# Deliverable 13.9: Update on training courses organised by EURAD WP13

Work Package 13

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**Disclaimer**



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## Executive Summary

The School of RWM acts as the executive body for all training and mobility activities that are organised within EURAD. It is the task of EURAD WP13 to ensure a uniform approach and quality throughout a needs-driven EURAD training course portfolio. This deliverable provides an overview of the training courses that where organised by the School of Radioactive Waste Management (RWM) up until the end of June 2023.

## Keywords

Training

Knowledge Management

Knowledge

Skill

Attitudes

Competences

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# 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 |
| 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)'. It acts as the executive body for all training and mobility activities that are organised within EURAD. It responds to the training needs of organisation acting in RWM in Europe (D13.1)[1]. It takes into account the EURAD Roadmap (D1.7)[2], which is used as a guide to map existing training (D13.2)[3], prioritise trainings based on the identified training needs by the RWM community and publish an overview of past, current and newly developed training courses that are available to the RWM community, which includes the EURAD community (D.13.3)[4]. In general, training courses within EURAD are organised by the School of RWM, following a process based on the Systematic Approach to Training (D13.5)[5] and experiences from the first training courses that were organised (D13.6)[6]. This deliverable provides an overview of the training courses that where organised by the School of RWM up until the end of June 2023.

# 2. Overview of training courses

In this section, a comprehensive overview will be provided by all training courses that were organised by WP13 in the frame of the EURAD School of RWM. They can also be consulted in the online overview on the School of RWM's website: https://euradschool.eu/events/category/eurad-training-course/.

## 2.1 EURAD Training course on multiphysical couplings in geomechanics

### 2.1.1 Practical details

Date: January 22 – 24, 2020

Location: Institut de Mathematique, Quartier Polytech 1, Allée de la Découverte 12, 4000 Liège, Belgium

Language: English

Training type: Classroom-based training and practical training sessions

Educational level: European Qualifications Framework (EQF) level 6 (equivalent to BSc degree)

Weblink: https://euradschool.eu/event/test-1-eurad-training-course/

### 2.1.2 Description

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.

### 2.1.3 Learning outcomes

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.

#### 2.1.4 Target audience

Graduates (MSc and PhD students)

#### 2.1.5 Link to EURAD Roadmap theme(s)

- 3.2 Waste packages for disposal
- 4.2 Perturbations

#### 2.1.6 Keywords

Geomechanics, gas transfer, thermal impact, gas migration

### 2.2 Introductory course on EURAD and Radioactive Waste Management

#### 2.2.1 Practical details

Date: September 14 2020

Location: online (recording available via https://www.youtube.com/playlist?list=PLahXOQn-bremYbN7GA8H9YN_m8AlVHCz1)

Language: English

Training type: Distance learning (webinar)

Educational level: EQF level 6 (equivalent to BSc degree)

Weblink: https://euradschool.eu/event/eurad_and_radioactive_waste_management/

#### 2.2.2 Description

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

#### 2.2.3 Learning outcomes

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

#### 2.2.4 Target audience

PhD students, post-docs, junior professionals in the field of RWM, all EURAD partners and (external) professionals interested in EURAD and RWM

#### 2.2.5 Link to EURAD Roadmap theme(s)

Given the nature of the course, it touched upon most EURAD themes.

#### 2.2.6 Keywords

Introduction course, EURAD, radioactive waste management

### 2.3 EURAD Training course on safety case development and review

#### 2.3.1 Practical details

Date: November 28 – December 2, 2022

Location: National Radiation Protection Institute (SURO), Bartoskova 1450/28, Prague, Czech Republic

Language: English

Training type: classroom-based training

Educational level: EQF level 6 (equivalent to BSc degree)

Weblink: https://euradschool.eu/event/training-course-on-safety-case-development-and-review/

### 2.3.2 Description

**Background information**

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.

**Training aims**

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.

