Co-funded by :
French Alternative Energies And Atomic Energy Commission (CEA)
& European Commission

Under the scope of:
French Presidency

EURADWASTE'22

BOOK OF ABSTRACTS

10th European Commission Conferences
on EURATOM Research and Training in Safety of
Reactor Systems & Radioactive Waste Management

30 May – 3 June **Lyon, France**

In cooperation with

With the support of

EURADWASTE '22 – Book of Abstracts

European Commission
Directorate-General for Research and Innovation
Directorate C — Clean Planet
Unit C.4 — Euratom Research

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Manuscript completed in May 2022.
1st edition.

Print	ISBN 978-92-76-48975-7	doi:10.2777/457889	KI-07-22-119-EN-C
PDF	ISBN 978-92-76-48976-4	doi:10.2777/652455	KI-07-22-119-EN-N

Luxembourg: Publications Office of the European Union, 2022

EUROPEAN COMMISSION

EURADWASTE '22

Book of Abstracts

2022

Directorate-General for Research and Innovation
Euratom Research and Training Programme

EN

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FISA 2022
EURADWASTE'22

FOREWORD

Since 1999, the EURADWASTE conference has been an important event to present the challenges, the outcome and the perspectives of the Euratom Research and Training Programme on Radioactive Waste Management and to provide a platform to the key players in Radioactive Waste Management (RWM).

This year's 10th edition jointly organised with the French Alternative Energies and Atomic Energy Commission (CEA), under the scope of the French Presidency of the Council of the EU in 2022, will take place in Lyon and the Région Auvergne-Rhône-Alpes will host all events held during the week. EURADWASTE '22 will be marked by the achievements of the first on-going European Joint Programme on Radioactive Waste Management EURAD and its sister project PREDIS.

While countries with mature programmes such as Finland, Sweden and France are planning to launch the operational phase of their respective repositories in the next decade, other Member States were in the early stages of establishing their RWM strategy. In order to encourage interactions between the Member States, the Euratom H2020 programme played an important role in strengthening the cooperation between the Member States and establishing a network and shared technological platforms.

The reference document for the Commission's action is the Framework Programme (FP) Horizon 2020 (2014-2018/2020). It defines the activities necessary to achieve the programme objectives to "Contributing to the development of safe, longer-term solutions for the management of ultimate nuclear waste, including final geological disposal as well as partitioning and transmutation", including

- Joint and/or coordinated research activities on remaining key aspects of geological disposal (GD) of spent fuel (SF) and long- lived radioactive waste with, as appropriate, demonstration of technologies and safety. Those activities are to promote the development of a common Union view on the main issues related to waste management from discharge of fuel to disposal.
- Research activities related to management of other radioactive waste streams for which industrially mature processes currently do not exist.

To attain FP objectives the regulation enables the activities to be implemented through: public-public partnerships based on the 'Programme co-fund actions' funding scheme.

During the EURADWASTE'19 edition in Pitesti, Romania, a presentation was dedicated to the JOPRAD project which had the objective of preparing the first Joint European Programme on RWM via the use of a new contractual instrument: Joint Programme co-fund.

Thereafter the first European Joint Programme took shape and was launched in June 2019 for five years, including the main stakeholders in research for the RW disposal. 51 beneficiary organisations and 62 affiliated entities or third parties from 23 European countries (20 Member States and 3 associated countries) have been working together over the three past years. EURAD's work programme is steered by the three categories of representatives of key players in radioactive waste management: Waste Management Organisations (WMOs), Technical Support Organisations (TSOs) and the Research Entities (REs). It includes all research activities and transversal aspects related to the geological disposal of radioactive waste.

Shortly after, the project PREDIS was launched in 2020 targeting the development and the implementation of activities for the predisposal management of radioactive waste streams other than nuclear fuel and high-level waste. The aim is to develop methods, processes, technologies and demonstrators for the treatment and conditioning of wastes for which no or inadequate solutions are currently available (except spent nuclear fuel and high-level radioactive waste). Finally, EURAD and PREDIS are complemented by a number of projects launched prior to 2019 covering specific technical areas such as the characterisation of radioactive waste (e.g. CHANCE, MICADO), the thermal treatment of waste (e.g. THERAMIN), the behaviour of bentonite-based engineered barrier systems (e.g. BEACON) and the spent fuel chemical behaviour in failed container conditions (e.g. DISCO).

The work programme aims at improving and developing science and technology for radioactive waste management and consolidating knowledge in support of the national programmes and in line with the requirements of the Nuclear Waste Directive[1]. EURAD established for instance a common vision and a Strategic Research Agenda (SRA) for a joint research programme based on the R&D needs and gaps. One important focus of EURAD, PREDIS and all EC-funded projects is knowledge management, ensuring that information and competences are retained over time and promoting knowledge transfer between Member States with advanced research programmes and those at an early-stage. The purpose was for these communities to integrate the needs from all parties and from all MSs, in particular those either with small programmes or with less-developed knowledge or less-advanced in overall radioactive waste management strategy.

