



Deliverable 13.13: Overview of all School of Radioactive Waste Management during EURAD

Work Package 13

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Executive Summary

In the European Joint Programme on Radioactive Waste Management (EURAD), Work Package 13 ('Training & Mobility') and the School of RWM focussed on four main pillars, two more than originally planned. Despite COVID-19 challenges, significant achievements were made across all pillars. This deliverable outlines all activities by WP13 within the School of RWM and reflects on successes and areas for improvement in the 'Lessons learned' section.

Overall, the School met its main objectives, receiving highly positive feedback for the 'Courses & Webinars' and 'Mobility Programme' pillars, as well as support for EURAD PhD students. However, improvements can be made, ranging from minor adjustments (e.g., enhancing training material quality) to major initiatives (e.g., establishing a PhD community within EURAD).

The School of RWM has been highly successful, becoming a valuable resource for end-users and contributing to competence building in the (European) RWM community. It also was part of and actively supported EURAD's Knowledge Management Programme. For example by publishing most of its activities accessible online, including Lunch & Learn recordings and mobility reports.

In conclusion, the School of RWM has established a solid foundation for competence building in RWM in Europe. Its successes and identified areas for improvement highlight the value of continuing its activities in future RWM projects.

Keywords

Training

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Skill

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Table of content

Executive Summary	4
Keywords	4
Table of content	5
List of figures	7
List of Tables	8
Glossary.....	9
1. Introduction	10
2. Pillar 1 – Courses & Webinars.....	12
2.1 Training courses	12
2.1.1 Overview of all EURAD training courses	12
2.1.2 Summary of end-user feedback following the training courses.....	25
2.2 Webinars.....	26
2.2.1 Overview of all EURAD webinars	27
2.2.2 Recordings and views of the webinars	42
2.2.3 End-user feedback.....	43
3. Pillar 2 - Mobility Programme	44
3.1 Mobility applications	44
3.2 Details concerning the Mobility Programme	45
4. Pillar 3 – Panorama	47
5. Pillar 4 – PhD students	48
5.1 EURAD School website	48
5.1.1 Overview of EURAD PhDs	48
5.1.2 A list of publications by PhD students	48
5.1.3 List of events.....	48
5.1.4 List of available PhD and post-doc positions.....	49
5.1.5 Discussion forum	49
5.2 1 st EURAD PhD Event	49
5.3 EURAD Annual Event N°1.....	50
5.4 EURAD Annual Event N°2.....	50
5.5 EURAD Annual Event N°3.....	51
5.6 EURAD Final Event	51
5.7 Considerations regarding the PhD students in EURAD	52
6. Lessons learned	53
6.1 Pillar 1 – Courses & Webinars.....	53

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

6.2 Pillar 2 – Mobility Programme.....	54
7. Conclusion.....	56
References	57
Appendix A. Feedback form for training course participants	58

List of figures

Figure 1. Schematic overview of the School of Radioactive Waste Management, highlighting its four main activities: (i) courses and webinars, (ii) Mobility Programme, (iii) panorama (i.e. providing a broad and general view of all aspects related to radioactive waste management through the School's activities), and (iv) the supporting the PhD Community. 10

Figure 2. Overview of mobility applications. The EURAD Mobility Programme has received 105 complete applications, of which 98 were accepted. This results in an overall success rate of 93%. 44

Figure 3. Evolution of the EURAD Mobility Programme. Evolution of the number of accepted applications within each of the main categories of the EURAD Mobility Programme between 2020 and 2024. In total, 98 out of 105 applications were accepted. 45

List of Tables

No table of figures entries found.

Glossary

ACED	Assessment of Chemical Evolution of ILW and HLW Disposal Cells
DONUT	Development and Improvement Of Numerical methods and Tools for modelling coupled processes
EJP	European Joint Programme
EQF	European Qualifications Framework
EURAD	European Joint Programme on Radioactive Waste Management
FTF	Face-to-face
FUTURE	Fundamental understanding of radionuclide retention
GAS	Mechanistic understanding of gas transport in clay materials
GBS	Goals Breakdown Structure
HITEC	Influence of temperature on clay-based material behaviour
IAEA	International Atomic Energy Agency
IGD-TP	Implementing Geological Disposal of radioactive waste Technology Platform
KM	Knowledge Management
OECD-NEA	Organisation for Economic Co-operation and Development – Nuclear Energy Agency
PREDIS	The pre-disposal management of radioactive waste
PMO	Project Management Office
R&D	Research and development
ROUTES	Waste Management routes in Europe from cradle to grave
RWM	Radioactive Waste Management
SAT	Systematic Approach to Training
SITEX	Sustainable network for Independent Technical Expertise on radioactive waste management
SME	Subject Matter Expert
Roadmap Themes	Large groupings of related Knowledge Domains typical in Radioactive Waste Management. They are the highest level of the EURAD Roadmap Goals Breakdown Structure.
UMAN	Understanding of uncertainty, risk and safety
WP	Work Package

1. Introduction

The main goal of European Joint Programme on Radioactive Waste Management (EURAD) Work Package (WP) 13 was to establish the 'School of Radioactive Waste Management (RWM)'; which acts as the executive body for all training and mobility activities that are organised within EURAD. Over the course of EURAD, the School of RWM developed activities in four main pillars (figure 1): (i) courses and webinars, (ii) Mobility Programme, (iii) panorama, and (iv) supporting the PhD Community. Throughout these pillars, the School aimed to make sure all activities are needs- and quality-driven. Additionally, a dedicated webpage (<https://euradschool.eu/>) was launched as a communication channel concerning all of the School's activities.

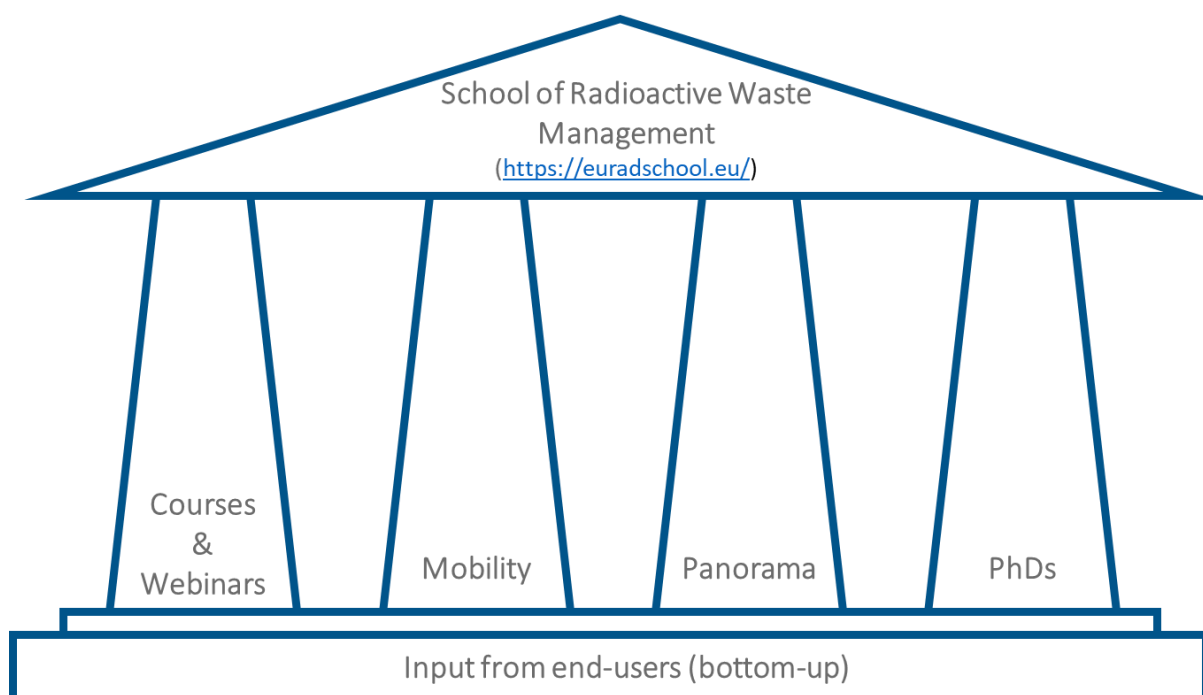


Figure 1. Schematic overview of the School of Radioactive Waste Management, highlighting its four main activities: (i) courses and webinars, (ii) Mobility Programme, (iii) panorama (i.e. providing a broad and general view of all aspects related to radioactive waste management through the School's activities), and (iv) the supporting the PhD Community.

The School's first pillar responds to the training needs its end-users (D13.1)¹ (figure 1). The training courses that the School organised are linked to the EURAD Roadmap (D1.7)², which is used as a guide to map existing training courses, as well as the training courses developed by the School (D13.2)³. The School prioritises training courses based on the identified training needs by the RWM community and published an overview of past, current and newly developed training courses (D.13.3)⁴. In general, training courses within EURAD are organised based on the Systematic Approach to Training (D13.5)⁵ and experiences from the first training courses that were organised (D13.6)⁶. In addition to training courses, the School, in close collaboration with the Project Management Office (PMO) of EURAD, started organising a webinar series called 'Lunch & Learn sessions' during the COVID-19 pandemic to compensate for the lack of face-to-face training opportunities. These informal webinars on both broad and specific topics are meant to share knowledge with the entire EURAD community and beyond. As time went on, multiple online training and information sessions were included as well (D13.11)⁷. All online sessions are recorded in order to preserve knowledge and to facilitate dissemination (<https://euradschool.eu/events/category/eurad-webinar/list/?eventDisplay=past>).

The School's second pillar contains the EURAD Mobility Programme (figure 1). Early in 2020, the School of RWM launched the EURAD Mobility Programme (D13.7)⁸(D13.8)⁹. The main objective of this Mobility Programme is to financially support end-users in: (i) performing internships, (ii) performing technical

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

visits, (iii) attending (international) training courses, and (iv) attending conferences in the field of radioactive waste management. Initially, the Mobility Programme focussed on the first two activities, but through a tiered approach and continuous monitoring of the Mobility Programme's performance and end-user feedback, the latter two activities were also included over time. While the first pillar of the School focusses mostly on transferring explicit knowledge, the Mobility Programme focusses on transferring mostly implicit and tacit knowledge through internships and technical visits to EURAD partners' infrastructures. In addition, it also feeds into the School's first pillar through the support for attending training courses (and conferences).

The third pillar is a standout pillar, as it is not directly related to a type of activity undertaken by the School of RWM (figure 1). This overarching pillar was created to ensure that the School provides information on all aspects related to radioactive waste management programmes throughout all of its activities. The aim is to make clear that not only scientific experts, but also generalists are required for a successful waste management programme. Therefore, highlighting the importance of all aspects and domains of the EURAD Roadmap are the main objectives of this pillar.

The fourth and final pillar consists of activities that the School organises to support EURAD's PhD student community. The aim is to facilitate academic and professional growth while fostering a sense of community among PhD students, but also researchers, and other end-users within the School of RWM. To this end, the School provides: (i) information on available/upcoming courses, (ii) mobility actions, (iii) an overview of PhD research in EURAD, (iv) a list of events of interest for PhD students, and (v) fostering PhD community engagement. Through these activities the School aims to support the PhD community in their competence building, while also acknowledging the role of PhD students as the future key figures in radioactive waste management.

All information on the School's activities can be consulted online via <https://euradschool.eu> (see also D13.12¹⁰). This deliverable provides an overview of all activities the School of RWM has undertaken in each of its pillars, as well as a summary of end-user feedback and lessons learned.

2. Pillar 1 – Courses & Webinars

2.1 Training courses

This section contains a comprehensive overview of all training courses that were organised by the EURAD School of RWM. They can also be consulted on the School of RWM's website: <https://euradschool.eu/events/category/eurad-training-course/>. Additionally, a summary of end-user feedback is included. In a later section, lessons learned will also be discussed (see section 6.1).

This section will build of what is described in earlier deliverables by WP13, namely D13.6⁶ and D13.9¹¹. It contains less details than D13.9, but sufficient information to get a clear picture of all activities performed in this pillar (i.e. a description of each training course and its learning outcomes).

2.1.1 Overview of all EURAD training courses

An overview of all EURAD training courses can be found in Table 1 – Overview of all EURAD training courses. This table serves as a capstone for the rest of this section. In the subsections, a short description and the main learning outcomes for each training course are listed (see also D13.6⁶ and D13.9¹¹).

