harvey (ejh@galson-sciences.co.uk)

Thanks to Rob Winsley, Andy Harris & Abbie Evans of NWS for inputs

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MOBILITY MISSION REPORT

This work has been partially supported by the EURAD project that has received funding from H2020-EURATOM 1.2 under grant agreement ID 847593.

The information included in this mission report consists of personal data of applicants, and in the frame of GDPR we ask you place emphasis on its integrity: the personal data in this mission report cannot be used for purposes other than the evaluation and the management of EURAD Mobility Programme. For the avoidance of doubt, this information – out of its nature – is confidential information as mentioned in Article 10.1 of the EURAD Consortium Agreement Version [17/09/2019] with effective date of 1 June 2019 (although it might not be explicitly marked as such).

MISSION TITLE

Training course of EURAD Summer School on Waste Acceptance Criteria

DESCRIPTION

Concerned organisations

- Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT). Madrid, Spain.
- Řež. Prague, Czech Republic

Themes and topics

EURAD and PREDIS have organized a joint Summer School on Waste Acceptance Criteria (WAC) for radioactive waste. During this five-day Summer School, participants will learn about the basics of WAC, WAC development and application, and examples of WAC in national programmes. Lectures will be complemented with exercises and two technical visits to radioactive waste facilities.

Upon successful completion of this training course, participants should be able to:

- Describe the waste management life cycle
- Describe the roles and responsibilities for the different elements of waste management, broadly understand the role and usefulness of requirements management
- Describe and explain waste acceptance systems and waste acceptance criteria elements
- Understand and explain the importance of waste acceptance criteria/waste acceptance process
- Discuss the WAC development process
- Provide examples of types of WAC
- Design WAC for a program without a disposal facility
- Describe WAC for legacy, non-standard, and problematic radioactive waste
- Discuss the treatment of non-conformances and departures from established WAC
- List examples of WAC in existing national programmes

Keywords

Radioactive waste, waste acceptance criteria, waste disposal safety, licensing, waste acceptance system.

EXECUTIVE SUMMARY

EURAD and PREDIS recently collaborated to host an intensive five-day Summer School focused on Waste Acceptance Criteria (WAC) for radioactive waste management. This comprehensive program provided participants with a deep understanding of WAC fundamentals, their development, and practical applications within national waste management frameworks. The Summer School combined insightful lectures with hands-on exercises and enlightening technical visits to radioactive waste facilities. Graduates of this training course are now equipped to describe the entire waste management life cycle, comprehend the various roles and responsibilities within waste management, and appreciate the significance of requirements management. They can elucidate waste acceptance systems and criteria, emphasizing their vital role in the waste acceptance process, and are adept at discussing the WAC development process. Additionally, participants can provide examples of diverse WAC types, design WAC for programs lacking disposal facilities, and navigate the intricacies of WAC for legacy, non-standard, and problematic radioactive waste. Moreover, they are well-versed in addressing non-conformances and deviations from established WAC, and are capable of identifying and citing examples of WAC within existing national waste management programs. This Summer School has undoubtedly enhanced their expertise and prepared them to make significant contributions to the field of radioactive waste management.

1. MISSION BACKGROUND

The EURAD Summer School presents a unique opportunity to delve into the fundamentals of waste acceptance criteria, their development, and their role within national and international waste management frameworks. The mission to attend this Summer School is driven by the desire to make a meaningful contribution to the sustainable management of radioactive waste, safeguarding both the environment and public health. The knowledge gained through this program will enable participants to describe the entire waste management life cycle, comprehend the nuanced roles and responsibilities inherent in this discipline, and critically assess the importance of requirements management.

Furthermore, the Summer School will empower attendees to articulate waste acceptance systems and criteria with precision, emphasizing their critical function in the waste acceptance process. Participants aim to grasp the intricacies of WAC development, learning how to design criteria for programs lacking disposal facilities and navigate the complexities of legacy, non-standard, and problematic radioactive waste.