### 2.3.3 Learning outcomes

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.

### 2.3.4 Target audience

National Regulators, Technical Support Organisations, Waste Management Organisations, Professionals/Experts involved in the safety case development and/or review, Civil Society Experts, Researchers involved in the RWM, Participants involved in cooperating projects (as PREDIS, etc.)

### 2.3.5 Link to EURAD Roadmap theme(s)

- 7.1 Safety strategy
- 7.2 Integration of safety related information
- 7.3 Safety assessment and tools

### 2.3.6 Keywords

Safety case development, safety case review, deep geological disposal

### 2.3.7 Feedback

The figures below illustrate the written feedback that was received at the end of the training course. Overall, the feedback was very positive, indicating that participants were satisfied. This is also useful feedback for WP13, indicating that the internal processes for designing and implementing training courses results in high quality training courses (D13.5[5] and D13.6[6]).

#### 2.3.7.1 Training content

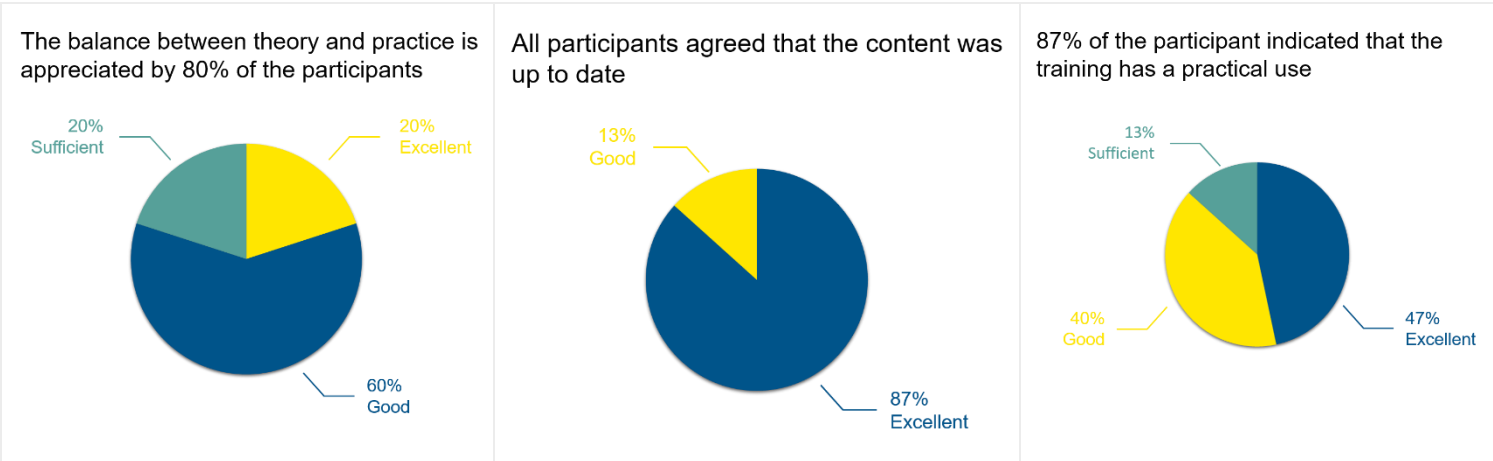


*Figure 1. Overview of the feedback received on the training content. The practice between and practice was very much appreciated (60% 'good' score, 20% 'excellent' score and 20% 'sufficient' score). All participants agreed that the content was up to date (87% 'excellent' score and 13% 'good' score). Finally, the practical use of the training was also positively appreciated by the majority of the participants (47% 'excellent' score, 40% 'good' score, and 13% 'sufficient' score).*