Table 1 - Overview of all EURAD training courses

Title	Date	Location	# attendees
EURAD Training on Multiphysical couplings in geomechanics	January 20 – 24, 2020	University of Liège, Belgium	75
Introductory course on EURAD and Radioactive Waste Management	September 14, 2020	Online	260
WP FUTURE Education & Training Event on the scientific basis and safety relevant aspects of radionuclide transport and retention	November 17, 2021	Online	50
EURAD Training Course on Safety Case Development and Review	November 28 – December 2, 2022	SURO, Prague, Czech Republic	19
Information session and discussion on the Spent Fuel State-of-Knowledge document	January 18, 2023	Online	54
Geochemical and Reactive Transport Modelling for Geological Disposal	February 6 – 10, 2023	University of Bern, Switzerland	30
EURAD Training course on Uncertainty Management	February 14 – 16, 2023	BelV, Brussels, Belgium	24
Information and discussion session on the SoK document on Containers	June 5, 2023	Online	67
Multiphysics and multiscale coupled processes in geomaterials – Focus on thermal effects and	August 28 – September 1, 2023	University of Liège, Belgium	48

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

gas transfer impact on the behaviour of geomaterials			
EURAD-PREDIS Summer School on Waste Acceptance Criteria	September 4 – 8, 2023	Rez Research Centre, Czech Republic	39
Workshop – Ukrainian experience from exercising radioactive waste management under exceptional conditions	October 16, 2023	Online	106
EURAD Training course on application of Requirement Management Systems	January 16 – 18; 2024	Mercure Budapest Castle Hill, Hungary	22
EURAD Training course on Monitoring in Geological Disposal facilities of radioactive waste	January 22 – 26, 2024	Online	95
EURAD Information & Discussion Session on IDKM	April 8, 2024	Online	71
EURAD Training course on the state-of-the-art of container corrosion phenomena under disposal conditions	April 26, 2024	Pullman World Centre Hotel Trade	2

2.1.1.1 EURAD Training course on multiphysical couplings in geomechanics

EURAD Work Package (WP) 'Influence of temperature on clay-based material behaviour' (HITEC) deals with thermal impact and EURAD WP 'Mechanistic understanding of gas transport in clay materials' (GAS) concerns gas transfer, both in the context of geological disposal of radioactive waste. This training course allowed the attendees to improve their understanding of heat transfers, water and gas migration, stress and strain evolution in a repository. It addressed both experimental and numerical investigations, at small (lab) and large (*in situ*) scale. They involved geomaterials such as the host rock, either clayey or crystalline rock, but also bentonite which is typically used in engineered barriers for its sealing capacity. At the end of the training course, participants had a broad view of the state-of-the-art and of the challenges related to the GAS and HITEC WPs research programme. They met a number of key researchers on THM and gas transport in the context of geological disposal, fostering information exchange and cooperation within the geomechanics community.

Upon completing this training course, participants should be able to:

- Understand the basics of thermo-hydro-mechanical (multi-physical) couplings in geomaterials;
- Perceive the experimental evidences and figure out the physical processes at the laboratory scale and from *in situ* tests;
- Capture the fundamentals on constitutive modelling of the relevant phenomena;
- Identify the challenges in numerical modelling of these physical processes.

2.1.1.2 Introductory course on EURAD and Radioactive Waste Management

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

The aim of this course was to give a comprehensive overview of the activities of EURAD, as well as an overview of the state-of-the-art in Radioactive Waste Management. The target audience were primarily PhD students, post-docs and junior professionals in the field of RWM, but the training course was open to all EURAD partners as well as the people from outside EURAD.

The following topics were addressed:

- Framework for radioactive waste disposal
- Introduction to EURAD
- Nuclear Fuel Cycle and Radioactive Waste
- Disposal Concepts
- Facility design
- Safety analysis and safety case

Upon completing this training course, participants should be able to:

- Describe the basic concepts of radioactive waste management
- Understand different disposal concepts
- Describe the aims and structure of the EJP EURAD
- Discuss the importance of safety analysis and safety case
- Discuss the nuclear fuel cycle

2.1.1.3 WP FUTURE Education & Training Event on the scientific basis and safety relevant aspects of radionuclide transport and retention

WP FUTURE is holding Education & Training Event on the scientific basis and safety relevant aspects of radionuclide transport and retention. The event could be of relevance to a broad audience of researchers, especially early career scientists, interested at better understanding the radionuclide retention mechanisms and their role in different disposal concept.

This training courses aims to provide an overview of retention and transport processes, the implication for performance assessment, and the handling of uncertainties.

Upon completion of this training course, participants should be able to discuss the scientific basis for repository safety assessment.

2.1.1.4 EURAD Training course on safety case development and review

EURAD WP13 in cooperation with Organisation for Economic Co-operation and Development – Nuclear Energy Agency (OECD-NEA), Implementing Geological Disposal of radioactive waste Technology Platform (IGD-TP) and the Sustainable network for Independent Technical Expertise on radioactive waste management (SITEX.Network) would like to invite you to participate in the EURAD Training Course on Safety Case Development and Review.

Every national programme dealing with radioactive waste management is obliged to develop the safety case in relation to the radioactive waste facility and related licensing processes. A safety case is generally understood as a collection of safety evidence and arguments demonstrating the safety of the facility and related management process throughout its lifetime.

The modern concept of the safety case was introduced in radioactive waste disposal in the 1990s by the NEA Expert Group on Integrated Performance Assessment. Afterwards, the concept has been further developed by the Integration Group for the Safety Case (IGSC) as well as by the International Atomic Energy Agency (IAEA) and national RWM programmes. In the present, the establishing a long-term safety case for geological disposal is widely adopted practice by the radioactive waste management community, in particular WMOs, TSOs and regulatory authorities.

The wide spectrum of different stakeholders is engaged along RW facility life cycle, including public representatives/experts. In order to ensure the highest possible level of safety of RW facility and to avoid its harmful impact on environment also involvement of research entities is necessary in the process as they mostly ensure necessary research and development (R&D).

Even though that this training course is preferably dealing with deep geological disposal some commonalities can be found with other kind of disposal options as, e.g. near surface disposal facility. The training course aims at providing a good base also for programmes not intending to construct deep geological disposal but considering near surface disposal, as small inventory member states, in particular to gather information on the approach and strategies to scenarios development and uncertainties management.

The aim of the training course is that participants will master their theoretical knowledge and will learn more about safety case objectives, strategy of its development, context and components, documentation and, about the different aspects involved in the safety case process. The role of R&D's will be discussed together with role of different stakeholders and safety case communication. They will learn why having a robust safety case for a radioactive waste disposal facility is crucial. Furthermore, they will learn about the different steps from safety case development, over review to implementation and safety requests settlement based on real life examples of safety case practice from advanced programmes. The lectures will be completed with practical exercise in supporting safety case understanding by different stakeholders.

The training aims at providing knowledge and expertise of main actors engaged in safety case process to provide participants the whole picture of safety case issue. In order to fulfil this objective, there will be engaged the lecturers from the IGD-TP representing disposal repository implementer and safety case developer, SITEX.Network experts representing regulatory body and their Technical Support Organisations, both ensuring safety case review and also experienced in public communication. The theoretical base of the safety case will be introduced by NEA experts engaged in the IGSC having also practical experience with safety case implementation in their national programmes.

During this training course the participants will learn what a safety case entails when related to radioactive waste disposal facility, for which phase facility lifecycle the licensing process is essential, how it is developed and how and by whom it is reviewed. These theoretical lectures are complemented by real life examples for a case study implementation from advanced programme. In addition to EURAD, the lecturers are given by subject matter experts from different organisations: OECD/NEA, IGD-TP and the SITEX.Network.

The one-week training was built on three parts:

- Generic safety case development presented by experts from the OECD/NEA, IGSC, in cooperation with EURAD experts. The focus will be on theoretical bases of safety case

development, in particular on safety case for deep geological repositories (DGR), specific aspects of safety case, safety assessment as a key element of the safety case. Special lecture will be done on the role and management of uncertainties in safety case. The communication with stakeholders will be discussed.

- Safety case review introduced by SITEX.Network will provide regulatory expectation for safety case together with evolving safety case expectation moving from conceptualization to the implementation. The safety case review preparation will be presented. These lectures will be completed with practical feedback from French safety case review. The special tool developed by SITEX enabling better understanding of RWM and safety case by different stakeholders, especially public will be presented.
- The experience of WMO with implementation of safety case will be addressed by IGD-TP lecturers. The practical examples from advanced programmes will be presented, in particular the development of SKB safety case within Swedish programme, the baselines of safety case from German programme and experience from Finish programme on the R&D's role in safety case development and implementations.

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

- Describe the importance of the safety case for a radioactive waste disposal facility
- Discuss the different steps of the safety case development
- Discuss the different steps of the safety case review
- Understand safety requirements in relation to disposal facility
- Discuss safety case strategy, components and documentation depending on safety case evaluation with respect to the facility whole life cycle, in particular within each licensing process
- Discuss existing safety standards, in particular those issued by IAEA, OECD/ NEA
- Provide information about necessary legal framework and international regulation in RWM
- Explain how the safety case in relation to geological disposal is implemented in an advanced programme.

2.1.1.5 Information session and discussion on the Spent Fuel State-of-Knowledge document

During this online lecture, Kastriot Spahiu, the author of the Spent Fuel State-of-Knowledge (SoK) document, discussed the SoK document, which focusses on the release of radionuclides from the spent fuel during disposal. He focused on the highlights from the document and dived deeper into issues related to spent fuel which are not mentioned in detail in the SoK document.

The second part of this lecture contained a discussion session which was based on requests from the audience. Additionally, there were ample room for spontaneous discussions.

This training session was open to all, especially those who had an interest in EURAD SoK documents and spent nuclear fuel.

Upon completion of this session, participants should be able to:

- List the most important aspect of spent fuel research
- Discuss open issues related to spent fuel

2.1.1.6 Geochemical and Reactive Transport Modelling for Geological Disposal

The geochemical evolution of the near field barrier system of a geological disposal is important in view of the safety and performance analyses of the repository as it will influence (i) the durability of the different materials, and (ii) speciation and mobility of radionuclides. Given the time scales involved (ten thousand to hundred thousand years), assessing the evolution can only be done with numerical models in which geochemistry is linked to transport, thus with reactive transport codes.

Geochemical models calculate geochemical state variables based on thermodynamic equilibrium and kinetic processes accounting for processes as aqueous speciation reactions, dissolution/precipitation based on saturation state, sorption based on mechanistic sorption models (exchange reactions, surface complexation) and possible kinetic processes (related e.g. to the dissolution of glass or clay minerals or the corrosion of steel canisters). Reactive transport codes typically couple these geochemical models to flow, heat transport and solute transport solvers. State-of-the-art reactive transport codes may couple this also the water flow or heat transport. Therefore, these codes are capable to simulate coupled thermal, hydraulic, chemical and biological (THCB) processes and possible feedback between the processes. They became a powerful tool for understanding and assessing these coupled processes and the consequences for containment.

Given the complexity of the system and the long-time scales, models typically have large computational times and many uncertainties associated with it. Recent developments in new couplings between different solvers, faster methods to solve equations including methods based on machine learning, and efficient algorithms for uncertainty analysis are crucial in the framework of the analysis of the long-term evolution, optimization and performance assessment of a radioactive waste repository.

In EURAD, the work packages ACED (Assessment of Chemical Evolution of ILW and HLW Disposal cells) and DONUT (Development and improvement of numerical methods and tools for modelling coupled processes) improve and implement codes and models for assessing the geochemical evolution in the near field of a repository. FUTURE develops further understanding in radionuclide migration. In view of that, this training will continue from the state-of-the-art and introduce the new developments acquire in these work packages.

Lectures on different topics related to geochemical and reactive transport modelling (provisional list)

- Modelling geochemical systems – Thermodynamics, databases, reaction progress
- Modelling slow processes (corrosion, dissolution, degradation)
- Modelling properties and geochemistry of cementitious systems
- Geochemistry of the host rock and natural barrier materials: Pore water, mineralogy, matrix-fracture
- Speciation of radionuclides
- Sorption of radionuclides
- Reactive transport modelling
- Uncertainty and sensitivity analysis

- Use of model abstraction – surrogate modelling – machine learning in geochemical and reactive transport modelling

Hands-on on implementation of geochemical and reactive transport modelling (about 10 sessions). Based on two applications linked to ACED and FUTURE and are used in DONUT for benchmarking, participants will be trained in defining a conceptual model and implementing it in a geochemical and reactive transport code. The participants can choose from one of 3 codes based on GEMS, ORCHESTRA and PHREEQC – it is advisable to join the same code during the whole training. We will strive to have an equal distribution of the participants between the three codes. The two applications are:

- Cementitious materials (ordinary Portland cement): database, hardening, geochemistry and other properties, chemical degradation/alteration, leaching or carbonation
- Uranium sorption on clay materials: database, speciation, sorption to clay minerals, migration

Demonstration of other codes: during short lectures, an introduction to a number of other geochemical and coupled reactive transport codes that are used in the framework of radioactive waste disposal. Examples are CRUNCH, MIN3P, HYTIC/CHESS, CORE, OPENGEOSYS, OpenFOAM-PHREEQC, ICP (specific choices will depend on the availability of presenters)

The training aims at enlarging knowledge and expertise in geochemical and coupled reactive transport modelling in the framework of disposal of radioactive waste with the focus on geological disposal. The theoretical basis will be enhanced by lectures on (i) principles of geochemical and reactive transport modelling, (ii) their applications for processes and evolution of materials in a geological disposal (cementitious materials, glass, steel, clay, granite) (iii) speciation and migration of radionuclides, and (iv) advanced topics related to uncertainty and machine learning. Practical skills will be improved by computer sessions in which participants will use available software to implement and analyze models for calculating properties and evolution of materials and speciation of radionuclides.

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

- Understand the principles of geochemical thermodynamic and kinetic modelling and reactive transport modelling
- Use these principles for application in the field of radioactive waste disposal
- Transform specific research questions related to geochemical properties or evolution into a conceptual model
- Implement simple conceptual models into numerical codes for geochemical and reactive transport modelling
- Identify advanced methods for sensitivity analysis, uncertainty analysis and integration of machine learning techniques

2.1.1.7 EURAD Training course on Uncertainty Management

The main aim of the training is to address the training need “7.3.1 Treatment of uncertainty” identified in EURAD deliverable D13.1 as one of the five most urgent and highest priority topics. The training will also address other urgent and high priority topics such as “7.1 Safety strategy”, “3.1 Confirm wasteform compositions, properties and behaviour under storage and disposal conditions, including impact on the disposal environment (wasteform)” or “3.1.1 Spent Nuclear Fuel”.