Upon completing this mission, attendees intend to return with the ability to address non-conformances and deviations from established WAC effectively. By participating in this Summer School, they also anticipate gaining valuable insights into examples of WAC within existing national waste management programs, which will inform their future work in this field.

Ultimately, the mission background is defined by the commitment to enhancing capabilities as professionals in radioactive waste management, with the goal of

contributing to sustainable and responsible waste disposal practices that benefit society and protect the environment.

1.1. Mission objectives

- Enhance Understanding of WAC Fundamentals: to provide participants with a comprehensive understanding of the fundamentals of Waste Acceptance Criteria (WAC).
- Equip Participants with Practical Skills that are essential for working with WAC in real-world scenarios. This includes hands-on exercises, case studies, and technical visits to radioactive waste facilities to provide practical experience in applying WAC to different waste types and disposal situations.
- Promote Interdisciplinary Collaboration: The course aims to foster interdisciplinary collaboration and networking among participants. An objective is to encourage participants to exchange ideas and experiences, building a network of professionals who can collaborate effectively in the field of radioactive waste management, particularly in the context of WAC.
- Prepare Participants for Decision-Making Roles: to prepare participants for decision-making roles in the management of radioactive waste. This involves not only understanding WAC but also the broader waste management life cycle, roles and responsibilities, and the ability to design and implement effective WAC systems.

1.2. Mission request

The mobility plan is requested in order to help cover travel, lodging and food expenses for the 5 days of the course. In addition, attendance to the course is expected to complement the training contemplated in the PhD research program of the beneficiary's doctoral studies.

1.3. Mission composition

Host organisation

Řež, Czech Republic

Host facility

Centrum výzkumu Řež s.r.o

Mission dates

September 4 – September 8, 2023

2. DELIVERY STRATEGY

The methods of the Summer School have been developed to address the training needs of all stakeholders, including adherence to regulatory mandates. These methods encompass several facets, including delineating lecture content, specifying relevant

regulations and guidelines pertaining to the covered subjects, elucidating work practices, equipment usage, and procedural aspects targeted for training, and providing a contextual framework to better understand the intricacies of the topics discussed in depth.

Among these methods we can name:

•Face-to-face classroom lectures,
•Practical exercise and discussions as a priority,
•Technical visits to radioactive waste repositories and research laboratories

2.1. Course duration

The course had a duration of 5 days for a total of 33 hours, which were divided:

- 15 theoretical classes,
- Two field trips to UJV/CVR waste processing facilities and to the Richard repository.
- Exercises on the formulation of WAC proposals for challenging waste forms.

2.2. Target Audience

- *PhD students from the EURAD and PREDIS projects*
- *Professionals/Experts working with WAC*
- *National Regulators*
- *Technical Support Organizations*
- *Waste Management Organizations*
- *Civil Society Experts*
- *Researchers involved in the Radioactive Waste Management*

2.3. Evaluation Strategy

The course evaluation was based on discussion/questions sessions at the end of each of the presentations, in which all students were encouraged to participate by providing a critical view on the implementation of WAC for potentially problematic waste streams that could arise in the different European national scenarios. Additionally, at the end of the course, exercises were presented in which the students had to propose different WAC and management methods for different types of waste, emphasizing the whole waste management cycle until a final solution for its disposal was proposed.

Benefits

Offer a comprehensive understanding of Waste Acceptance Criteria (WAC) and their critical role in radioactive waste management, equipping attendees with practical skills through hands-on exercises and technical site visits, fostering interdisciplinary collaboration and networking opportunities, and preparing participants for decision-making roles in waste management programs. Additionally, the course provides valuable insights into regulatory compliance, enhances knowledge of the waste management life cycle, and empowers individuals to contribute effectively to sustainable and responsible radioactive waste disposal practices, ultimately advancing environmental protection and public safety in the nuclear industry.