#### 2.3.7.2 Course materials

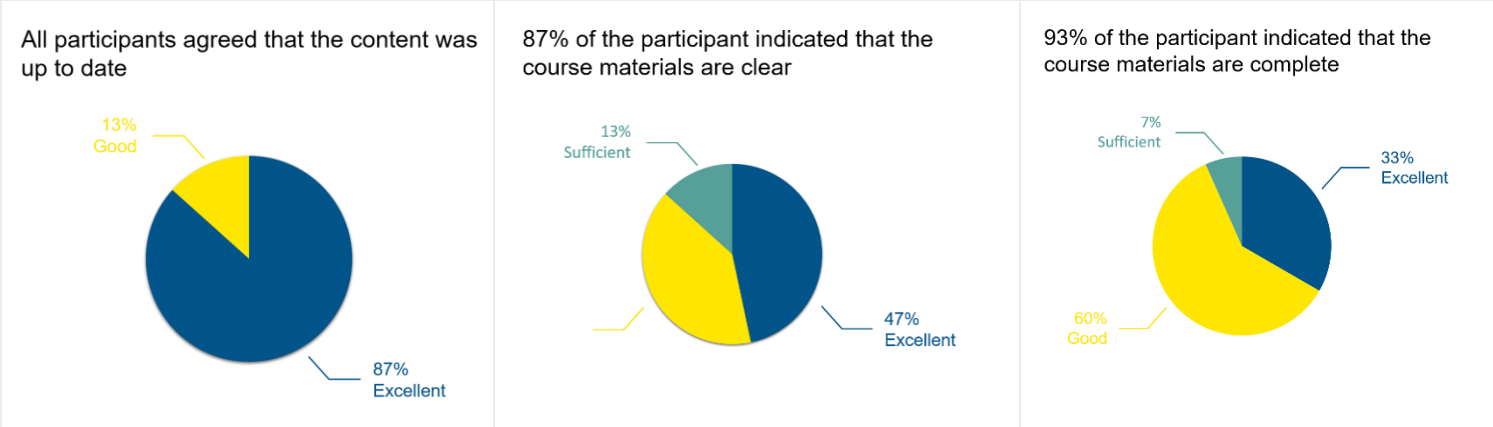


*Figure 2. Overview of the feedback on the course materials. All participants agreed that the course materials were up to date (13% 'good' score, 87% 'excellent' score). 87% of the participants indicated that the course materials were clear (47% 'excellent' score, 40% 'good' score, and 13% 'sufficient' score). Finally, over 90% of the participants indicated that the course materials were complete (33% 'excellent' score, 60% 'good' score, and 7% 'sufficient' score).*

#### 2.3.7.3 Overall judgement

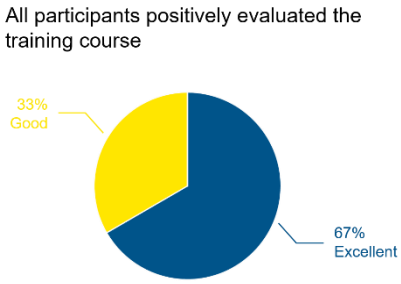


*Figure 3. Feedback on the overall judgement. All participants indicated to be pleased with the training course overall (67% 'excellent' score and 33% 'good' score).*

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

### 2.4.1 Practical details

Date: January 18, 2023

Location: MS Teams

Language: English

Training type: Webinar (distance learning)

Educational level: EQF level 7 (equivalent to MSc degree/post graduate)

Link: https://euradschool.eu/event/information-session-and-discussion-on-the-spent-fuel-state-of-knowledge-document/

### 2.4.2 Description

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.

Programme

13h00 – Introduction on SoK documents and the EURAD Roadmap – Alexandru Tatomir

13h05 – Lecture on spent fuel SoK document – Kastriot Spahiu

13h50 – Break

14h00 – Discussion session – Kastriot Spahiu and participants

16h00 – Closure of session

### 2.4.3 Learning outcomes

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

### 2.4.4 Target audience

Junior researchers, senior researchers, decision makers, waste management organisations, technical support organisations, research entities

### 2.4.5 Prerequisites

Participants to this session are requested to have read the SoK document on Spent Fuel. Participants were asked to propose a topic for the discussion session (if any). This could be any topic related to spent fuel they wanted more information on.