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

- Understand and classify the different types of uncertainties that may need to be managed in a RW disposal programme
- Explain the links between uncertainty management, the safety case and the decision-making process
- Use the global UMAN scheme of uncertainty management strategies
- Explain the main strategies and approaches available to manage uncertainties
- List the approaches available to perform uncertainty and sensitivity analyses and discuss their pros and cons
- Grasp the views of Civil Society representatives involved in EURAD on uncertainty management
- Understand potentially significant uncertainties related to the waste inventory (with a special focus on problematic wastes, organic-bearing wastes and the radiological characteristics of spent nuclear fuel) and discuss their significance
- Understand potentially significant uncertainties related to human aspects and discuss their significance
- Describe and discuss the options available to manage specific examples of uncertainties related to the waste inventory and human-related aspects

2.1.1.8 Information and discussion session on the SoK document on Containers

The presentation will be based on the State of Knowledge (SoK) report for HLW/SF Containers (Domain 3.2.1). Various aspects of container design and long-term performance will be covered in the talk, including: (i) safety functions, performance targets and container requirements, (ii) the factors underlying the choice of container material, (iii) a description of the nature of the environmental conditions and mechanical loads to which the container will be exposed and how they evolve over time, (iv) container design and fabrication, (v) the post-closure corrosion and mechanical performance of the container, and (vi) lifetime prediction and methods for justifying those predictions over the long timescales of interest. Emphasis will be placed on the long-term corrosion behaviour of the container, although the mechanical performance and the impact of coupled corrosion-mechanical degradation modes will also be considered. The talk will focus on the design and performance of “conventional” container materials, including carbon steel, copper, titanium, and nickel alloys, with some discussion of copper-coated designs. Other types of metallic and ceramic coating and the use of bulk ceramics as container materials are outside of the scope of this SoK.

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

- Discuss the basis for the selection of the container material and design.

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

- List the advantages and disadvantages of different container materials and repository designs.
- Understand the importance of the nature of the environment to which the containers will be exposed in the repository and relating these to the conditions used in laboratory experiments.
- Understand the corrosion behaviour of the various alloys proposed as container materials and of the types of corrosion that are, and are not, expected to occur.
- Discuss the importance of developing a sound mechanistic understanding of the corrosion and mechanical processes in order to support long-term predictions.
- Provide an overview of the types of empirical and deterministic models that have been developed to support both the calculation of container lifetimes and the broader safety case.

2.1.1.9 Multiphysics and multiscale coupled processes in geomaterials – Focus on thermal effects and gas transfer impact on the behaviour of geomaterials

Geomechanics plays a significant role in the understanding of the multiphysics and multiscale processes taking place in a geological disposal facility for radioactive waste. The objective of the training course is to introduce state-of-the-art understanding, concepts and methods related to thermo-hydro-mechanical coupled processes, the physical impacts of thermal loading and the mechanistic understanding of gas migration in geomaterials. Results from the EURAD project will be integrated to the course. Half day will be dedicated to presentations by early-career researchers. A visit to the HADES Underground Research Laboratory (EURIDICE, Mol, Belgium) will be organised on the last day of the course.

2.1.1.10 EURAD-PREDIS Summer School on Waste Acceptance Criteria

EURAD and PREDIS are organising 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 programs. Theoretical lectures are complemented with exercises and two technical visits.

Upon completion of this Summer School, participants should be able 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

2.1.1.11 Ukrainian experience from exercising radioactive waste management under exceptional conditions

During times of war, licensees of nuclear and radiation technology facilities may be unable to meet regulatory safety requirements designed for peacetime. This challenge has arisen in Ukraine, particularly within the radioactive waste and spent nuclear fuel management facilities located in the Chernobyl Exclusion Zone and units of the Chernobyl Nuclear Power Plant under decommissioning. Regulating the safety of facilities with nuclear and radiation technologies during wartime is an unprecedented task.

In an upcoming workshop, representatives from the Ukraine's nuclear regulatory body (SNRIU) and its Technical Support Organization (SSTC NRS), will share their experiences regarding the three topics mentioned below.

1. Maintaining Safety Principles and Provisions in Wartime Conditions

The SNRIU, in collaboration with the SSTC NRS and with support from the Norwegian regulatory body (DSA), has developed approaches and procedures for regulating the safety of facilities and activities within the Chernobyl Exclusion Zone during wartime. The core of this approach is to require licensees to operate facilities in modes with minimal risk of emergencies and accidents while limiting authorized activities. Based on this, the scope of application of the safety principles and general provisions has been determined.

2. Handling Licensing Matters During and After Liberation by the Hostilities

After regaining by Ukraine control of the Chernobyl Exclusion Zone, licensees of facilities within the zone faced challenges complying with safety requirements due to factors such as a shortage of personnel and uncertainty regarding the safety of the facilities following the uncontrolled presence of occupying troops. In response, the regulatory body temporarily suspended licenses and established conditions for their reinstatement. Before license restoration, facility operators had to ensure the facilities were in a safe state, capable of conducting authorized activities, and underwent comprehensive safety inspections. The SNRIU reinstated licenses following a thorough state review conducted with the assistance of the SSTC NRS, which assessed the acceptability of facility safety levels and the operators' ability to ensure safe operations.

3. Lessons Learned from Emergency Preparedness and Response in Wartime Conditions

Based on the Ukrainian experience, most recommendations, regulations and guidelines on emergency preparedness and response cannot be applied in the context of wartime. The probable events cannot be classified according to INES due to limitations established in the application area of the document for wartime. Also, divisive criteria for preparedness and emergency stages, such as event class declaration, are unclear. All these problems became obvious for the experts of the SNRIU Information and Emergence Center during an assessment of the consequences of a potential accident at the occupied Zaporizhzhia NPP. Currently, experts are working on adapting standard calculations and procedures to the war conditions. Depending on the available time resources, the application of the assessment approaches referring to both, preparedness and response stages, is reasonable. Preparedness for an emergency resulting from military attacks at an NPP requires more information and knowledge about the potential military threats and the facility's response to hostilities. However, a group of postulated reference events can be considered based on an expert's view, the possible type of impact at the NPP, the ongoing situation at the site, and its potential evolution.

The presentations will be followed by a session where participants can ask questions and discuss these topics. The feedback and discussions from workshop participants will be beneficial for the future work of the Ukrainian regulator and its Technical Support Organization.

2.1.1.12 EURAD Training course on application of Requirement Management Systems

The EURAD guidance work package (WP12) aims at developing a comprehensive suite of instructional guidance documents that can be used by EU Member-States and associated countries with radioactive waste management programmes, regardless of their phase or level of advancement with implementing their waste management activities. Requirements management has been selected as the broad topic for further guides to be developed within EURAD. To effectively support the understanding of the application of requirements management systems (RMS) in radioactive waste management (RWM), a training session is going to be organised in collaboration with EURAD WP13 (focussed on training). During this two and a half days training, participants will learn about the basics of RMS, its role in planning RWM programmes and some lessons learnt from application of RMS in some national programmes will be shared. Theoretical lectures and the introduction of the results of the literature survey on RMS are complemented with exercise and test case.

Upon completion of this Training Session, participants should be able to:

- describe the RWM planning instruments and role of RMS,
- describe the disposal system RMS, with special emphasis on post-closure safety aspects,
- describe the architecture of an RMS (high-level goals, functions, targets, design requirements etc.),
- understand the RMS development process including how to set constraints (geology, waste), system boundaries and how to identify stakeholders (their role, responsibilities and expectations),
- understand the evolution of the system, the need of flexibility in planning and the update and iterations needed in the RMS,
- apply the “way of thinking” to the RMS in their home country,
- list lessons learnt (key messages) from examples on application of RMS in advanced national programs.

2.1.1.13 EURAD Training course on Monitoring in Geological Disposal facilities of radioactive waste

A successful strategy for radioactive waste disposal should address both technical and societal needs, and monitoring has the potential to contribute to both of these aspects. Monitoring during repository operations can be used to build further understanding of the processes occurring in the repository during operational phase (construction, waste emplacement, backfilling and closure) and early post-closure phase.

Monitoring can also contribute to public and stakeholder understanding of processes occurring in the repository, and hence, it can respond to public concerns and be used to build further confidence in geological disposal in addition to that achieved during licensing. Monitoring can therefore play a role in enabling waste management organisations to work towards the safe disposal of radioactive waste.

The Monitoring training is targeted to offer an overview of monitoring aspects in the field of geological disposal (in crystalline and clay host rocks) and methodology to conduct a monitoring strategy. The training aims to provide participants a set of competences based on the work inside the EU project dedicated on monitoring (Modern, Modern2020...).

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

- Describe the relevant processes for the geological disposal during operational phases and early post-closure phase
- Discuss the role of monitoring for geological disposal during operational phases and early post-closure phase
- Understand the methodology to select monitoring parameters
- Describe monitoring sensors and technologies
- Discuss monitoring system design, installation, and operation
- Reflect on the contribution of monitoring data to decision making
- Understand expectations from different stakeholders

2.1.1.14 EURAD Information & Discussion Session on IDKM

Management of knowledge, information and data can be a challenge in radioactive waste disposal and decommissioning. Planning, construction, operation and closure of a repository involves large volumes of information over an extended duration. At the same time information, data and knowledge about repositories must be accessible and understandable by numerous generations. Managing knowledge, archiving records and preserving information for a timescale across many generations is a common task for all countries.

The NEA's Radioactive Waste Management Committee (RWMC) established the Working Party on Information, Data and Knowledge Management (WP-IDKM) to examine the management of information, data and knowledge for/in radioactive waste disposal programmes. Since 2019, the working party has brought together experts from 26 organisations representing 11 NEA member countries and the European Union.

On EURAD's Information & Discussion Session (the IDS) offers an opportunity to provide an overview of the WP-IDKM's predecessor initiatives, present working areas, existing and planned deliverables, future activity plans and dissemination events.

The IDS presentation topics include:

- Predecessor NEA initiatives and their respective deliverables:
 - Preservation of Records, Knowledge and Memory (RK&M) Across Generations (RK&M Initiative)

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

- Radioactive Waste Repository Metadata Management (RepMet)
- Expert Group on Waste Inventorying and Reporting (EGIRM)
- Overview of WP-IDKM, members, expert groups, working areas, and planned deliverables
- EURAD Domain Insight 7.2.2 on Information, Data and Knowledge Management (IDKM)
- Expert Group on Knowledge Management (EGKM)
 - Introduction of the challenges and opportunities of managing knowledge to support radioactive waste management
 - Overview of the KM Guidance document under preparation and how it relates to other normative/standard references
- Expert Group on Archiving (EGAR) – Set of Essential Records (SER)
 - Introduction of the SER concept
 - Overview of organisational SER implementation examples
- WP-IDKM international cooperation, planned future activities, conferences and dissemination events
- Summary of the information session and opening of discussion session

The IDS will likely appeal to RWM experts interested in how effective IDKM can benefit radioactive waste management and disposal. This includes technical staff in implementing organisations charged with the digitisation of safety cases, data and information management, archiving, knowledge management and stakeholder communication. In addition to RWMOs, it could be of interest to policy makers, regulators, IT professionals, national archivists, community groups and social scientists involved in communicating information over extended timescales.

EURAD's IDS will consist of approximately one hour for presentations from WP-IDKM, and approximately one-and-a-half-hour session for answering audience questions.

2.1.1.15 EURAD Training course on the state-of-the- art of container corrosion phenomena under disposal conditions

Even though the feasibility and safety of established container solutions has been demonstrated, recent progress in understanding of materials and processes has shown that optimisation of container manufacturing and performance is possible. Widespread interest in repository optimisation exists and relevant projects are ongoing, e.g., WP HITEC and the HotBENT experiment in Grimsel. The systematic exploration of novel materials, while placing existing solutions in a broader context, will provide a solid state-of-the-art for the pursuit of container optimisation according to available geology, disposal concept and regulatory requirements. The testing of alternative container materials, their mechanical structural response and corrosion resistance will also bring new insights into novel technical solutions for container design. Therefore, it is important to further increase the knowledge base and reduce remaining uncertainties by extending the understanding of complex/coupled interfacial processes influencing container performance under repository relevant conditions at various scales, exploring the potential of novel/advanced container materials and processes for optimisation of container performance within the engineered barrier system and improving performance assessments addressing identified safety needs through mechanistic process understanding and development of predictive models.

This training course is based on the work inside the EURAD project CONtainer CORrosion under Disposal conditions (ConCorD). It aims to provide an overview of the evolution of the environmental conditions focused on the near-field and their impact on corrosion behaviour with a focus on irradiated-accelerated corrosion, microbial activity and degradation during nearfield transients. Furthermore, a detailed overview of novel technological concepts for container materials is provided. The final part of the course gives a theoretical and practical overview of prediction tools for assessment of long-time barrier integrity and the integration of corrosion phenomena in performance assessments.

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

- Understand the function of the waste container in the disposal of HLW/SF
- Identify the different transient process in the near field environment
- Comprehend the effect of transient processes on the corrosion behaviour of waste containers
- Understand the advantages & disadvantages of the use of ceramic/metallic materials in nuclear waste disposal
- Identify the current knowledge gaps of the use of ceramic/metallic materials in nuclear waste disposal
- Identify principles, advantages & disadvantages of different modelling approaches for several corrosion processes
- Understand how corrosion processes can be integrated in performance assessments (PA)
- Familiarise themselves with basic modelling tools

2.1.2 Summary of end-user feedback following the training courses

Feedback is an important tool to evaluate and help improve the training activities (D13.5⁵). Therefore, feedback is gathered after training activities organised by the School of RWM. In this section, a summary of the general feedback that was received is presented in order to get an overview of the general appraisal of the training courses by the participants.