The structure of the conference programme and the objective of the sessions reflect the main transversal aspects of the Euratom Programme on RWM and in particular the structure of the EJP EURAD. It aims at taking stock of what kind of research the Commission has funded during Horizon 2020 and open-up exchange and discussions on future collaborative research of EU added-value. Finally, speakers from

[1] Council Directive 2011/70/Euratom https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32011L0070

international organisations such as the IAEA and the OECD/NEA were invited as well to present an overview of their recent activities on radioactive waste management. Each one of the three sessions will be introduced by a keynote lecture given on behalf of one of the three colleges of EURAD, followed by a series of presentations from the different on-going projects and work packages and closed by a roundtable discussion between the speakers. These three sessions summarise the approach described above:

- **Session One: 'Collaborative R&D in Radioactive Waste Management'.** Research and innovation studies related to RWM such as short and long-term experiments and/or modelling work to demonstrate the robustness of the waste management concepts, to increase understanding and predictability of the impact of fundamental processes and their couplings or to maintain scientific excellence and competences throughout the stepwise long-term management of radioactive waste. A keynote introduction will be given by the Implementing Geological Disposal Technology Platfor (IGD-TP) to present the implementer point of view.

- **Session two: 'Strategic issues in Radioactive Waste Management'.** Strategic studies in support of the implementation of the national programmes that address scientific, technical but also societal aspects of RWM such as the establishment of radioactive waste inventories, safety cases, performance assessments, the costing of a RWM programme and the interactions with the civil society. A keynote introduction will be given by the Sustainable network for Independent Technical Expertise (SITEX) Network to present the regulator point of view.

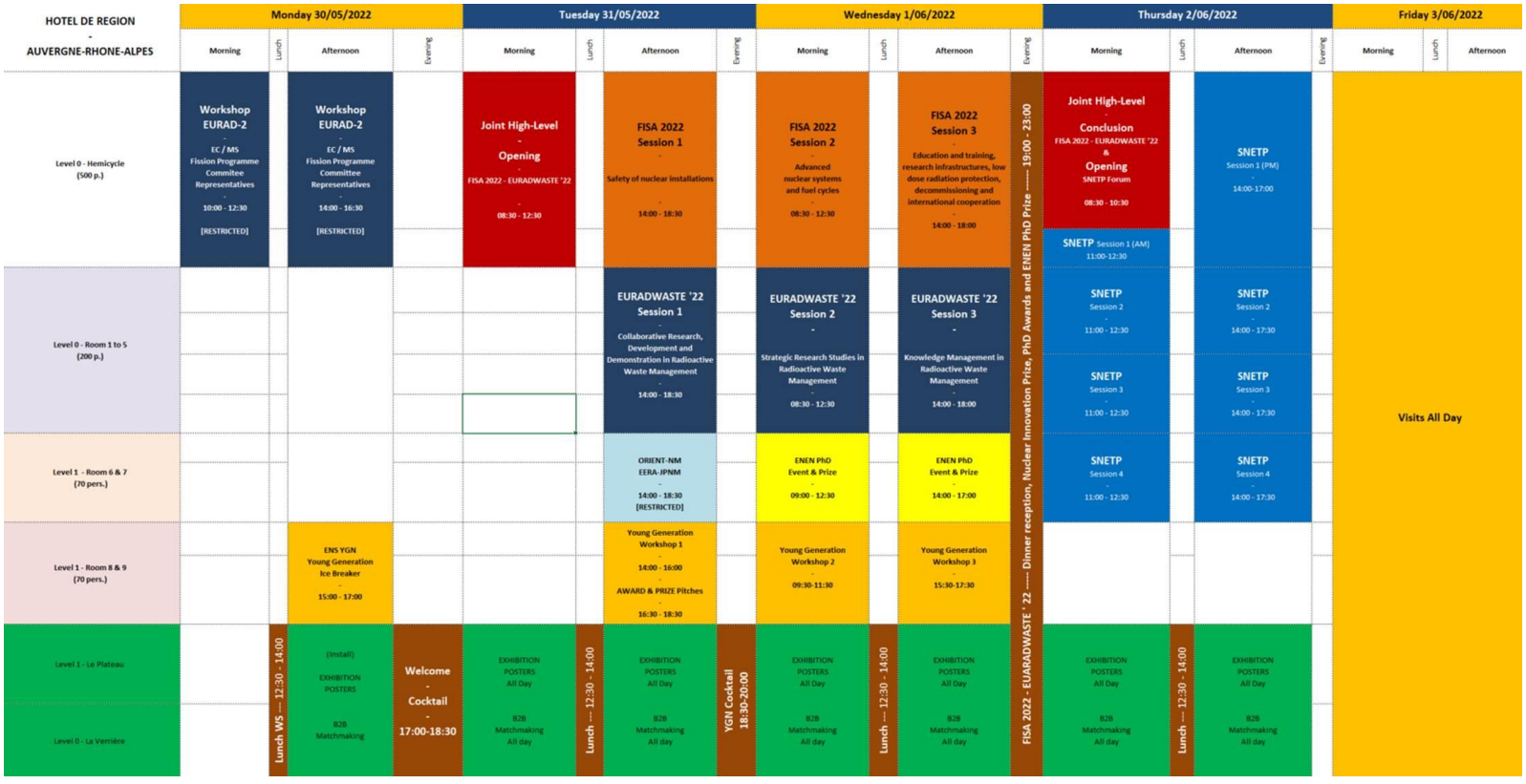
- **Session Three: 'Knowledge management in Radioactive Waste Management'.** Transversal activities in knowledge management related to RWM including exiting knowledge, guiding the planning and implementation of a RD&D plan and developing/delivering a training and mobility programme in line with core competencies. The session covers as well transfer/sharing of knowledge between front runners and countries at an early stage of their programmes and between generations. A keynote introduction will be given by the Joint Research Center as they are strongly involved in the knowledge management of both EURAD and PREDIS. EURADSCIENCE, the third and youngest college of EURAD will be represented by a poster and a presentation during this third session.