### 2.4.6 Link to EURAD Roadmap theme(s)

3.1 Wasteforms

#### 2.4.7 Keywords

Spent fuel, State-of-Knowledge, dissolution, leaching, reducing conditions, release rates of radionuclides

## 2.5 Geochemical and Reactive Transport Modelling for Geological Disposal

#### 2.5.1 Practical details

Date: February 6 – February 10 2023

Location: University of Bern, Hochschulstrasse 4, Bern, 3012 Switzerland

Language: English

Training type: classroom-based training (face-to-face), practical training session

Educational level: EQF level 7 (equivalent to MSc degree/post-graduate)

Link: https://euradschool.eu/event/geochemical-and-reactive-transport-modelling-for-geological-disposal/

#### 2.5.2 Description

**Background information**

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.

**Detailed description**

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 chose 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)

**Training aims**

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.

#### 2.5.3 Learning outcomes

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

#### 2.5.4 Target audience

Students and junior researchers applying modelling for radioactive waste applications

#### 2.5.5 Link to EURAD Roadmap theme(s)

3.4 Engineered Barrier System integration

#### 2.5.6 Keywords

Reactive transport codes, geochemical modelling

#### 2.5.7 Feedback

The figures below illustrate the written feedback that was received at the end of the training course. Overall, the feedback was very positive, indicating that participants were satisfied. This is also useful feedback for WP13, indicating that the internal processes for designing and implementing training courses results in high quality training courses[5,6].

#### 2.5.7.1 Training content

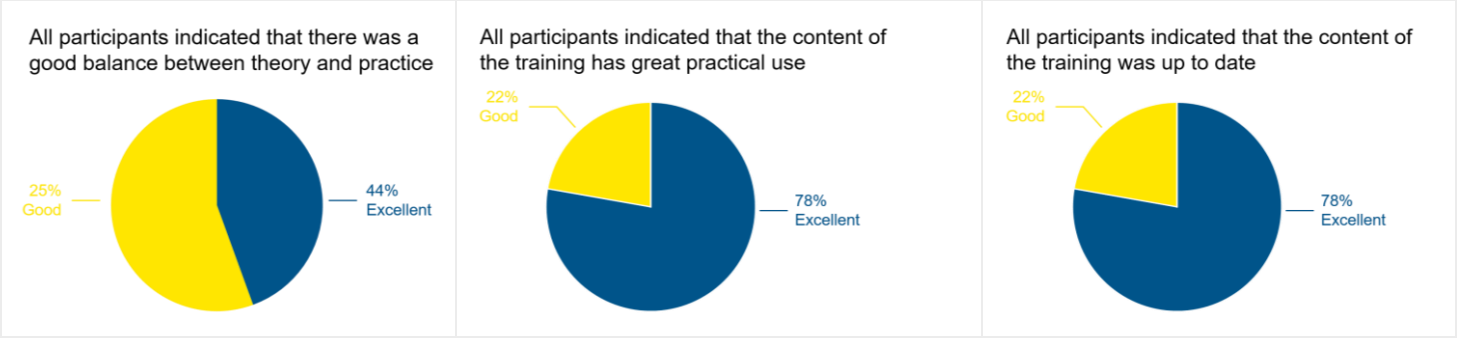


*Figure 4. Overview of the feedback received on the training content. The practice between and practice was very much appreciated (56% 'good' score and 44% 'excellent' score). All participants agreed that the content was up to date (78% 'excellent' score and 22% 'good' score). Finally, the practical use of the training was also positively appreciated by the participants (78% 'excellent' score and 22% 'good' score).*