In the following subsections, several main criteria are summarized across all training courses. All feedback was gathered using the same feedback form to ensure a uniform approach (see Appendix A and D13.5⁵). This form uses a four-point scale (i.e. 4 = excellent; 3 = good; 2 = sufficient; 1 = poor). Scores 4 and 3 are considered 'positive'; 2 and 1 are considered 'negative'. Please note that not all participants have returned a complete feedback form, which may affect the results discussed below. Finally, when an 'average' is mentioned, this is a weighted average taking into account how many participants have completed the feedback forms per training course.

2.1.2.1 Feedback on training content

A (weighted) average of 87% of all participants appraised the training content (i.e. balance between theory and practice, up-to-datedness of the content, and practical use of the training) of the School of RWM's training courses as positive. This reinforces the importance and the success of the bottom-up approach by providing training courses based on end-user needs. Most participants who provided 'negative' feedback pointed out that the balance between theory and practice could be improved

(i.e. more need for practical sessions in some training courses) for some training courses (e.g. in the safety case (see 2.1.1.4) and the uncertainty management (see 2.1.1.7) training courses (D13.9¹¹).

2.1.2.2 Feedback on training materials

The training materials were also positively reviewed by the participants. On average 89% of them provided a 'positive' score for the materials they received. This included feedback on clearness, completeness and quality of the materials. Most commented feedback related to the quality of the materials: that the quality of some slides was rather poor (i.e. too much text, too many pictures per slide, etc.). This can be avoided in the future by having more quality guidelines on the course materials themselves (explicit guidelines for course materials are currently missing).

2.1.2.3 Feedback on course organisation

Feedback on course organisation includes feedback on the time schedule (e.g. the agenda), the course environment (e.g. is the room suited for lecturing?), and catering (e.g. coffee breaks, lunch). Here, participants were overwhelmingly positive: 98% of all participants gave a positive score. Some negative notes were mostly due to the time schedule being too dense or too long.

2.1.2.4 Overall judgement of the training course

Across all training courses and feedback forms received, the overall judgement for training courses organised by the School of RWM was 100% positive. This means only 'good' and 'excellent' scores were given as response to this question.

Based on this score, WP13 concludes that all training courses have met specific end-users' needs and were of sufficiently high quality, as was intended. It reinforces that the 'bottom-up' approach of deciding topics for training courses has paid off over the course of EURAD.

2.1.2.5 Would you recommend this training course to others?

On average, 98% of all participants would recommend the training course they attended to others. This high number again illustrates the high quality of the training courses organised within the School of RWM.

2.2 Webinars

This section summarises all webinars the School of RWM has organised. All information, and more, can also be consulted via the School's online webinar archive:

<https://euradschool.eu/events/category/eurad-webinar/list/?eventDisplay=past>.

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

These webinars, hosted together with the PMO are known as ‘Lunch & Learn’ sessions. This name was chosen as these sessions were organised around lunchtime, and were short (informal) sessions on either broad or specialised topics related to RWM.

In the following subsections, a description of each webinar, as well as the names of the speakers is listed. From each of these webinars, a recording is available via the School’s website (see previous weblink) and YouTube (a private channel, not searchable through YouTube search functions):

<https://www.youtube.com/watch?v=pMS9C16Gg60&list=PLahXOQn-bremN911IEEn0w8yAzQyuUR3ky>.

Additional information can be found in EURAD Deliverable D13.11⁷.

2.2.1 Overview of all EURAD webinars

On overview of all EURAD webinars can be found in Table 2. This table serves as a capstone for the rest of this section. In the subsections, a short description and the names of the speakers for each webinar are listed (see also D13.11⁷).

Table 2 – Overview of all EURAD webinars

Title	Date	# live attendees	# views
Synergies of EURAD with the PREDIS project addressing pre-disposal waste treatment	28 October 2020	30	101
News from the German Site Selection Procedure	25 November 2020	19	100
Celebrating 20 years of the IGSC	27 January 2021	45	46
Knowledge Management in Nuclear Organizations	24 February 2021	22	42
The IGD-TP: European waste management organisations coordinating international R&D activities	31 March 2021	19	70
The next-generation scientific research for safe radwaste management - EURADSCIENCE	28 April 2021	75	30
The ERDO Association - Steps for Sharing	26 May 2021	44	24
The SITEX Network	30 June 2021	53	29
European Commission’s Joint Research Centre activities on RWM and decommissioning	29 September 2021	51	42
The US Nuclear Waste Management and Disposal Strategy: Status and Possible Futures	6 October 2021	107	53
News on the siting process in Italy	27 October 2021	57	25
Methods of information and knowledge transfer regarding final disposal of radwaste	23 February 2022	133	40

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

Deep Borehole Repository of high-level radioactive waste - State of knowledge	19 May 2022	99	37
Implementation of the world's first GDF for SNF – Status update from Finland	22 June 2022	82	39
Knowledge management in the German WMO - Origin, approach & practical implementation	29 June 2022	50	29
A pluralistic tool of dialogue on RWM: the Pathway Evaluation Process (PEP)	28 September 2022	40	62
The NEA Forum on Stakeholder Confidence	2 November 2022	47	27
The role of Knowledge Management in Civil Society	30 November 2022	23	72
Guidance on Cost Assessment and Financing Schemes of Radwaste Management Programmes	23 January 2023	70	17
Introduction to EC projects HARPERS and HARMONISE	25 January 2023	23	24
Mission (almost) completed. Swiss proposal for a combined repository in clay rocks	22 February 2023	185	61
OFFERR - eurOpean platForm For accEssing nucleaR R&d facilities	31 March 2023	36	7
Submission of the application for authorization to create Cigéo (France)	14 June 2023	86	22
UK GDF Programme update	21 June 2023	73	14
IAEA On-Going Activities on Nuclear Fuel Cycle Options and Spent Fuel Management	28 June 2023	51	18
Beyond conventional methods: The role of ANN in nuclear waste management	27 November 2023	79	1
Tailoring the digital transition to the challenges of geological disposal in Japan	29 November 2023	26	1
Update by the CORI Work Package	12 December 2023	77	8
Plus minus what? - Uncertainty in destructive spent nuclear fuel inventory analysis	14 February 2024	53	2
Advisory Board Committee (ESK)	28 February 2024	27	5
Sensitivity Analyses in Safety Assessments for Geologic Disposal Facilities	27 March 2024	80	4

2.2.1.1 Synergies of EURAD with the PREDIS project addressing pre-disposal waste treatment

Welcome to join this “Lunch & Learn” session to hear about the new EU project PREDIS, including 47 partners from 17 countries developing innovations for more efficient and safe treatment of LILW streams.

Hear about the cooperation planned between PREDIS and EURAD on issues such as waste acceptance criteria, strategic research agendas and knowledge management. The event hopes to generate more ideas for strengthening other areas of technical cooperation between the two projects.

Speaker: Erika Holt (VTT, Finland)

2.2.1.2 News from the German Site Selection Procedure

Pursuant to the Site Selection Act of 2017, on Monday, September 28th, the BGE has published its interim report on identified sub-areas which can be expected to have a favourable overall geological situation for the safe disposal of high-level radioactive waste. The three host rock types salt rock, clay stone and crystalline rock have been taken into consideration. Comparing and analysing over a million data records, applying exclusion criteria, minimum requirements and geo-scientific weighing criteria, BGE has identified 90 sub-areas spread across all German federal states (with the exception of Saarland).

Speaker: Astrid Göbel (BGE, Germany)

2.2.1.3 Celebrating 20 years of the IGSC

Learn more about NEA's IGSC or the Integration Group for the Safety Case.

IGSC is the main technical advisory body to the Radioactive Waste Management Committee (RWMC) on the deep geological disposal, particularly for long-lived and high-level radioactive waste. It was established in 2000 in recognition of the need to foster full integration of all aspects of the safety case.

The mission of the IGSC is to assist member countries to develop effective safety cases supported by a robust scientific-technical basis. In addition to the technical aspects in all developmental stages of repository implementation, the group also provides a platform for international dialogues between safety experts to address strategic and policy aspects of repository development.

To help accomplish its activities, the IGSC is supported by four subgroups carrying out tasks on specific topics. Three subgroups that focus on the feasibility of repositories in three different generic host rock types are: Clay Club, Salt Club and Crystalline Club. A fourth subgroup, the Expert Group on Operational Safety (EGOS), deals with the operational safety of geological repositories.

Speaker: Lucy Bailey (IGSC)

2.2.1.4 Knowledge Management in Nuclear Organizations

Knowledge Management (KM) is quite a recent concept, having come to prominence during 1990s, however become an essential part of Management in all Nuclear Organizations. Since nuclear knowledge is unique, without diligence in managing such knowledge, substantial portion of it could be lost due to personnel retirements or could be disused as a result of either negligence or changing

priorities. The scope of knowledge management is very broad and the aspects of managing knowledge in its different forms are manifold. IAEA defined Knowledge Management as an integrated, systematic approach to identifying, acquiring, transforming, developing, disseminating, using, sharing and preserving knowledge, relevant to achieving specified objectives.

During this Lunch & Learn session knowledge management fundamentals, policy, strategy, methods and tools will be discussed.

Speaker: Dinara Abbasova (IAEA)

2.2.1.5 The IGD-TP: European waste management organisations coordinating international R&D activities

The Implementing Geological Disposal of radioactive waste Technology Platform (IGD-TP) is dedicated to initiating and carrying out European strategic initiatives to facilitate the stepwise implementation of safe, deep geological disposal of spent fuel, high-level waste and other long-lived radioactive waste. It aims to address the remaining scientific, technological and social challenges, and support European waste management programmes. In the talk, the IGD-TP will be presented with its vision, its strategic research agenda, the activities it undertakes and how it interacts with EURAD.

Speaker: Dr. Irina Gaus (IGD-TP)

2.2.1.6 The next-generation scientific research for the safe management of radioactive wastes – views and role of EuradScience

A comprehensive overview of the view and role of EuradScience, which represents research institutes in radioactive waste management across Europe.

Speaker: Christophe Bruggeman (SCK CEN, EuradScience; Belgium)

2.2.1.7 The ERDO Association - Steps for Sharing

EC directive 2011/70/Euratom acknowledges that disposal is the end-point for radioactive waste and spent fuel, which implies that all member states must prepare a credible disposal strategy. The chosen disposal strategy can be implementation of a national disposal facility but also participation in a multinational repository (MNR). Only the first option is currently being implemented, with the most advanced programmes being in Finland, Sweden, and France. However, for technical, financial, and societal reasons, disposal in most countries – and in particular for new or small nuclear programmes – lies decades into the future. Accordingly, a prudent strategy is to keep options open: adopt a dual track strategy. For more than 20 years the MNR track has been studied, with varying degrees of support from the IAEA, the NEA and the EC. The ad-hoc ERDO-Working Group that has been dedicated to developing the dual track approach since 2009, has in January 2021 established a formal ERDO Association with headquarters at COVRA, the radioactive waste organization of the Netherlands. Why

this new association? What will it do for multinational solutions? In this Lunch & Learn sessions you will hear all about the status and future goals of the ERDO association.

Speaker: Dr. Ir. Ewoud Verhoef (COVRA, The Netherlands)

2.2.1.8 The SITEX.Network

This Lunch & Learn session focusses on the SITEX.Network, the organization representing European national Technical Support Organisations in the field of radioactive waste management. Its main activities and achievements are discussed by three representatives from different EU Member States.

Speakers: Delphine Pellegrini (IRSN, France), Nadja Zeleznik (EIMV, Slovenia) and Frédéric Bernier (FANC, Belgium)

2.2.1.9 European Commission's Joint Research Centre activities on RWM and decommissioning

This Lunch & Learn session will be presented by Manuel MARTIN-RAMOS (JRC). Manuel Martín Ramos (Madrid, 1970) has 25 years of experience in nuclear safety, management of spent fuel and decommissioning both in the industry and research areas. Since 2012 he serves in the Euratom Coordination Unit in the JRC Headquarters in Brussels. Manuel was Manager of the Spent Fuel Management Project of José Cabrera Nuclear Power Plant (including the building and commissioning of the Independent Spent Fuel Storage Installation), and Country Group Chairman (on behalf of Euratom) in the Sixth Review Meeting of the Joint Convention for the Safety of Spent Fuel Management and for the Safety of Radioactive Waste Management, among other relevant milestones in his professional career.