We wish you a pleasant and productive FISA 2022 conference with many fruitful discussions for future international cooperation and partnerships in research and innovation!

Your participation, as honourable guests or speakers, co-chairs, rapporteurs, high-level experts, to the Euratom conferences FISA 2022 and EURADWASTE ’22, in Lyon, in France, or even online, is highly appreciated by the entire research community and will contribute for sure to a successful 10th edition of these high level scientific and policy events.

A great thank you to everyone participating in our events!
Yours sincerely,

On behalf of the Organising and Programme Committee
Roger Garbil and Seif Ben Hadj Hassine
EC DG RTD, FISA 2022 - EURADWASTE ’22 Co-chairs
Valérie Vandenberghe, Danielle Gallo and Philippe Montarnal
CEA and French Presidency, Co-chairs
Karolina Janatkova, Marie Fonteneau, Claudine Dubiau and Isabelle Auffret Babak


HOTEL DE REGION
-
AUVERGNE-RHONE-ALPES
Monday 30/05/2022
Tuesday 31/05/2022
Wednesday 1/06/2022
Thursday 2/06/2022
Friday 3/06/2022
Morning
Lunch
Afternoon
Evening
Level 0 - Hemicycle (500 p.)
Workshop EURAD-2 - EC / MS Fission Programme Commitee Representatives - 10:00 - 12:30 - [RESTRICTED]
Workshop EURAD-2 - EC / MS Fission Programme Committee Representatives - 14:00 - 16:30 - [RESTRICTED]
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FISA 2022 Session 1 - Safety of nuclear installations - 14:00 - 18:30
FISA 2022 Session 2 - Advanced nuclear systems and fuel cycles - 08:30 - 12:30
FISA 2022 Session 3 - Education and training, research infrastructures, low dose radiation protection, decommissioning and international cooperation - 14:00 - 18:00
Joint High-Level Conclusion FISA 2022 - EURADWASTE '22 & Opening SNETP Forum 08:30 - 10:30
SNETP Session 1 (AM) 11:00-12:30
SNETP Session 1 (PM) - 14:00-17:00
Level 0 - Room 1 to 5 (200 p.)
EURADWASTE '22 Session 1 - Collaborative Research, Development and Demonstration in Radioactive Waste Management - 14:00 - 18:30
EURADWASTE '22 Session 2 - Strategic Research Studies in Radioactive Waste Management - 08:30 - 12:30
EURADWASTE '22 Session 3 - Knowledge Management in Radioactive Waste Management - 14:00 - 18:00
SNETP Session 2 - 11:00 - 12:30
SNETP Session 2 - 14:00 - 17:30
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ENEN PhD Event & Prize - 14:00 - 17:00
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Lunch WS --- 12:30 - 14:00
(Install) EXHIBITION POSTERS B2B Matchmaking
Welcome - Cocktail - 17:00-18:30
EXHIBITION POSTERS All Day B2B Matchmaking All day
Lunch --- 12:30 - 14:00
YGN Cocktail 18:30-20:00
FISA 2022 - EURADWASTE '22 ---- Dinner reception, Nuclear Innovation Prize, PhD Awards and ENEN PhD Prize ---- 19:00 - 23:00

Tuesday 31 May 22 **Day 1 AM**	**Joint introduction FISA 2022 / EURADWASTE '22** Co-chair: Bernard SALHA (FR, SNETP) Co-chair: Rosalinde VAN DER VLIES (EC, DG RTD) Rapporteur: Henri PAILLERE (FR, Expert)
08:30 (15')	**Welcome**
08:45 (15')	**Mariya GABRIEL** (EC) European Commissioner for Innovation, Research, Culture, Education and Youth Keynote: Euratom Research and Training and Horizon Europe framework programmes: Opportunities and challenges in the EU Innovation landscape
09:00 (15')	**Claire GIRY** (Ministry, FR), Directrice Générale de la recherche et de l'innovation, Ministère de l'Enseignement Supérieur Keynote: From Higher Education to Research and Innovation, a 'Team Europe and Global' approach / De l'enseignement supérieur à la recherche et à l'innovation : une approche globale et « équipe d'Europe »
09:15 (15')	**Laurent MICHEL** (Ministry, FR), Directeur Energie et Climat, Ministère de la Transition Ecologique Keynote: Challenges and levers for the energy and climate transition - Evolutions of the energy mix and nuclear - Challenges of R&D and innovation for the ecological transition / Enjeux et leviers pour la transition énergétique et climatique. Évolutions du mix énergétique et place du nucléaire. Enjeux de R&D et d'innovation au service de la transition écologique
09:30 (15')	**Rafael Mariano GROSSI** (IAEA), Director-General of the International Atomic Energy Agency Keynote: IAEA Research and Innovation for safe, secure and safeguarded nuclear for every citizen, in support of the UN Sustainable Development Goals
09:45 (15')	**Sama BILBAO Y LEON** (WNA), Director-General of the World Nuclear Association Keynote: WNA Promoting a wider understanding and streamlining international licensing and regulatory frameworks