#### 2.5.7.2 Course materials

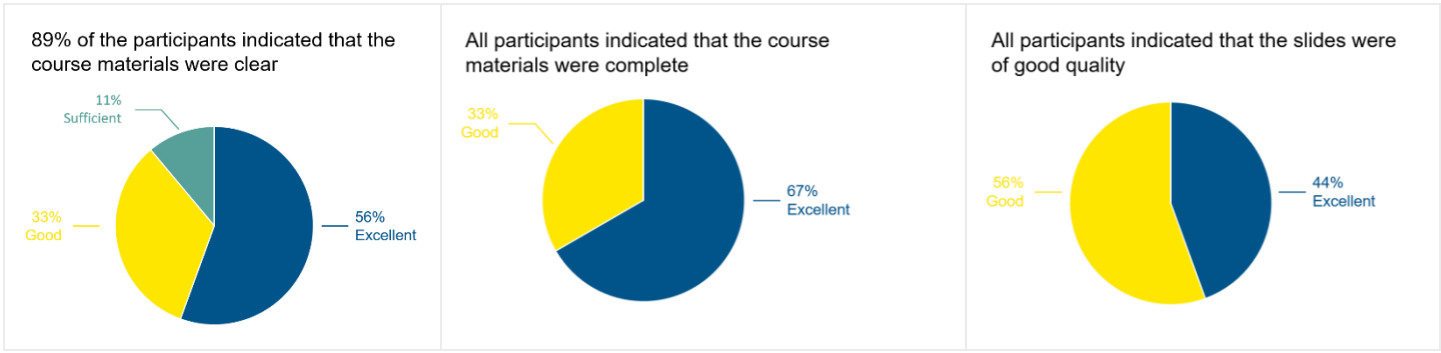


*Figure 5. Overview of the feedback on the course materials. The majority of the participants agreed that the course materials were clear (11 % 'sufficient' score, 33% 'good' score, and 87% 'excellent' score). All participants indicated that the course materials were complete (67% 'excellent' score and 33% 'good' score). Finally, all participants indicated that the course materials were of good quality (44% 'excellent' score and 56% 'good' score).*

#### 2.5.7.3 Overall judgement

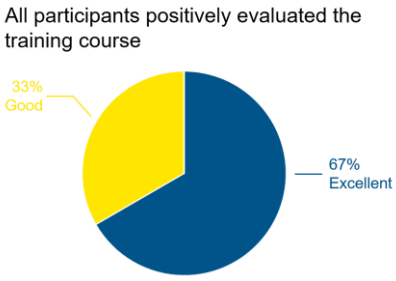


*Figure 6. Feedback on the overall judgement. All participants indicated to be pleased with the training course overall (67% 'excellent' score and 33% 'good' score).*

## 2.6 EURAD Training course on Uncertainty Management

### 2.6.1 Practical details

Date: February 14 – February 18 2023

Location: Bel V, Rue Walcourt 148, Brussels, 1070 Belgium

Language: English

Training type: classroom-based training (face-to-face)

Educational level: EQF level 7 (equivalent to MSc degree/post-graduate)

Link: https://euradschool.eu/event/eurad-training-course-on-uncertainty-management/

### 2.6.2 Description

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 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".

### 2.6.3 Learning outcomes

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

#### 2.6.4 Prerequisites

MSc degree is required

#### 2.6.5 Target audience

Multidisciplinary (professional) experts and specialized experts; non-EURAD partners; Experts involved in the development of the safety case; safety case reviewers

#### 2.6.6 Link to EURAD Roadmap theme(s)

- 3.1 Waste forms
- 7.3 Safety assessment and Tools

#### 2.6.7 Keywords

Uncertainty management; radioactive waste management; waste forms

#### 2.6.8 Feedback

The figures below illustrate the written feedback that was received at the end of the training course. Overall, the feedback was very positive, indicating that participants were satisfied. Except for the balance between theory and practice of the content. This indicates that there was a mismatch between the offered course and the expectation of the participants. This is also useful feedback for WP13, indicating that the internal processes for designing and implementing training courses results in high quality training courses[5,6].