Speaker: Manuel Martin-Ramos (European Commission, DG JRC)

2.2.1.10 The U.S. Nuclear Waste Management and Disposal Strategy: Status and Possible Futures

This Lunch & Learn session will be presented by Prof. Dr. Rodney C. Ewing. Prof. Ewing is the Frank Stanton Professor in Nuclear Security and Co-Director of the Center for International Security and Cooperation in the Freeman Spogli Institute for International Studies and a Professor in the Department of Geological Sciences in the School of Earth, Energy and Environmental Sciences at Stanford University. He is the past president of the Mineralogical Society of America and the International Union of Materials Research Societies. Rod has written extensively on issues related to nuclear waste and is a co-editor of *Radioactive Waste Forms for the Future* (1988) and *Uncertainty Underground – Yucca Mountain and the Nation's High-Level Nuclear Waste* (2006). He received the Lomonosov Medal of the Russian Academy of Sciences in 2006 and the Roebling Medal of the Mineralogical Society of America in 2015. He is a member of the National Academy of Engineering. He is a Founding Editor of the magazine, *Elements*, which is now supported by 17 earth science societies. He is a Principal Editor for *Nano LIFE*, an interdisciplinary journal focused on collaboration between physical and medical scientists

and is a member of the Science and Security Board of the Bulletin of Atomic Scientists. In 2014, he was a Founding Executive Editor of Geochemical Perspective Letters and named to the Editorial Advisory Board of Applied Physics Reviews. In 2012, he was appointed by President Obama to chair the Nuclear Waste Technical Review Board, which provides scientific and technical reviews of the U.S. Department of the Energy's programs for the management and disposal of spent nuclear fuel and high-level radioactive waste. He stepped down in 2017.

Speaker: Rodney C. Ewing (Stanford University, United States of America)

2.2.1.11 News on the siting process in Italy

An overview of the current siting process in Italy is presented. The speakers will focus on the steps taken up to now, and the road ahead.

Speakers: Riccardo Levizzari (ENEA, Italy) and Angelo Paratore (SOGIN, Italy)

2.2.1.12 Methods for transferring information and knowledge regarding final disposal of radioactive waste

Carl-Henrik Pettersson (SSM, Sweden) will present on methods for transferring information and knowledge regarding final disposal of radioactive waste during this EURAD Lunch & Learn session.

2.2.1.13 Deep Borehole Repository of high-level radioactive waste – State of knowledge and pros&cons

Many countries are developing a geological disposal project to dispose of their high-level radioactive waste (HLW), potentially their intermediate, long-lived radioactive waste (ILW-LL) as well as spent nuclear fuel (SF) when considered as waste. The most widely selected option, for which a site selection process is underway in several countries or even achieved, is the deep geological repository (DGR) concept, a mining repository located underground in a geological layer, in which conditioned waste is placed.

As an alternative concept for geological disposal, the deep borehole repository (DBR) concept relies on two main safety functions similar to those of the DGR: isolate waste from natural surface phenomena, thereby significantly reduce the risk of human intrusion, and lean on the geological environment to ensure long-term passive containment.

To a greater extent, several very different concepts of borehole disposal have already been studied or implemented. The deep injection of liquid waste through boreholes has been implemented for low and intermediate-level radioactive waste in the USA and Russia. The option of deep disposal of exothermic waste provoking fusion and melting with the surrounding rock has been studied in the '70s and '80s, but only the sealing of the disposal zone in a borehole by welding of a granitic rock is still examined by the scientific community. There are several projects of disposal of small quantities of packaged solid waste, such as disused sealed sources, in a several tens to hundreds meters depth borehole, following a guide developed by the IAEA; some of which are underway, such as in Ghana. Finally, the disposal of larger quantities of solid waste and potentially of HLW or SF, in a DBR at a depth of thousands of meters, was

first considered in the '50s but rejected as it was considered to be beyond drilling capabilities. Improvements in drilling and associated technologies, together with sealing methods progress have led several countries to reconsider this option for the disposal of HLW. It is actively studied in the USA, including for SF disposing.

The DBR option drew the attention of some institutional organisations but also of some environmental Non-Governmental Organisations, some of which are part of SITEX.Network, as a plausible alternative to the DGR. However, some issues are controverted, and other institutions see DBR as an unappropriated option for management of HLW and SF. That motivated SITEX to launch a review project including a state of the art's bibliographic review as well as a workshop for discussions among members and wider. These SITEX activities have highlighted potential advantages and weaknesses of DBR compared to DGR, from the point of view of safety, social and societal expectations, regulatory aspects and finally R&D needs.

Speaker: Muriel Rocher (IRSN, France)

2.2.1.14 Implementation of the world's first geologic disposal facility for spent nuclear fuel – Status update from Finland

At the end of 2021, Posiva Oy submitted to the Finnish Government the application for a licence to operate a geological repository for spent nuclear fuel at the Olkiluoto site, off the South-West coast of the country. The talk will focus on the following:

- Overall schedule for disposal operations
- The licensing process and division of responsibilities in Finland
- The safety case supporting the operating license application
- Current status of the of the geologic disposal facility and encapsulation plant
- Addressing challenges related to the construction and operation of a deep geologic repository
- Path forward toward the beginning of spent nuclear fuel disposal

Presented by Barbara Pastina (POSIVA, Finland)

2.2.1.15 Knowledge Management in the German NWMO (BGE) – Origin, approach and practical implementation

Gunnar Hoefler (BGE) will present and discuss the knowledge management programme at BGE, Germany. He will discuss the following:

- Starting with a short retrospect why the BGE is the responsible Waste Management Organization including the past and current state of knowledge on nuclear waste disposal in Germany.
- Showing the types of knowledge which has to be dealt with and how this challenge is handled in the BGE and what tools used to make them available.

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

- This will be supported by a “Life feed” of the software iFinder the BGE is using to make explicit knowledge available. Furthermore one or more examples will be shown for the availability of tacit knowledge showing a “Life feed” of interactive knowledge maps.
- Finally presenting what challenges BGE knowledge management is dealing in the present and future and talking about the BGE KM concepts and how to deal with these opportunities.

Speaker: Gunnar Hoefler (BGE, Germany)

2.2.1.16 A pluralistic tool of dialogue on RWM: the Pathway Evaluation Process (PEP)

This Lunch & Learn session will provide a short description of the objectives, methodology and mechanisms of the tool of dialogue entitled Pathway Evaluation Process (PEP). The PEP is a serious game on RWM Governance that has been developed within the SITEX II project (2015-2017). The objective is to identify issues all along the pathways that would really matter for different categories of actors, which have not the same vision of what should be the pathway and what should be the safe situation for the long term. A PEP session put into discussion different strategies allowing to reach a safe situation for the long term. The tool is envisioned to be used in the frame of different EURAD projects and notably UMAN and ROUTES.

Speaker: Julien Dewoghélaëre (NTW)

2.2.1.17 The NEA Forum on Stakeholder Confidence: A Platform to Share Knowledge on Stakeholder Engagement in Radioactive Waste Management

Introduction to past and ongoing work of the OECD/NEA Forum on Stakeholder Confidence (FSC). Since its creation in the year 2000, the FSC has enabled direct stakeholder exchange in an atmosphere of mutual respect and learning. Members from 21 countries have shared experiences and challenges, identified best practices and published reports on current and future challenges related to stakeholder engagement in radioactive waste management and decommissioning processes. Some of the recent methods of work and recent activities of the FSC will be introduced.

Speaker: Pascale Kuenzi (OECD-NEA)

2.2.1.18 The role of Knowledge Management in Civil Society

In this Lunch and Learn session we will talk about the role of the Knowledge Management in Civil Society. How KM initiatives support CS and what is the benefit of KM for individuals and society in general. This presentation will cover many KM goals which are supported by EURAD SoK activities. Thus, one of the goals of KM is transparency of knowledge the EURAD SoK puts many efforts to provide EURAD Community with wide access to knowledge generated in RWM.

The EURAD programme includes interactions with Civil Society (ICS) based on a so-called “double-wing” model that have been settled on and tested throughout SITEX II and JOPRAD projects, notably in the perspective of the EURAD programme. After reminding the main elements of the ICS model implemented in EURAD, the presentation will include feedbacks and lessons learnt from the ICS activities implemented regarding knowledge management. It will present results coming from strategic projects (ROUTES, UMAN), from ICS workshop, from the evaluation process of ICS activities and other activities (follow-up by civil society of technical projects). As a conclusion, the presentation will draw main messages and recommendations for future knowledge management in EURAD.

Speaker: Dinara Abbasova (IAEA) and Nadja Železnik (EIMV, Slovenia)

2.2.1.19 Guidance on Cost Assessment and Financing Schemes of Radioactive Waste Management Programmes

A reliable assessment of future costs for radioactive waste management (RWM) up to its disposal and adequate mechanisms for providing financial resources for these activities form fundamental prerequisites for responsible management of radioactive waste, in line with the requirements of the Council Directive 2011/70/Euratom of 19 July 2011.

Although there are many technical documents dealing with cost estimations and financing schemes for RWM, countries at an early stage of RWM programmes or small waste inventories and newcomer countries may benefit from the guide presented here, that addresses the cost assessment in a systematic and structured way and gives also practical instructions how to start and estimate the cost of radioactive waste disposal in different stages of development.

This Guidance on Cost Assessment and Financing Schemes of Radioactive Waste Management Programmes describes the cost assessment as a stepwise process. Each of the steps is briefly described and useful practical examples of cost estimations for various aspects of the disposal programme from different countries are added. The guide also provides information on the most common uncertainties and risks related to geological disposal programmes and suggests how they might be addressed. It also gives basic information on financing schemes for RWM.

Speaker: Irena Mele (SURA0, Czech Republic)

2.2.1.20 Introduction to EC projects HARPERS and HARMONISE

Euratom Council Directives and IAEA Safety Standards provide the basis for the underlying legal and regulatory framework in radioactive waste management and decommissioning. However, the implementation of international safety standards and European Union (EU) directives can vary from one country to another as they are adapted to local considerations and national policies. These national differences can create difficulties in interpreting and comparing waste management practices between Member States (MS) and establishing consistent and coherent waste management policies and implementation strategies at the European scale. Moreover, this lack of commonality may contribute to sub-optimal waste management outcomes in terms of safety, economics, sustainability and innovation as well as public acceptance.

A greater convergence and harmonisation of national standards would allow for increased international cooperation among all relevant actors in nuclear decommissioning and radioactive waste management

and could lead to expanded international market opportunities and more rapid adoption of advanced and/or emerging technologies. Alignment and harmonisation based on EU standards would also be advantageous towards enabling more robust comparisons of the efficiency, suitability and limits of available techniques being used in similar conditions.

The 3-year Euratom project, “HARPERS: HARmonised PracticEs, Regulations and Standards in waste management and decommissioning,” aims to establish and clarify the benefits and added value of more aligned and harmonised regulations, practices and standards in decommissioning and radioactive waste management, including possibilities for shared processing, storage and disposal facilities between Member States (MS). The HARPERS project aims to reinforce the activities of the NFRP-2018-6 European Joint Programme on Radioactive Waste Management (EURAD, in particular with the ROUTES WP) [1], NFRP-2019-2020-10 Pre-disposal Treatment of European Radioactive Waste Streams (PREDIS) [2] and NFRP-2018-5 Stakeholder-based Analysis of Research for Decommissioning (SHARE) [3] projects. HARPERS will also connect with the wider European Community through, e.g., SNETP, NEA, IGDTP, IAEA, ENSREG, ERDO, DigiDecom, and will encourage interaction between different national programmes.

Identifying relevant regulatory differences across MS and assessing the rationale for these differences and establishing the potential for their harmonisation relative to cross border services/facilities, moving to a circular economy and implementation of advanced technologies are the primary focuses of the HARPERS project. Obstacles and issues preventing the implementation of a more common regulatory framework will be established. Furthermore, the Strengths, Weaknesses, Opportunities and Threats with respect to harmonisation of the identified regulatory differences and produce reports on harmonising regulatory systems in Europe will be evaluated. A TECOP (Technical, Economic, Commercial, Operational, or Political) analysis will identify a multitude of potential changes, which will be reviewed further in terms of strategic impacts for stakeholders across all MS. The high-level benefits of more aligned and harmonised regulations are related to 1) greater business opportunities, 2) better understanding between diverse groups serving wider markets, 3) improved cost efficiency, 4) waste minimisation and 5) improved final disposability of waste. Realisation of these high-level benefits would contribute to enhancing the overall safety and economics of the nuclear sector. The project, which launched in June 2022, will run for three years and includes 26 organisations from 13 countries. It will strive to have wide stakeholder engagement including regulatory agencies, governments, researchers and industry to meet its objectives.

The current nuclear regulatory framework appeared in the 1960s for licensing early NPP designs and since then it has undergone substantial modifications because of major nuclear accidents and in response to challenges posed by the licensing of Generation III designs. Innovative fission and fusion installations encompass novel technologies that drive the need for developing new licensing procedures. The legal framework and procedures applied in the field of nuclear power are very rigid, which significantly limits new technologies coming to operating NPPs.

There are a number of conventions, directives and other international legal documents signed by the countries. Despite the broad consensus legislations in different countries maintain diverse definitions and interpretations in their application of basic safety principles while being consistent with the IAEA Safety Standards. There is a broad agreement on the need to review the existing regulatory framework, incorporate novel concepts and endow it with sufficient capabilities for assuring safety during design and enabling proper regulatory oversight during operation of innovative facilities.

Taking as a basis the IAEA fundamental safety objective, the HARMONISE project has set five Objectives:

- Objective 1: To analyse preliminary safety assessments of innovative fission and fusion installations
- Objective 2: To peruse the licensing needs for innovative nuclear installations

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

- Objective 3: To examine risk-informed, performance-based (RIPB) approaches in licensing reviews and regulatory decision-making
- Objective 4: To delimit harmonisation and standardisation on component assessments, methodologies, codes and standards
- Objective 5: To learn from earlier experience in harmonisation efforts

HARMONISE findings will be disseminated and reported to Member States' nuclear safety regulators with the aim to facilitate their early involvement regarding safety verifications and licensing of future fission and fusion installations. HARMONISE will suggest solutions but decisions are to be later taken by the responsible decision making bodies.