10:00 (15’)	**William D. MAGWOOD IV** (OECD/NEA), Director-General of OECD Nuclear Energy Agency Keynote: OECD/NEA Nuclear Research and Innovation Successes and Accomplishments, Looking to the future
10:15 (15’)	**Pierre-Marie ABADIE** (ANDRA, FR), Director-General of Agence Nationale de Gestion des déchets radioactifs ANDRA Keynote: European and international status of the management and disposal of radioactive waste, developments and challenges ahead / La gestion et le stockage des déchets radioactifs en Europe et à l‘international, situation et perspectives
10:30 (15’)	**Mariya GABRIEL** (EC) European Commissioner for Innovation, Research, Culture, Education and Youth Awards ceremony for the Euratom Nuclear Innovation Prize
Coffee Break (30’)	
11:15 (15’)	**François JACQ** (CEA, FR), Administrateur Général, Commissariat à l’Energie Atomique et aux Energies alternatives Keynote: Research and Innovation interdisciplinary opportunities and challenges to enable sustainable and decarbonised societies / Recherche et innovation : une approche interdisciplinaire pour relever les défis d'une société durable et décarbonée
11:30 (15’)	**Cristian-Silviu BUŞOI** (ITRE, EP), Chair of the Committee for Industry, Research and Energy, European Parliament Keynote: Let’s join Euratom Research and Training and Horizon Europe forces, investments and ideas for making research and innovation the driving force of our future
11:45 (15’)	**Baiba MILTOVIČA** (EESC, EU), President of the section for Transport Energy, Infrastructure and Information Society, European Economic and Social Committee Keynote: Research and Innovation missions and benefits from continuous and meaningful Civil Society’s involvement to tackle today’s Societal Challenges
12:00 (15’)	**Marta ZIAKOVA** (ENSREG), Chair of the European Nuclear Safety Regulators Group Keynote: ENSREG commitment to continuous improvement of nuclear safety when new knowledge and experience are available: Progress, Lessons learned and Challenges

12:15 (15')	**Yves DESBAZEILLE** (FORATOM), Director-General of the European Nuclear Industry Association FORATOM Keynote: Research and Innovation benefits for a low-carbon and climate neutral economy, Industrial Competitiveness and sustainable development
12:30 (15')	**Jadwiga NAJDER** (ENS YGN), Chair of the Young Nuclear Generation of the European Nuclear Society Keynote: The future of Nuclear: Collaboration, Vision and Innovation – perspectives from YGN
Lunch (75')	

Day 1 PM	**EURADWASTE'22 – Session 1: Collaborative Research, Development and Demonstration in Radioactive Waste Management** Co-chair: Daniela DIACONU (RO, RATEN ICN) Co-chair: Seif BEN HADJ HASSINE (EC, DG RTD) Rapporteur: Marie-Anne BRUNEAUX (FR, Expert)

Session 1 is dedicated to research and innovation studies related to Radioactive Waste Management. It includes short and long-term experiments and/or modelling work to demonstrate the robustness of the waste management concepts, to increase understanding and predictability of the impact of fundamental processes and their couplings or to maintain scientific excellence and competences throughout the stepwise long-term management of radioactive waste.

The session will be introduced by a keynote lecture given by the Implementing Geological Disposal of radioactive waste Technology Platform (IGD-TP) to present the accomplishments and the future challenges of the Waste Management Ogranisations in the implementation of the geological repositories towards further optimization and operation. Following the first keynote, a series of six presentations will address the technical results of individual projects and EURAD Work Packages on specific topics, components and systems of the geological disposal concepts. The first will be about the characterization of the radioactive waste (MICADO, CHANCE, PREDIS), followed by a presentation on the predisposal operations (PREDIS, THERAMIN). The third presentation will be dedicated to the long-term behavior of the near-field components focusing on container optimization, monitoring, radionuclide retention, mobility and transport mechanisms (CORI, CONCORD, FUTURE, MODATS) and the fourth presentation will address the modelling of the long-term evolution and the performance of the Engineered Barrier System (ACED, DONUT, MAGIC, BEACON). The fifth presentation will cover the mechanical and thermal behavior of clay-based materials considered for the geological disposal of radioactive waste (GAS, HITEC) and the last presentation is specifically about the spent fuel management, characterization and dissolution behavior (DISCO, SFC). Finally, the speakers of the session will be invited to a final roundtable discussion. The roundtable should focus on how collaborative research on crosscutting topics related to radioactive waste management made significant breakthroughs in the recent years. The speakers will be invited to describe and give concrete examples of collaborative research in their respective projects/programs, discuss the outcomes and the achievements and dwell on the lessons learned and the possible improvements in future collaborations.