#### 2.6.8.1 Training content

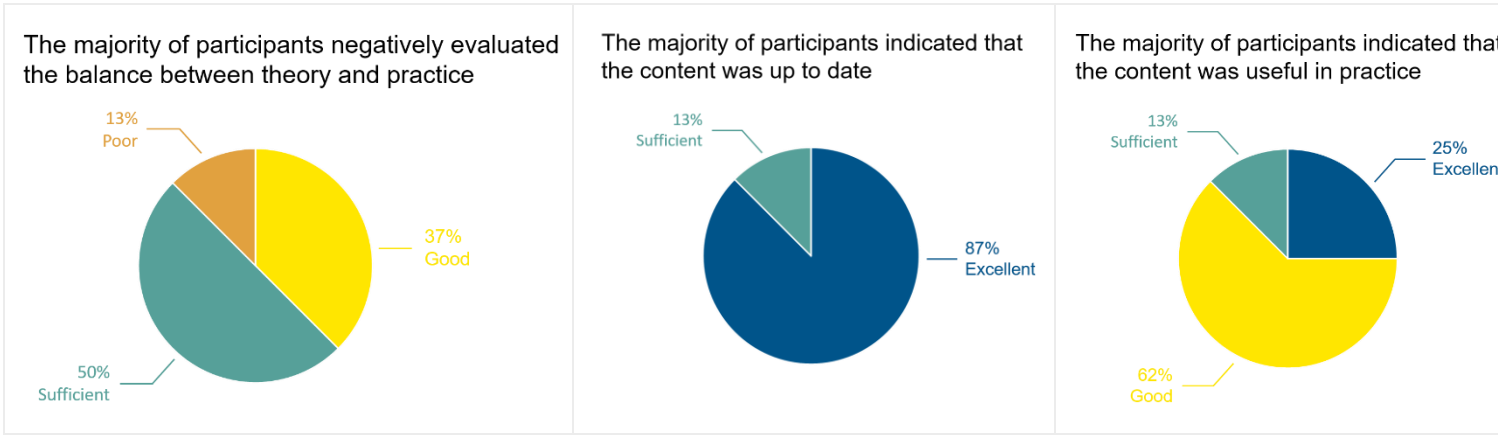


*Figure 7. Overview of the feedback received on the training content. The practice between and practice was appreciated mostly negatively (37% 'good' score, 50% 'sufficient' score, and 13% 'poor' score). The majority of the participants agreed that the content was up to date (87% 'excellent' score and 13% 'sufficient' score). Finally, the practical use of the training was also positively appreciated by the majority of the participants (25% 'excellent' score, 62% 'good' score, and 13% 'sufficient' score).*