Speakers: Réka Szőke & Egidijus Urbonavicius

2.2.1.21 Mission (almost) completed. The Swiss proposal for a combined repository in clay rocks.

In September Nagra has reached a major milestone. 15 years after the re-start of the nationwide search process we have communicated our proposal for the site of the Swiss repository for radioactive waste. While a formal review is still to be done. The announcement has received supporting comments from cantonal stakeholderes as well as expert groups from abroad.

In the talk Dr. Tim Vietor will outline the history of the search, it's challenges and the reasoning behind the selection now communicated.

Speaker: Tim Vietor (Nagra, Switzerland)

2.2.1.22 OFFERR – eurOpean platForm For accEssing nucleaR R&d facilities

OFFERR is a new European project whose aim is to set up a European User Facility Network, in nuclear science, and to establish an operational scheme facilitating access for R&D experts and students to key nuclear science infrastructure. The facility network will include more than 170 related facilities. The text of the call for application will be published at the end of March 2023. Cut-off dates will be defined every 6 months. In May 2023, the European User Facility Network built by OFFERR will be ready to fund a sustainable network open to Europe but also to other international initiatives.

Speaker: Charles Toulemonde

2.2.1.23 Submission of the application for authorization to create Cigéo (France)

On January 16th, Andra submitted the construction licence application (DAC) of Cigeo, the French project for the deep geological disposal facility for the most highly radioactive waste. This is a crucial step marking both a culmination and a new start for the project. First and foremost, it is the result of 30 years of progressive development under regular evaluation. Over time, the scientific and technological

aspects of the project have been refined, supported by intense R&D, including an underground research laboratory, to lead to well-defined design principles and a robust safety demonstration for both operating period and post closure period.

But the submission of the application and the upcoming review by the French Nuclear Safety Authority (ASN), together, also represent the start of a new phase: Cigeo is getting ready for the construction phase and Andra is becoming the operator. Although Cigeo still needs additional development and refinement, the Agency is already responsible for it, in terms of reporting to the ASN. Moreover, with the submission, Cigeo reaches the point when a national project, supported by the French State, meets a host region, a territory, the Meuse and Haute-Marne districts.

The review of the DAC by ASN and its technical support IRSN is planned for 30 months, followed by a consultation phase with various actors (national commission board, environmental authority, local authorities, OPECST, etc.) and a public inquiry. At the end of the technical review and the public inquiry, after consulting the French council of State, the decree authorizing the creation of Cigeo could be obtained by 2027, allowing the initial construction to begin of the disposal (stage 1) as part of a pilot industrial phase. After the start-up tests, the commissioning of Cigeo is expected around 2040 and the end of the pilot industrial phase around 2050.

Speaker: Frédéric Plas & Marine Levieux (ANDRA, France)

2.2.1.24 UK GDF Programme update – a suitable site, a willing community and a maturing facility design and safety case

In December 2018, a revised UK consent based GDF siting policy was finalised. In this talk, Dr Rob Winsley of Nuclear Waste Services', will explain recent progress that has been made towards implementation of a UK geological disposal facility (GDF). The presentation will cover the UK nuclear context, the radioactive waste inventory that the facility may need to accommodate, the siting process and particularly how NWS are working with communities to identify potentially suitable sites and develop community support. It will also touch upon NWS's maturing design and safety case work.

Speaker: Rob Winsley (Nuclear Waste Services, United Kingdom)

2.2.1.25 IAEA On-Going Activities on Nuclear Fuel Cycle Options and Spent Fuel Management

The IAEA actively supports the sustainable, safe, secure, reliable, and economic management of spent fuel by providing its Member States (MSs) with relevant technical information and guidance based on operational experiences, lessons learned and good practices regarding spent fuel management options (recycling and disposal), and by promoting the exchange of results and the sharing of knowledge.

For nuclear power to be sustainable, the nuclear fuel cycle must remain economically viable and competitive, which can be achieved by optimizing the use of fissile materials in reactor cores, by increasing uranium enrichment and fuel burnup, and by recycling valuable materials. This results in different fuel cycle options, some of them already implemented and others may be implemented in the future.

As storage durations extend, some storage systems in some countries are/will be deployed beyond their initial design and licensed periods. This requires knowing the conditions and behaviour of the spent fuel

and storage systems, structures and components (SSCs) over a longer period to ensure safe storage and future transportability. In this regard the IAEA is coordinating international R&D activities through Coordinated Research Projects (CRPs) on assessing the performances of spent fuel and cladding during storage, and on developing ageing management programmes for storage systems operating beyond their initial licenced periods.

Over the last decades, national and international R&D programmes have been conducted on the development of advanced nuclear fuel cycles associated to Gen-IV reactors to improve the utilization of uranium resources, maximize energy production, minimize waste generation, improve safety and limit proliferation risks. Advanced fuel cycles are devoted to recycling and burning most of the long-lived radionuclides, lowering the burden of generated waste and reducing the 'repository footprint'. The IAEA recently organized in Vienna the fourth international conference on Fast Reactors and Related Fuel Cycles (FR22), in April 2022, which enabled the exchange of information on national and international programmes, by providing experienced scientists, engineers, government officials, safety officers, fast reactor managers, etc. with a platform to share their scientific outlooks, with special attention to the future young generation of scientists.

The importance of having the right scientific, technical, and engineering skills, and of maintaining these competences, goes hand in hand with ensuring to deliver a comprehensive and safe nuclear fuel cycle. For these reasons the IAEA actively supports its MSs on the technical knowledge preservation and transfer to enhance the capabilities of professionals, especially of the young generation, through the development of e-Learning materials and courses on nuclear fuel cycle options and spent fuel management.

All stages of a selected nuclear fuel cycle option raise particular challenges and issues; therefore it is paramount to have an integrated view of the nuclear fuel cycle to ensure that influences from, and impacts on, all stages of the nuclear fuel cycle are clearly identified and understood, to enable effective decision making in the back end of the fuel cycle as well as to keep flexibility to accommodate new developments and technologies, as for example the new spent fuels coming from the small modular reactors that will be deployed in the next decades.

Interesting web links referenced during this L&L session:

- TM on Backend of the Fuel Cycle Considerations for Small Modular Reactors, 20-23 September 2022 <https://conferences.iaea.org/event/321/>
- CRP on NEW CRP: Challenges, Gaps and Opportunities for Managing Spent Fuel from Small Modular Reactors (T13021) | IAEA
- IAEA Spent Fuel Management Network: Pages – SFM (iaea.org)
- IAEA Interactive GuideBook on Spent Fuel Storage Options and Systems: Guidebook on Spent Fuel Storage Options and Systems (simopt.cz)

Speaker: Amparo González Espartero (IAEA)

2.2.1.26 Beyond conventional methods: The role of ANN in nuclear waste management

In this talk, Virginie Solans will present the role of Artificial Neural Networks (ANNs) in a nuclear waste management context and explain how ANNs are reshaping conventional methods. ANNs are an example of machine learning, where typically large amounts of data are analysed.

After a brief introduction to ANNs, she will provide examples of where ANNs are proposed to be used in the nuclear context and of relevance to nuclear waste management. Such developments are requested in the safeguards community already today to increase the effectiveness and efficiency of nuclear material verification and can be adopted as an inspiration for the waste community and its plans for the verification of fuel in the coming decades.

One example is detecting and classifying particle defects in spent nuclear fuel assemblies. The Partial Defect Tester (PDET) is an instrument proposed to investigate the integrity of irradiated nuclear fuel assemblies by analysing the gamma and neutron flux inside the fuel assembly. Researchers have proposed to analyse the data from PDET using ANNs, aiming to identify if missing or replaced fuel material in a spent nuclear fuel assembly. Such verifications are particularly important before disposal in a geological repository, after which further verification is not possible. Another application is the anomaly detection using the Next Generation Surveillance System Camera Data. The ANN could assist IAEA safeguards inspectors to identify unexpected activity in nuclear facilities, including in facilities linked to the final disposal of nuclear waste.

Finally, Virginie will present her own work that specialises in predicting safety parameters for fuel to be encapsulated. She will demonstrate how ANNs can be used to predict the effective multiplication factor (k_{eff}), a parameter for criticality-safety, for different canister loading using the radionuclides concentrations. This ANN can take advantage of the heterogeneity of the spent nuclear fuels irradiation history, including how the ANN can even capture changes in the canister k_{eff} when spent nuclear fuels are axially rotated. She will also demonstrate how ANNs can be used to predict the decay heat from experimental measurements planned to be performed before encapsulation and how it can be used to verify state-of-the-art calculations.

This presentation aims to show the large range of possibilities that ANN offers to help with the different aspects of nuclear waste management and how it might be used in the future.

Speaker: Virginie Solans (Uppsala University, Sweden)

2.2.1.27 Tailoring the digital transition to the challenges of geological disposal in Japan

Based on the huge volume of raw and processed information (here grouped as “knowledge”) to be handled in a national geological disposal programme, it is no longer a question of whether advanced KMS will be introduced into radwaste management programmes or not – only whether such systems can be developed and implemented before total collapse of conventional approaches.

The Japanese decision to rapidly move into advanced KM was driven by the boundary conditions of the large and diverse nuclear programme, with special considerations resulting from required responses to the Fukushima Daiichi accident. In particular, imminent loss of many experienced staff as they retire leaves only a small window to capture tacit knowledge (a common problem throughout the nuclear industry).

The basic concept of the KMS under development is to structure knowledge according to the logical structure of an integrated “Safety Case” that brings together key pre- and post-closure safety goals together with closely related requirements, such as minimising environmental impacts and assuring

public acceptance. The incorporated functionality supports synthesis and integration of material from diverse sources, identifying trends and inconsistencies, and providing feedback to data producers. It should assure the flexibility to cope with a rapidly-growing, technically-diverse knowledge base and the user-friendliness required to encourage its adoption. For these purpose, maximum use of advanced electronic information management technology is critical.

In this presentation, such development of an integrated digital KMS for geological disposal as part of NUMO's digital transformation is illustrated and future challenges discussed.

Speaker: Hiroyuki Umeki (NUMO, Japan)

2.2.1.28 Update by the CORI Work Package

The Lunch&Learn session organized by CORI is summarizing main information relevant in the context of this work package. Aim is to introduce (i) the basic scientific facts and concepts underlying this research focused on Cement-Organics-Cement-Interactions, (ii) explain the relevance of CORI in view of enhancing Safety, and (iii) present selected technical highlights from this EURAD activity.

Scope: CORI improves the knowledge on the organic release issues which can accelerate the radionuclide migration in the context of the post closure phase of geological repositories for ILW and LLW/VLLW, including surface/shallow disposal. CORI addresses topics in the context of cement-organic-radionuclide interactions. Organic materials are present in some nuclear waste and as admixtures in cement-based materials and can potentially influence the performance of a geological disposal system. This potential effect of organic molecules is caused by the formation of complexes in solution with radionuclides which can potentially increase radionuclide solubility and/or decrease radionuclide sorption. Organic substances require increased attention since a significant quantity exists in the waste and in the cementitious materials, with a large degree of chemical diversity. Cement-based materials are degraded with time in the context of waste disposal inducing a large range of alkaline pH conditions. Alkaline pH provides specific conditions under which the organics can degrade, which contributes to increasing their potential impact on repository performance. The new scientific results from WP CORI are providing new quantitative and qualitative data as well as improved process understanding to support RWMD implementation needs and safety.

Speaker: Markus Altmaier (KIT, Germany)

2.2.1.29 "Plus minus what?" – Uncertainty in destructive spent nuclear fuel inventory analysis

All analytical results of an analysis come (or should come) with an uncertainty. This uncertainty, the "plus/minus number", is often just taken for granted by the user of the results, without much further thought. In this talk, we shall explore in more detail what is hidden (or not) behind the uncertainty number of a destructive spent nuclear fuel analysis. The aim is to raise users' awareness of the multiple parameters reflected in that single uncertainty number.

Speaker: Stefaan Van Winckel (European Commission, DG JRC)

2.2.1.30 Advisory Board Committee (ESK)

During this session, an overview of the activities of the Advisory Board Committee from ESK will be given.

Speaker: Barbara Reichert (ESK, Germany)

2.2.1.31 Sensitivity Analyses in Safety Assessments for Geologic Disposal Facilities: An International Collaboration

Addressing uncertainties is an essential part of Safety Cases for geologic disposal facilities. An important instrument for doing so is sensitivity analysis (SA), by which the impact of input parameter uncertainties on the output(s) of model calculations is studied and evaluated. While some SA methods (such as linear and rank-based methods) are routinely applied in safety assessments, the toolbox of available methods is much richer and capable of detecting effects which might not be captured by the approaches mentioned above. However, it is also true that some of the more advanced and sophisticated methods are hard to understand and to apply, produce ambiguous or unstable results, or cause high computational costs. The seminar will, after a brief introduction to the “world of SA”, provide insight in an ongoing international exercise in which various SA methods are systematically applied to a number of simulation models from the practice of repository safety assessment. The aim of the exercise is to evaluate the performance of various methods vis-à-vis the characteristics of the different simulation models, and ultimately, to derive guidance for the application of SA in safety assessments. Participants are, or have been, Sandia National Laboratories (USA), TU Clausthal, GRS (Germany), Universidade da Coruña (Spain), SCK CEN (Belgium), POSIVA (Finland), and IBRAE (Russia, until February 2022).