14:00 (30’)	**Tiina JALONEN** (POSIVA, FI) *IGD-TP* Keynote: IGD-TP – Towards operating and optimization.
14:30 (25’)	**Massimo MORICHI** (CAEN, IT) *MICADO – CHANCE – PREDIS* Radioactive Waste Characterization
14:55 (25’)	**Erika HOLT** (VTT, FI) *PREDIS – THERAMIN* Predisposal conditioning, treatment, and performance assessment of radioactive waste streams
15:20 (25’)	**Marcus ALTMAIER** (KIT, DE) *CORI – CONCORD – FUTURE – MODATS* Long-term radionuclide retention in the near field: collaborative R&D studies within EURAD focusing on container optimisation, mobility, mechanisms and monitoring
15:45 (25’)	**Francis CLARET** (BRGM, FR) *ACED – DONUT – MAGIC – BEACON* Modelling of the long term evolution and performance of engineered barrier systems
Coffee Break (20’)	
16:30 (25’)	**Séverine LEVASSEUR** (ONDRAF/NIRAS, BE) *GAS – HITEC* Mechanistic understanding of gas and heat transport in clay-based materials for radioactive waste geological disposal
16:55 (25’)	**Anders SJÖLAND** (SKB, SE) *SFC – DISCO* Spent fuel management characterisation and dissolution behaviour: progress and achievement from SFC and DISCO
17:20 (45’)	**Roundtable and general discussion. The roundtable should focus on how collaborative research on crosscutting topics related to radioactive waste management made significant breakthroughs in the recent years. The speakers would be invited to describe and give concrete examples of collaborative research in their respective projects/programs, discuss the outcomes and the achievements and dwell on the lessons learned and the possible improvements in future collaborations.**
18:00 (30’)	***YGN Cocktail Dating, Meet and Match Lounge***

Day 2 AM	**EURADWASTE'22 – Session 2: Strategic Research Studies in Radioactive Waste Management** Co-chair: Irina GAUS (NAGRA, CH) Co-chair: Zuzana Monika PETROVICOVA (EC, DG ENER) Rapporteur: Piet ZUIDEMA (CH, Expert)

Session 2 is dedicated to strategic studies in support of the implementation of the national programmes that address scientific, technical but also societal aspects of RWM such as the establishment of radioactive waste inventories, safety cases, performance assessments, the costing of a RWM programme and the interactions with the civil society.

The session will be introduced by a keynote lecture given by the Sustainable network for Independent Technical EXpertise on radioactive waste management (SITEX) Network to present their key activities, lessons learned and the upcoming challenges. The objectives of the association is to enhance and foster cooperation at the international level in order to achieve a high quality Expertise Function in the field of safety of radioactive waste management, independent from organizations responsible for the implementation of waste management programs and waste producers, aiming at supporting the Nuclear Regulatory Authorities, as well as the Civil Society. Following the keynote, a series of five presentations will address the technical results of EURAD Work Packages and give an overview of the activities of international institutions on strategic issues related to RWM. The first presentation will cover the uncertainty management in the definition and the implementation of a radioactive waste management programme (UMAN), followed by a presentation by the European Economic and Social Committee of the EU on the development of a civil society perspective on a range of energy policy issues including RWM (EESC, EU). The third presentation will provide an overview of the recent activities of the DG ENER on strategic issues related the radioactive waste management programmes in the EU, followed by a presentation on the key issues and open questions about waste management routes in Europe, from cradle to grave (ROUTES). The last presentation will be given by the IAEA on the different missions and common goals of the AIEA and the EC, working together to strengthen RWM world-wide (IAEA, EURAD, PREDIS). Finally, the speakers of the session will be invited to a final roundtable discussion. The roundtable will focus on the strategic studies in support of the implementation of the national programmes that address scientific, technical and societal aspects of Radioactive Waste Management. The different speakers will be invited to give their views on how to tackle these issues, how the methodologies changed over time, the most important challenges in the process and the involvement of the Civil Society.

08:45 (15’)	**Welcome**
09:00 (30’)	**Valéry DETILLEUX** (Bel-V, BE) *SITEX Network* Keynote: SITEX Network key activities, lessons learned and upcoming challenges
09:30 (25’)	**Daniela DIACONU** (RATEN ICN, RO) *UMAN* UMAN – A pluralistic view of uncertainties management
09:55 (20’)	**Pietro Francesco DE LOTTO** (EESC, EU) *EESC* A consensus-based approach is the essence of EESC opinions in developing a civil society perspective on a range of energy policy issues including RWM towards improving European citizens' lives and environment, along with economic activity and jobs
10:15 (20’)	**Zuzana Monika PETROVICOVA** (DG ENER, EC) Radioactive Waste Management in the European Union - State of play and strategic prospects
Coffee Break (25’)	
11:00 (25’)	**François MARSAL** (IRSN, FR) *ROUTES* ROUTES - Identified key issues and open questions about waste management routes in Europe, from cradle to grave
11:25 (20’)	**Rebecca ROBBINS** (IAEA) *IAEA* Different Missions – Common Goals: the IAEA, PREDIS and EURAD Working Together to Strengthen Radioactive Waste Management World-wide
11:45 (45’)	**Roundtable and general discussion. The roundtable should focus on the strategic studies in support of the implementation of the national programmes that address scientific, technical and societal aspects of RWM. The different speakers will be invited to give their views on how to tackle these issues, how the methodologies changed over time, the most important challenges in the process and the involvement of the CSS.**
Lunch (90’)	

Day 2 PM	**EURADWASTE'22 – Session 3: Knowledge Management in Radioactive Waste Management** Co-chair: Rebecca ROBBINS (IAEA) Co-chair: Manuel MARTIN RAMOS (EC, DG JRC) Rapporteur: Christophe BRUGGEMAN (BE, Expert)

Session 3 is dedicated to transversal activities in knowledge management related to RWM including exiting knowledge, guiding the planning and implementation of a RD&D plan and developing/delivering a training and mobility programme in line with core competencies. The session covers as well transfer/sharing of knowledge between front-runners and countries at an early stage of their programmes and between generations.