3. MISSION FINDINGS AND CONCLUSIONS

3.1. Lessons learned and conclusions

The EURAD Summer School on Waste Acceptance Criteria has been an invaluable educational experience that has deepened participants' understanding of this crucial aspect of radioactive waste management. Through a comprehensive curriculum that covers the fundamentals of WAC, practical applications, and regulatory considerations, attendees have gained essential knowledge and skills. The interactive nature of the course, including hands-on exercises and technical site visits, has provided a real-world perspective that enhances their ability to apply WAC effectively. Furthermore, the collaborative environment of the course has fostered connections and partnerships among professionals in the field. With the knowledge and tools acquired, participants are well-prepared to play instrumental roles in addressing the challenges of radioactive waste management, ensuring that waste acceptance criteria are met while safeguarding the environment and public health. The EURAD Summer School has indeed empowered attendees to make meaningful contributions to the sustainable and responsible disposal of radioactive waste, furthering the mission of responsible nuclear energy production.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
09:00 to 09:45	Arrival to Prague	WAS development process (S. Konopaskova)	Generic (preliminary) WAC (A. Baksay) Examples of national WAC systems: Belgium (Ch. De Bock)	Excursion to Richard repository Czech RWM system Waste acceptance process (M. Macelova)	Exercise: Proposal of WAC for challenging waste forms (L. Nachmilner)
09:45 to 10:30		Types of WAC (L. Nachmilner)	Hungary (A. Baksay)		
Break					
11:00 to 11:45		Responsibilities & requirement management (P. Zuidema)	Spain (José Luis) UK (L- Harvey)		Exercise: reporting about results (L. Nachmilner)
11:45 to 12:30 **13:30**	Registration in CVR	Examples of national WAC systems: Switzerland (P. Zuidema)	Discussion on national differences/commonalities (all)		Wrap-up discussion Evaluation of the event Conclusions Closing
Lunch					
14:00 to 14:45	Introduction, goals of the course (L. Nachmilner)	WAC specifics (Jeroen Mertens - BelV)	Excursion to UJV/CVR waste processing facilities	Excursion follow-up discussion	
14:45 To 15:30	RWM lifecycle (J. Faltejsek)	Acceptance of problematic waste (J.-L. Leganés Nieto)			
Break					
16:00 to 16:45	Description of WAS (S. Konopásková)	Treatment of non-conformances (J.-L. Leganés Nieto)			
16: 45 to 17:30	WAC in different stages of RWM (L. Nachmilner)	France (V. Wasseline)			

MISSION BENEFICIARY

Mikel Daniel Dieguez Iribarren
PhD Student
Unit of Physicochemistry of Actinides and Fission Products
Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT). Spain

PARTNER EXPERTS CONTRIBUTING TO THE MISSION

Host organisation experts

- Lumír Nachmilner, Head of Waste Disposal Unit. CV Řež. Prague
- Jiří Faltejsek, House consultant at SÚRAO and ÚJV Řež. Prague
- Soňa Konopásková, Research and development activities in NRI Řež. Prague
- Piet Zuidema, Former director Science & Technology, Nagra, Zuidema Consult GmbH. Switzerland
- Jeroen Mertens, Bel V
- José Luis Leganés Nieto, ENRESA
- Virginie Wasselin, Andra
- Attila Baksay, TS Enercon Ltd., Hungary
- Chris De Bock, ONDRAF/NIRAS
- Liz Harvey, Galson Sciences Ltd
- Martina Máčelová, SURAO

Home organisation experts

- Tiziana Missana, Head of the Unit of Physicochemistry of Actinides and Fission Products, CIEMAT. Spain

REPORT APPROVAL

Date	Beneficiary	Home mentor/supervisor	Host mentor/supervisor
Date of last signee	Name	Name	Name
	Visa	Visa	Visa

Mikel Dieguez 11/10/2023

11/10/2023 Tiziana Missana .