#### 2.6.8.2 Course materials

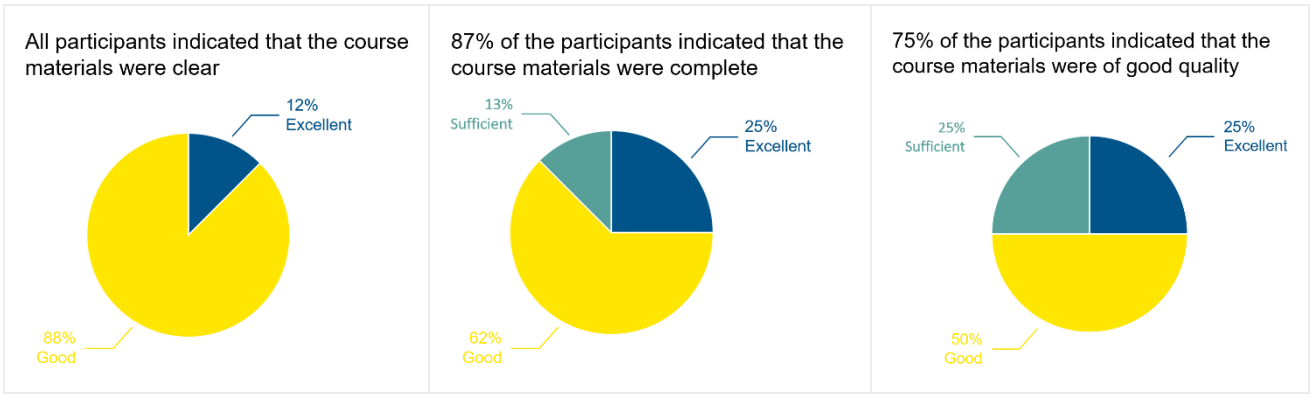


*Figure 8. Overview of the feedback on the course materials. All participants agreed that the course materials were clear (88% 'good' score and 12% 'excellent' score). The majority of the participants indicated that the course materials were complete (25% 'excellent' score, 62% 'good' score, and 13% 'sufficient' score). Finally, the majority of the participants indicated that the course materials were of good quality (25% 'excellent' score, 50% 'good' score, and 25% 'sufficient' score).*

#### 2.6.8.3 Overall judgement

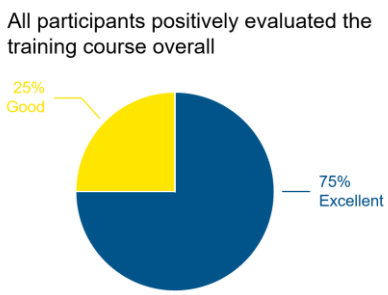


*Figure 9. Feedback on the overall judgement. All participants indicated to be pleased with the training course overall (75% 'excellent' score and 25% 'good' score).*

## 2.7 Information and discussion session on the SoK document on Containers

### 2.7.1 Practical details

Date: June 5 2023

Location: MS Teams (online)

Language: English

Training type: Webinar (distance learning)

Educational level: EQF level 7 (equivalent to MSc degree/post-graduate)

Link: https://euradschool.eu/event/information-and-discussion-session-on-the-sok-document-on-containers/

### 2.7.2 Description

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-tern 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.

### 2.7.3 Learning outcomes

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

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

### 2.7.4 Target audience

Radioactive waste management professionals, students, waste management organisations, technical support organisations, research entities

### 2.7.5 Link to EURAD Roadmap theme(s)

- 3.1: Waste forms
- 3.2: Waste packages for disposal
- 3.4: Engineered Barrier System integration

### 2.7.6 Keywords

Containers; Safety function; Materials; Environmental conditions

# 3. Lessons learned

As described in D13.5, feedback is gathered after each training course[5]. This document only mentions the feedback from larger training courses, as those ask the most input and preparation from WP13. Looking at the feedback, it is clear that the satisfaction rate of the course participants is very high for our training courses. For the three major training courses organised (June 2022 – June 2023), the overall satisfaction is 100% positive (exclusively 'excellent' and 'good' scores). This indicates that the processes and methods described in D13.5 and D13.6 prove successful in organizing high level training courses[5,6].

However, there are some points of improvement/attention:

- Involving the lecturers (= experts) is crucial for a good course programme and course materials
- Describing the course content and learning outcomes clearly is paramount to set the expectations of the participants

# 4. Conclusion

In general, training courses within EURAD are organised by the School of RWM, following a process based on the Systematic Approach to Training (D13.5) and experiences from the first training courses that were organised (D13.6). This deliverable provides an overview of the training courses that where organised by the School of RWM up until the end of June 2023 and the main lessons learned. The School of RWM has successfully organised six training courses up to the end of June 2023.

All courses are considered successful based on attendance and participant feedback. In fact, all feedback on the overall appreciation is highly positive. For some training courses, there are some minor points that can be improved, which are of course the reason for gathering feedback in the first place. The feedback that was gathered and reported in this deliverable will be used to continue improving upon training courses organised by the School of RWM in the final year of EURAD.

# References

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