The session will be introduced by a keynote lecture given jointly by EURADSCIENCE and the Joint Research Center of the EC. EURADSCIENCE is the first international network of research entities established to unite the work of national research organisations on radioactive waste management, and to drive scientific excellence in the field over the next decades to come while the JRC is strongly involved in the knowledge management aspects of the European projects. The presentation will address the important future challenges of EURADSCIENCE and the accomplishments so far on knowledge management in the two main programme/project on RWM: EURAD and PREDIS. Following the keynote, a series of six presentations will address the outcome of EURAD KM Work Packages and give an overview of the activities of international institutions on Knowledge Management. The first presentation will focus on how the state of knowledge is capture in the European Joint Programme EURAD (SoK) while the second presentation will address the devlopemnt of guidance documents in EURAD and PREDIS (Guidance, PREDIS). The third presentation will give an overview of the training and mobility programme in EURAD and PREDIS (Training & Mobility, PREDIS), followed by an invited speaker presentation on the ERDO initiative on sharing radioactive waste management solutions. The fifth presentation will give an overview of the NEA Activities on information, data and Knowledge management (NEA/OECD) and the last presentation will present the IAEA approach to information and knowledge transfer on RWM (IAEA, EURAD, PREDIS). Finally, the speakers of the session will be invited to a final roundtable discussion. The roundtable will focus on the specificities and the challenges of an efficient and consistent Knowledge Management methodologies and systems applied to the radioactive waste management programmes.

14:00 (30’)	**Paul CARBOL** (JRC, EC) Keynote: Knowledge Management aspects in the EJP EURAD and the PREDIS project
14:30 (25’)	**Alexandru TATOMIR** (BGE, DE) *SoK (EURAD)* Capturing the state of knowledge in EURAD knowledge management
14:55 (25’)	**Jiri FALTEJSEK** (SURAO, CZ) *Guidance (EURAD) - PREDIS* Development of guidance documents in EC projects EURAD and PREDIS
Coffee Break (30’)	
15:50 (25’)	**Niels BELMANS** (SCK-CEN, BE) *Training & Mobility (EURAD) - PREDIS* Training and mobility in EU projects EURAD and PREDIS
16:15 (20’)	**Marja VUORIO** (COVRA, NL) *ERDO* A road to sharing radioactive waste management solutions
16:35 (20’)	**Rebecca TADESSE** (NEA/OECD) NEA Activities on information , data and Knowledge management
16:55 (20’)	**Stefan MAYER** (IAEA) The IAEA approach to information and knowledge transfer on radioactive waste management – a brief review of synergies with the international cooperation conducted under EURAD and PREDIS projects
17:15 (45’)	**Roundtable and general discussion. The focus of the third roundtable would be on the specificities and the challenges of an efficient and consistent KM methodologies and systems applied to the radioactive waste management programs. Similarly, to the second roundtable, the panel of speakers will have to include different and balanced panellist profiles.**
19:00 (4h)	***Dinner reception, Nuclear Innovation Prize, PhD Awards, ENEN PhD Prize, and ENS High Scientific Council PhD Awards***

Thursday 2 June 22	
Day 3 AM	**Joint conclusion FISA 2022 / EURADWASTE '22** Co-chair: Philippe STOHR (FR, CEA) Co-chair: Bernard MAGENHANN (EC, DG JRC) Rapporteur: Henri PAILLERE (FR, Expert)
08:15 (15')	**Welcome**
08:30 (20')	**Bernard MAGENHANN** (EC, DG JRC), Deputy Director-General of the Joint Research Centre Keynote: JRC's role in Euratom Research and Training and Horizon Europe
08:50 (20')	**Hans FORSSTROM** (SE, Expert), General Rapporteur EURADWASTE '22 - Key messages and future perspectives
09:10 (20')	**Henri PAILLERE** (FR, Expert), General Rapporteur FISA 2022 - Key messages and future perspectives
09:30 (20')	**Laurent WAUQUIEZ** (FR, or AURA representative), President of the Region Auvergne-Rhône-Alpes Keynote: Région Auvergne-Rhône-Alpes, promoting Innovation Ecosystems and Strategic Clusters
09:50 (20')	**Philippe FRANTZ** (FR, NUCLEAR VALLEY), President of Nuclear Valley Keynote: Nuclear Valley's Pôle de competitivé, the Nuclear Industry Cluster in the Région Auvergne-Rhône-Alpes and GIFEN (Groupement des Industriels Français de l'Energie Nucléaire)
10:10 (20')	**Philippe STOHR** (FR, CEA) and **Bernard MAGENHANN** (EC, DG JRC) Closing remarks from the French Presidency and the European Commission
Coffee Break (30')	