The scope of the exercise is restricted to global probabilistic SA methods, i. e. methods that explore the full input parameter space, use a joint probability density function for characterising the input uncertainty, and analyse the relationship between input and output uncertainty (i. e. the sensitivity) using stochastic concepts. SA methods applied include graphical, variance-based, and moment-independent methods, some of which take advantage of surrogate models when estimating sensitivity measures. The models studied cover a wide range of applications, including near-field hydraulics, mechanics and chemistry as well as far-field transport in fracture networks. Their features relevant for SA include the need for nested input sampling, nonlinear behaviour, as well as outputs which exhibit bifurcation and regime changes. Such varying challenges have to be addressed by choosing appropriate SA methods.

Speaker: Klaus-Jürgen Röhlig (TU Clausthal, Germany)

2.2.2 Recordings and views of the webinars

All Lunch & Learn sessions were hosted via the online Bigmarker webinar platform (www.bigmarker.com). This platform allows to record all sessions and make the recordings easily available to all participants. In order to increase the outreach and availability of these recordings, they are also made accessible through the School of RWM's website. This way, everyone who is interested in the topics discussed during the Lunch & Learn session has access to them, free of costs.

Of course this raises the question of sustainability: how will these recordings be preserved and made available after EURAD ends? To this end, WP13 is working closely together with the other KM work packages to work/search for a long-term solution to store all KM-related documents.

2.2.3 End-user feedback

Overall, the feedback on the webinars has been very positive. Most end-users praise the format, indicating that it is a very suitable format to get people acquainted with both general and expert topics in a short time. This effect is enhanced by the speakers. The majority of the speakers succeeded in delivering their message in a comprehensible manner, in less than one hour. This shows that even for complex topics, it is possible, and also very appreciated by the end-users, to be able to summarise complex information. Furthermore, it allowed the Lunch & Learn session to reach non-experts as well, which was part of the goal of these sessions.

However, there are some points of improvement to be noted. There can be more variation in the number of topics. For example, now there were multiple topics on KM, but few on safety case. In the future there can be attention to a more equal distribution among the topics. There were some points of critique on the system used (Bigmarker®). This system does not easily allow live interactions when the number of participants is high. Therefore, one might consider to switch platforms (e.g. Microsoft Teams). It should be noted that at the time of launching the Lunch & Learns sessions, Bigmarker® was among the best options for this type of online events.

Finally, it can be concluded that these sessions were a success among speakers and participants.

3. Pillar 2 - Mobility Programme

Early in 2020, the School of RWM launched the EURAD Mobility Programme (D13.7⁸)(D13.8⁹). The main objective of this Mobility Programme is to financially support end-users in (i) performing internships, (ii) performing technical visits, (iii) attending (international) training courses, and (iv) attending conferences in the field of radioactive waste management.

In this section, the main results from this pillar are discussed. This includes an overview of the number of applications, feedback on the Mobility Programme (D13.10^X), and the mobility reports.

3.1 Mobility applications

As of April 2024, the EURAD Mobility Programme is closed. Initially launched in April 2020, in full COVID-19 pandemic, the Mobility Programme had a slow start.

But through the years, it continued to grow (including support for conferences/workshops and training courses as of 2022) and in the end was very successful in supporting young researchers and professionals in arranging their mobility actions.

In the end, 105 applicants filed a complete application form. Of these 105 applications, 98 were approved by the evaluators, resulting in a 93% success rate (figure 2). It should be noted that three applicants have cancelled their mobility action after approval. The most successful categories in the EURAD Mobility Programme were 'Conferences or Workshops' and 'Intra WP', which supported mobility actions within a certain EURAD WP. They make up 67% of all accepted applications. With 'Training courses' (23%) and 'Cross WP' (10%), which supported mobility actions between EURAD WPs, filling the remaining 33% (figure 3).

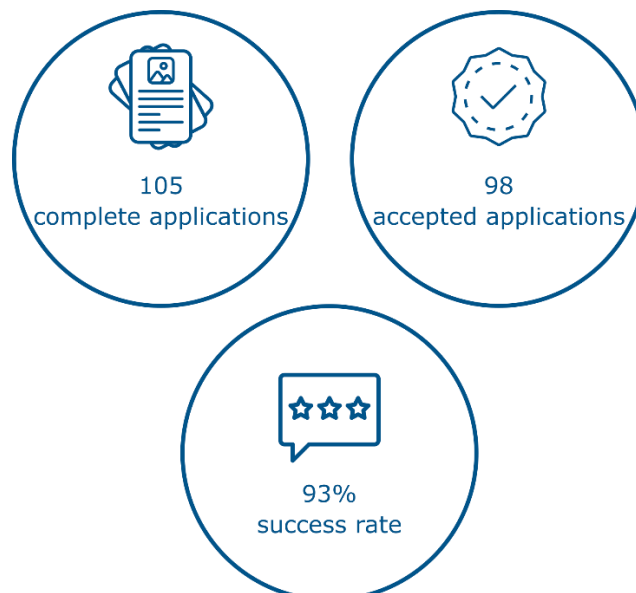


Figure 2. Overview of mobility applications. The EURAD Mobility Programme has received 105 complete applications, of which 98 were accepted. This results in an overall success rate of 93%.

Categorie	Total ▼	2020	2021	2022	2023	2024
Conferences or Workshops	34	0	0	6	10	18
Intra WP	32	2	4	8	13	5
Training courses	23	0	0	9	13	1
Cross WP mobility actions	9	0	0	3	5	1

Figure 3. Evolution of the EURAD Mobility Programme. Evolution of the number of accepted applications within each of the main categories of the EURAD Mobility Programme between 2020 and 2024. In total, 98 out of 105 applications were accepted.

3.2 Details concerning the Mobility Programme

A detailed report on the performance of the Mobility Programme can be found in D13.10 –KM Training - Update on mobility actions performed in EURAD¹². In this section, a summary of the most important findings will be provided.

As mentioned above, 105 complete applications were made over 24 calls, which were even spread out in time over the course of EURAD (i.e. 1 application deadline every two months). In total 1484 days of mobility actions were covered by the Mobility Programme. The budget allocated for these 1484 mobility days was approximately €155.000. The average duration of a mobility action was 18 days. The average cost of a mobility action is about €1.630. The programme supported young generation mainly both in terms of the number of supported participants as well as in terms of allocated budget.

3.3 End-user feedback

As with training courses, end-user feedback was gathered in order to help improve the Mobility Programme (full details can be found in D13.10¹²).

Twenty-four beneficiaries provided feedback, which was very positive, although there is still room for improvement. All respondents who had undertaken an internship and/or exchange visit were pleased with the experience, stating that the mobility action met their personal expectations. The beneficiaries clarified that they carried out the planned experiments, learned new techniques, built strong networks, and developed several new opportunities for future collaboration. They noted that they were able to conduct important experiments using equipment unavailable at their home organisations, and the results of these experiments are intended for publication in a peer-reviewed scientific paper.

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

The beneficiaries who attended training courses with financial support from the Mobility Programme stated that the courses resolved many uncertainties they had and provided additional information and knowledge in a structured and organised manner. They also appreciated the new insights into many useful methods and tools for their research and the additional explanations provided during the Q&A sessions.

Attendees of conferences and workshops built new partnerships and strengthened current engagements. They expressed great interest in the conference topics, appreciating the opportunity to gain an overview of current activities in the research field. They received useful comments and suggestions from peer researchers that were helpful for improving future work.

The majority of the beneficiaries were very satisfied with both the application platform and guidelines and the received lump sums. However, the process of obtaining the money was rated less favourably, although most managed it without significant issues. Problems identified included a lack of clarity about whether the reimbursement would go to the individual or the organisation and the very long reimbursement process. Nonetheless, it was also stated that the support from WP13 resolved all open issues.

The information in this report clearly shows the successful implementation of the four-year EURAD mobility programme, despite most actions being carried out in the last two years of EURAD. The "young generation" was the main group supported, and the feedback suggests that the main goal of the Mobility Programme was well achieved.

4. Pillar 3 – Panorama

The third pillar of the School of RWM does not encompass specific activities, rather it aims to ensure that overall, all activities organised by the School highlight most, if not all, relevant aspects of a successful radioactive waste management programme. The importance of this pillar lies in informing students, the new generation of experts, end-users and Civil Society about the trans- and inter-disciplinarity and complexities involved in establishing a successful RWM programme. Furthermore, this way the School also invites senior experts to broaden their view beyond the scope of their area of expertise. Examples that show this are the School's website as its primary communication channel and listing the PhD research being performed within EURAD.

Though not initially part of the scope of WP13, this part was integrated to increase visibility and importance to all aspects related to RWM. The School of RWM has succeeded in doing so by its diverse training course portfolio and the catalogue of Lunch & Learn sessions (see 'Pillar 1 – Courses & Webinars').

It is important to continue this effort in the future as it remains important to inform and educate the end-users on this. Finally, it also helps highlight the diversity of career opportunities in the field of RWM to students and junior professionals, which could help attract them to the field.

5. Pillar 4 – PhD students

This pillar focusses on supporting the PhD student that are active within EURAD. Although it was not explicitly in the scope of WP13, very early on, the School started to initiate activities specifically aimed at students. The rationale behind this is that the PhD students of today are the key figures in RWM of tomorrow. Therefore, the School initiated several activities to include the PhD students in EURAD and provide more support to them.

Besides offering them the opportunity of applying for mobility grants, the School of RWM, together with the EURAD PMO, has organised several initiatives that were specifically aimed at the PhD students. These are listed in coming sections.

5.1 EURAD School website

On the School's webpage, a dedicated part is reserved for information that is relevant to the EURAD PhD students. This section contains four subsections: (i) an overview of EURAD PhDs, (ii) a list of publications by PhD students, (iii) a list of events that are of interest to PhD students, and (iv) an overview of available PhD thesis and post-doc positions at EURAD partner organisations. In addition, a discussion forum was added to the website in order to foster discussion between students and experts, students among themselves, and even between experts.

5.1.1 Overview of EURAD PhDs

The School has tried and (largely) succeeded in highlighting the work being done by PhD students within EURAD. Via <https://euradschool.eu/overview-of-phds/> a list can be consulted which provides a short overview of the work performed by PhD students. Unfortunately, due to administrative circumstances (or some students that do not wanted to be featured) this list was never a complete overview of all PhD students, rather a subset that was known by WP13 and the PMO.

5.1.2 A list of publications by PhD students

In this subsection, the aim was to highlight scientific publications made by PhD students (<https://euradschool.eu/publications-phds/>). This way, the School could put the spotlight on their scientific achievements. However, for this list the School relied on input from the students (and their EURAD mentors) to feed the list. WP13 has no resources to keep track of these publications. Therefore, this list is very limited (only one publication at the time of writing), although many more papers were published by EURAD PhD students. To improve of this in the future, there needs to be a mechanism in place which allows students to more easily inform the School of their scientific achievements.

5.1.3 List of events

This subsection was reserved for highlighting interesting events for EURAD PhD students. This includes training courses (from outside EURAD), conferences, and workshops. This list was used, but only in a limited way. Due to limited resources in WP13 to specifically search for these events, WP13 depended on EURAD partners and end-users to provide input for this list. This has occurred to minor extent, but not to the degree that this list has become a valuable tool for PhD students. To improve on this, the School should ask more frequent input from all EURAD partners to make sure most events are captured.

5.1.4 List of available PhD and post-doc positions

The fourth subsection was set up as a place for EURAD partner organisation to highlight open PhD and post-doc positions (https://euradschool.eu/phd_vacancies/). The aim was to provide a summary of available positions throughout Europe that could help kick-start students' scientific careers. Multiple vacancies were taken up in this list, but WP13 has no way of monitoring if this list has helped fill these positions. Nonetheless, it is a useful resource for students/PhDs which allows them to look for future career opportunities and therefore should be maintained in the future. Finally, the number of vacancies submitted to the School was rather limited, so there is still room to improve on this concept.

5.1.5 Discussion forum

Finally, the School also integrated a discussion forum on its webpage (<https://forum.euradschool.eu/>). The forum offers an online space for participants to discuss various subjects related to the School of RWM (e.g. course contents, perspectives for implementation, etc.), EURAD activities, the EURAD Roadmap Themes and radioactive waste management in general. The aim was to foster discussions between students and experts, and to provide an easy link to discuss with WP13 as well. Although anticipation for this forum was high, it was actually never used to launch any meaningful discussions. Over the four years it was active, it mainly included spam messages. Therefore, WP13 decided to take the forum offline in May 2024.

However, WP13 is convinced that it is crucial to foster a community between the PhD students and to bring them into contact with experts. To that end, small steps were taken to help create a PhD community, which was managed by the students themselves. The ultimate aim is to have this PhD community as a type of end-user in EURAD, which allows the students to ask for training, give a voice in WP and/or WP Leader meetings, get them more involved in EURAD events, etc.. Although the concept and the ideas were there, the execution started too late in the EURAD programme (first actions were only taken by the end of Year 4 (March 2023)). Thus this effort will have to be renewed in the future (see also '6 Lessons learned').

5.2 1st EURAD PhD Event

On September 15, 2020 the School of RWM organised a full day of presentation by the EURAD PhD students. This was organised fully online (due to COVID-19) to allow all PhD students to introduce themselves to the wider EURAD community and their peers. All PhD students contributing to EURAD at that time were invited to present themselves and their research. Besides PhD students, junior and senior professionals associated with EURAD were expected to join this event.