FISA 2022
EURADWASTE'22

Day 3 AM-PM	SNETP Forum 2022
11:00 (1h30) 14:00 (4h)	SNETP annual FORUM in 2022 workshops to launch new project ideas: • SMRs • Nuclear codes and standards and supply chain • Digital and robotics • R&D&I facilities • Waste minimization and fuel cycle • The role of nuclear in mitigating climate change

The SNETP Forum 2022 edition (https://snetp.eu/2022/02/28/save-the-date-for-the-snetp-forum-2022/) will be held on 2 June 2022 in Lyon, France, in conjunction with FISA 2022 (10th Euratom Conference on Reactor Safety) and EURADWASTE '22 (10th Euratom Conference on Radioactive Waste Management).

The SNETP Forum 2022 will aim at discussing and analysing recent technological innovations in different fields selected by the SNETP Scientific Committee as to cover major topics of interest to the stakeholders of SNETP.

Technical sessions

SMRs

New innovative solutions are needed to ensure cost competitiveness with other power generation technologies, as well as speed of construction and implementation in local systems. In addition to the nuclear reactors in operation and those under construction, Europe needs to expand the range of reactors technologies available to meet national/local specificities. The development of different SMRs, based on most matured technologies or on other advanced technologies, offers the possibility to deploy flexible options for both power and non-power applications and contribute to decarbonisation of the economy. Research & Development & Innovation (R&D&I) should support the development of SMRs to make them safe and competitive with other means of production as part of a global deployment strategy over the coming decades.

Nuclear codes and standards and supply chain

Safety-related structures, systems and components (SSCs) of nuclear power plants are normally designed and produced according to stringent nuclear codes & standards (NC&S). Supplying such SSCs normally requires companies to establish and maintain costly nuclear quality-assurance (QA) programme. In response to growing supply

chain challenges, European NPP operators started looking into greater deployment of high-quality non-nuclear industry standard components and equipment for safety-related SSCs of NPPs (i.e. commercial-grade dedication) and launched corresponding pilot projects with approval of their regulators. This is supported by European and international nuclear organisations like Foratom and the IAEA by providing guidance in this area. The further development of NC&S remains high on the agenda. Novel materials, manufacturing methods and technologies need to be included in NC&S before being allowed to be used for safety-related SCCs. This and also NC&S development for advanced reactors (SMRs, Gen IV) require significant R&D&I efforts. In this session, ongoing NC&S development activities and needs and supply chain related activities and challenges for the current reactor fleet and advanced reactors will be presented and discussed.

Digital and robotics

Digital: The digital transformation has become a cross-cutting trend to all industrial sectors and nuclear is no exception to this. The European Commission digital strategy aims to make this transformation work for people and businesses, while helping to achieve its target of a climate-neutral Europe by 2050. As such, it is essential for nuclear to be fit for the digital age, to achieve digital twins and a Digital Nuclear Reactor. Concerted R&D&I work is essential to make progress in terms of multi-physics modelling and simulation, high performance computing, data analysis and analytics, visualisation, virtual reality, advanced instrumentation (e.g. Internet Of things) and I&C.

Robotics: NPP operation combines a number of interlinked human, organisational and technical factors. A strong drive to opt for advanced robotics in nuclear industry appeared after the Three Mile Island incident and the development of engineering technologies. Improving nuclear power plant operation, health and safety of operators, managing safely their decommissioning are considered to be key, but also for further public acceptance of nuclear. If robots take over the human personnel in conducting risky operations, the latter will have a reduced exposure to radioactivity. Significant investments in artificial intelligence sustain this eventuality. Moreover, the ability to maintain the nuclear power infrastructure may depend on robots being able to carry out maintenance tasks that would otherwise be impossible, thus significantly extending the lifetime of reactors.

R&D&I facilities

Several R&D facilities have been shut down in the EU over the last decade. The loss of critical research infrastructures (i.e. facilities, capabilities and expertise) remains a concern to all EU policy makers, Member States and SNETP stakeholders as a whole. SNETP and some of its members took initiative to set up the “OFFERR” project in

response to the Euratom Research and Training 2021-22 call for proposals. It aims to capitalise the Euratom R&D community's operational and financial schemes facilitating open and inclusive trans-national access to infrastructures for R&D experts. The latest will be able to perform high-priority experiments within the best infrastructures available, with the benefit of co-funded grants (in-kind/in-cash) by Euratom, the consortia and/or Member States' research infrastructure owners. The goal is to build a sustainable "User facility network (UFN)". This session shall discuss the way this network of existing smaller networks shall be further managed, while providing the current status of research facilities available, which will also support the implementation of the SNETP Strategic Research and Innovation Agenda (2021), MS and Euratom Research and Training objectives, and beyond.