During this half-day long event, 22 PhD students presented themselves and their work. The students were grouped based on the WP they were active in. Each group session was moderated by the respective WP Leader. Each student presented for five minutes, followed by five minutes of questions. Each presentation was recorded and can be consulted online via <https://www.youtube.com/playlist?list=PLahXOQn-brel-IWB1CeykU9pqYyUMaesl>.

5.3 EURAD Annual Event N°1

From March 16 until March 18 2021, EURAD's first annual event was organised. This was done entirely remotely due to COVID-19. It was open to all EURAD members, registered end-user members and the Civil Society larger group. During this event, there was session that focussed specifically on the School of RWM and the PhD students (programme can be downloaded here: <https://ejp-eurad.eu/sites/default/files/2021-03/Annual%20event%20-%20Detailed%20agenda-reminder.docx>).

First, there was a presentation about the objectives and activities of the School of RWM, followed by a presentation by the first recipient of the EURAD Mobility Grant. He presented what he did during his mobility action and how the EURAD Mobility Programme benefitted his PhD work.

Next, there were six PhD students (one per technical WP) that presented their scientific contributions to EURAD to the wider EURAD community. By highlighting their work during this large-scale (online) event, their work got a lot of praise from the experts and also helped their work gain the necessary publicity, which was important as due to COVID-19 it was more difficult for them to present their work at conferences.

Finally there was room for a debate between the students and the experts. This allowed experts to ask questions about the students' work, but also for the students to ask advice from the experts. This type of two-way interaction is key in getting students involved in the larger EURAD programme and allows them to start networking with experts in the field. Unfortunately the networking was limited to this session as it was an online event and the discussion could not continue during the breaks.

5.4 EURAD Annual Event N°2

The second EURAD Annual Event took place from March 28 until March 30 2022. Given the COVID-19 restrictions that were still in place, this was a hybrid event with the majority of the participants attending online. As with the other Annual Events, a specific timeslot was reserved for the PhD students (full programme can be downloaded here: https://ejp-eurad.eu/sites/default/files/2022-03/Annual%20event%20n2%20-%20Detailed%20agenda_site%20web_1.pdf). During this Annual Event, the student session had two main objectives: to allow them to present their scientific progress and to improve on the lack of networking options during the first Annual Event (which was lacking because it was an online only event). Additionally, students from the PREDIS ('The pre-disposal management of radioactive waste') project were also invited to present their work. This allowed students from EURAD and PREDIS to network with each other.

During the session nine EURAD PhD students and one Masters' student involved in EURAD presented their work, followed by three PREDIS PhD students. This was followed by a traditional Q&A between the speakers and the audience. Overall the presentations and the discussions were highly appreciated by all.

The other aspect that was included in this Annual Event was a hybrid networking event. Using the online networking platform Conversation Starter (<https://www.conversationstarter.net/>) students could create a short profile and get in touch with other students and experts via short online speed dates hosted on the platform. These discussions could then afterwards continue via mail, in person meetings, ... The goal was to overcome the hurdles of networking during a hybrid event and allow all participants to get in contact with each other. Despite the great anticipation of using this platform and the work done by WP13 to set this up, the online networking was barely used during this event. Feedback that was gathered afterwards indicated that people prefer networking in person and that there was only a limited number of experts registered on the platform, reducing the number of useful interactions to be. Additionally only a very small number of students used the platform to get in touch with their peers. As a result Conversation Starter was not used in subsequent Annual Events and priority was given to in person networking.

5.5 EURAD Annual Event N°3

The third Annual Event was organised from March 14 until March 16 2023. Unlike the previous years, this was an in person event (programme can be downloaded here: https://ejp-eurad.eu/sites/default/files/2023-02/Annual%20event%20n3%20-%20Detailed%20agenda_2.pdf).

During this event the focus for the PhD students was on presenting their progress, improving the connecting with PREDIS' PhD students and providing them the opportunity to meet in person for the first time (for many of them).

As during the previous edition, three PREDIS PhD students were invited to present their work to show how closely it is linked to the work being done within EURAD. Following these presentations, eight EURAD PhD students presented their progress. After all presentation, a panel discussion was organised during which all participants could ask questions to the students and vice versa.

In addition to the presentations, WP13 took steps to stimulate the EURAD PhD students to form their own PhD community, which could serve as an end-user group within EURAD (cfr. PREDIS Student Group). To that end, the PREDIS student representative was also invited to this Annual Event. Some informal discussion took place regarding this. Despite interest and willingness from the PhD students, only small steps were taken. Thus work still remains to be done do create a more sustainable PhD community, work that will have to continue in the future.

5.6 EURAD Final Event

Finally, from April 23 until April 25 2024 the EURAD Final Event was organised (programme can be downloaded here: https://ejp-eurad.eu/sites/default/files/2023-09/Final%20Annual%20event%20-%20Draft%20agenda_V2.pdf). This time, the focus of the Student Session was different from previous Annual Event in that now organisations were also invited to present themselves and the job profiles they

are looking for now and in the future. This was done per request of the PhD students themselves as to show them more career options.

Two EURAD PhD students presented their work and three RWM organisations also presented themselves. Originally, the idea was to include a small-scale job fair for the PhD students and junior professionals, but due to the lack of interest from the organisations and the low number of PhD students that attended this event this idea was dropped.

5.7 Considerations regarding the PhD students in EURAD

Within EURAD, little over 100 PhD students are registered. It is therefore remarkable that only a minority of these attended the events mentioned above. Therefore, moving forward, more attention should be given to include most (if not all) PhD students in these events, be it through specific satellite events, poster sessions, job fair, etc.. Although initially it was not in the scope of WP13 to promote the student community, it is an effort that was appreciated by the students and the experts alike. Therefore this effort needs to be continued to get more students involved so that a vibrant PhD student community can flourish on a European level. Only then, can they form their own EURAD end-user group.

6. Lessons learned

This deliverable describes all activities undertaken by WP13 through the School of RWM. All of them are discussed in the previous sections. In this section, the main lessons learned will be listed: both good aspects as well as points of improvement. They will be listed per pillar of the School to keep a nice overview of all activities. Pillar 3 – Panorama will not be featured in this section as this pillar does not contain specific activities that can be evaluated/improved. It does contain activities from the other pillars, which are discussed in their respective subsections.

6.1 Pillar 1 – Courses & Webinars

The following list summarises the positives from the first pillar:

- The documented feedback from the training courses is very positive, indicating that they are very much appreciated by the end-users. This is supported by the quality guidelines outlined in D13.5⁵ and continuous monitoring of performance via feedback forms (see Appendix A).
- The bottom-up approach of tackling training needs from the end-users was a major strength of the School of RWM.
- The topics covered by the training courses met the expectations from the end-users.
- The Lunch & Learn sessions are very much appreciated by the EURAD community. The topics and the format allow for a low barrier of entry to many of the facets involved in a RWM programme.

The following list summarises the areas of (potential) improvement of the first pillar:

- Some of the learning materials were evaluated poorly. To avoid this, more specific guidelines and support on how to create effective learning materials should be provided to the lecturers. The School of RWM could also foresee a short review of all materials before they are being used.
- The School should continuously monitor and update the end-users' needs in order to provide the necessary training at the correct times.
- Closer interactions with subject matter experts so that involving them in the training design and delivery is more fluid.
- Expand on the Lunch & Learn formula: try to increase the frequency and increase the variety of topics. This entails involving subject matter experts more as well as presenters of EURAD R&D and Strategic studies WPs.
- Improve visibility of the Lunch & Learn recordings. Although they are appreciated, the number of views is rather low.
- The platform that is used for the Lunch & Learn sessions could be replaced in order to improve interactions between the audience and the speakers.

6.2 Pillar 2 – Mobility Programme

The following list summarises the positives:

- Success rate of the Mobility Programme is very high and it allowed most of the participants to carry out their mobility action.
- Appreciation of the Mobility Programme is high. It offers a real benefit to the beneficiaries to be able to perform these mobility actions.
- The mobility reports are a valuable KM resource, which details what competence were acquired/improved during the mobility action. Making these publicly available improves their value as everyone has access to them.
- Expanding the Mobility Programme to include financial support to attend training courses, conferences, and workshops was very much appreciated by the end-users, as reflected in the high number of applications in those categories.
- The application and evaluation platform (Evalato) was easy to use and to navigate. It is customisable and easy to operate from an administrative point of view.

The following list summarises the areas of (potential) improvement:

- The Mobility Programme payments were very inefficient from an beneficiary point of view: the applicant's organisation had to pay the applicant and then ask for reimbursement via Form C from EURAD via the financial report. This resulted in a lot of confusion and applicants that only received the money weeks/months after finalising the mobility action.
- Communication about and visibility of the Mobility Programme could be improved as for many it was (even at the end of EURAD) not clear where to find all the relevant information.
- The Mobility Programme could be expanded with a 'mentoring programme'. This feeds into support for PhD students and junior professionals as well. The idea is to have a list/community of mentors available that are able and willing to guide juniors in their first steps into RWM. The Mobility Programme could support this by financially supporting travel for mentor and mentee to meet physically when required. This concept has received positive feedback from the EURAD community, but implementation still needs to start.

6.3 Pillar 4 – PhD students

The following list summarises the positive aspects of the activities organised for EURAD PhD students:

- Actively including the PhD students in major EURAD events, such as the Annual events.
- Providing information aimed at PhD students via the School of RWM's website.
- Planting the seeds of forming a PhD Community, a potential vibrant end-user group within EURAD.

The following list summarises the areas of (potential) improvement:

- Despite over 100 PhD students being registered in EURAD, the School only managed to reach 20-30 actively. Keeping contact with all PhD students is an aspect that should be improved in the future. This can be done via a PhD community, where the School (and other WPs) can be in touch with all students in a structured manner (e.g. via 1 or 2 student representatives that relay all information to the wider PhD community).
- The content on the School's website that is aimed at PhD students is useful, but it is far from complete. Therefore, as a resource, it is not used very much. By keeping the content up to date and adding new content regularly, this can be improved in the future.
- More specific activities for PhD students can be organised. Currently, they are actively involved in the EURAD Annual Events, but hosting events specifically for them (or in co-organisation by them) can help them even more in networking and acting more as a tight-knit community.
- The School (as well as other WPs) would do well to be more open to feedback and input from the PhD students. This can be done via communicating with them more often, asking them to attend certain meetings (e.g. WP Leader meetings), etc.. All of these actions can be implemented easier when there is a PhD community (and some representatives) that can be involved.

7. Conclusion

In EURAD, WP13 and the School of RWM focussed its activities mainly on four main pillars (figure 1). This includes two more pillars than initially foreseen in the 'Description of Work' for the EURAD programme. Despite this, and multiple hindrances by COVID-19, the School of RWM managed to book great results across all pillars.

This deliverable provides a general overview of all activities undertaken by WP13 in the frame of the School of RWM, followed by a critical reflection of the successes and points of improvements in the 'Lessons learned' section. Overall, the main objectives the School has set for itself at the start of EURAD were achieved. Feedback on the first two pillars, 'Courses & Webinars' and 'Mobility Programme', was highly positive. Similarly, activities the School undertook to support the EURAD PhD students has received positive feedback. However, each activities also has points of improvements going into the future, ranging from (very) minor (e.g. watch more closely over the quality of the training materials) to major (e.g. setting up a PhD community as an end-user group with the EURAD community) improvements in each of its pillars.

The School of RWM has demonstrated remarkable success across most of its pillars, positioning itself as a valuable resource for end-users. It has proved itself to be a valuable resource in competence building with the European RWM community (and beyond). Furthermore, it actively contributed to EURAD's KM Programme by ensuring heightened awareness of KM principles. All relevant activities remain accessible online, including Lunch & Learn recordings and mobility reports.

In conclusion, the School of RWM has laid the foundation of a successful hub for competence building in RWM in Europe through its four pillars. Thanks to its successes, and room for improvement, it is valuable to continue its activities going forward into future RWM-focused projects.

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Appendix A. Feedback form for training course participants

Title of the training course

Date | Location

Tick the boxes (4 = excellent; 3 = good; 2 = sufficient; 1 = poor)

Content	Balance theory practice	Up-to-date	Practical use of the training
	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The degree of difficulty in comparison with the proposed level is:	<input type="checkbox"/> higher	<input type="checkbox"/> lower	<input type="checkbox"/> as expected
In your opinion, which topics were missing to have an effective course on the stated topic?			
Remarks:			
Course material	Clearness	Completeness	Quality of the slides
	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Remarks:			
Organisation	Time schedule	Course environment training room	Catering, coffee breaks, lunch
	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Remarks:			

General			
Why did you follow this course?	<input type="checkbox"/> own interest	<input type="checkbox"/> recommended	<input type="checkbox"/> on demand of the employer
Would you recommend this course to other persons?	<input type="checkbox"/> yes	<input type="checkbox"/> no	

Why (not)?					
What would be the target public?					
What would be the optimal frequency to organize this course?					
Remarks:					
Overall judgement of the course	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	

EURAD D13.13 - Overview of all School of Radioactive Waste Management during EURAD

Tick the boxes (4 = excellent; 3 = good; 2 = sufficient; 1 = poor)

(Please note that this table is for multiple instructors. Please adjust to the number of instructors in your training course)

Instructors			Clearness	Possibility for questions, interaction	Scientific knowledge	Very interesting topic	Less interesting topic
Lecture title	Date	Time					
			4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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			4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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			4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
General judgement on instructors:			4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	4 3 2 1 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		
Remarks:							