Waste minimization and fuel cycle

The current and projected fleet of plants consists largely of water-cooled, water-moderated reactors. These reactors have over time achieved a high degree of maturity in terms of economic performance and safety. To achieve major steps in terms of sustainability (by reducing high-level waste production, better use of resources and higher thermal efficiencies), new types of reactors based on other coolant technologies and high-temperature non-electrical applications, should be envisaged and combined with more advanced fuel cycles. The use of fast reactors in a closed fuel cycle approach will allow a large decrease in consumption of natural resource (uranium) and a significant reduction of high-level radioactive waste in terms of radiotoxicity and volume, which is one of the major concerns of society, towards a more sustainable implementation of nuclear energy. Advanced reprocessing and fuel manufacturing techniques, from a laboratory to an industrial scale of deployment, are needed to recycle for instance minor actinides. This session shall discuss how sustainability in terms of resource utilization and high level waste minimization can be gradually increased.

The role of nuclear energy in mitigating climate change including non-electrical applications (hydrogen, heat, etc)

With increased awareness of climate change in recent years, nuclear energy has received renewed attention. Nuclear energy can make a significant contribution to reducing greenhouse gas emissions (GHGs) worldwide, while at the same time meeting the increasing demand for energy of a growing world population and supporting global sustainable development. Nuclear energy has considerable potential to meet the challenge of climate change mitigation by providing a secured supply of electricity, district heating and high temperature heat for industrial processes while producing almost no GHGs. This session will focus on the different possible uses of nuclear to contribute to the EU 2050 decarbonisation strategy.

SNETP FORUM TECHNICAL SESSIONS – 2 June 2022				
#	**Room 1**	**Room 2**	**Room 3**	**Room 4**
	TS1: SMRs **Moderators: Ferry Roelofs (NRG), Jozef Sobolewski (NCBJ)**	**TS4: R&D&I facilities** **Moderators: Pavel Kral (UJV), Petri Kinnunen (VTT)**	**TS2: Nuclear codes & standards & supply chain** **Moderators: Oliver Martin (JRC)**	**TS6: Nuclear to mitigate climate change including non-electricity applications** **Moderators: Ronald Schram (NRG), Michael Fütterer (JRC),**
11:00	**P1:** SMR-partnership, **DG-ENER** **P2:** Market analysis, **Bernard Dereeper** **P3:** Licensing harmonization, **ENSREG**	**P1**: OFFERR project, **Charles Toulemonde (EDF)** **P2**: Setting up the "European User Facility Network", **Jiri Zdarek (UJV)** **P3**: RJH, **Petri Kinnunen (VTT)**	**P1:** Comparison of pipe integrity concepts for LWRs, **Bruno Autrusson (nuclear consultant, formerly IRSN)** **P2:** Ongoing development activities on RCC-MRx and its enlargement to Gen IV reactor systems with coolants other than sodium, **Karl-Fredrik Nilsson (JRC)** **P3:** The NUCOBAM project – Incorporation of additive manufacturing into NC&S, **Oliver Martin (JRC)**	**P1**: N.N., NC2I: Introductory Scene Setter (new Euratom projects, NEA, GIF, IAEA) **P2**: **Andrei Goicea, Foratom**, EU: EU's energy sector integration and hydrogen strategies **P3**: **Agnieska Boettcher, NCBJ**, PL: Polish GOSPROSTRATEG project **P4**: **Jacek Jagielski, NCBJ**, PL: NOMATEN Centre of Excellence in Multifunctional Materials for Industrial and Medical Applications
12:00	**P4:** Supply Chain, **Roberto Adinolfi (Ansaldo)** **P5:** R&D&I - **Sylvain Takenouti** **P6:** Core and Fuel - **Eric Hanus (CEA)** **P11:** Non-electricity (power) applications, **Ville Tulkki (VTT)**	**P4**: NEA task Force on Nuclear Safety Research support facilities for existing and advanced reactors, **François Barré (IRSN)** **P5**: BR2, **Joris Van den Bosch (SCK.CEN)** **P6**: PKL/SACO, **Simon Schollenberger (Fra-G)**	**P4:** R&D challenges in improving civil structures design rules for sustainable nuclear energy technology, **Etienne Gallitre (nuclear consultant, formerly EDF)** **P5:** Qualification of electrical equipment according to RCC-E **Benedict-John Willey (EDF)** **P6:** European Commercial-grade Dedication Guidelines: **Andrei Goicea (Foratom)** **)**	**P5**: Integrated Energy Systems and the pathway to Net Zero by 2050 (a UK context), **Paul Newitt (NNL)** **P6**: **Michael Fütterer, JRC**, NL: GEMINI+ nuclear process heat applications, hydrogen, steel **P7**: **Andre Faaij, TNO**, NL: "Deployment of nuclear energy in deep decarbonization of the energy system." **P8**: **Geert-Jan de Haas, NRG**, NL: "Exploring the deployment of advanced reactor systems for decarbonization of future energy generation: research highlights of molten salt reactors and liquid metal cooled reactors." Wrap-up by **Ronald Schram, NRG**, NL: Wrap-up
13:00	**Lunch Break**			
	TS1: SMRs **Moderators: Ferry Roelofs (NRG), Jozef Sobolewski (NCBJ)**	**TS4: R&D&I facilities** **Moderators: Pavel Kral (UJV), Petri Kinnunen (VTT)**	**TS3: Digital & Robotics** **Moderators: Eero Vesaoja (FORTUM), Christophe Schneidesch (Tractebel), Elisabeth Guillaut (ORANO)**	**TS5: Waste minimization and fuel cycle** **Moderators: Erika Holt (VTT), Anthony Banford (NNL)**
14:00	**P7:** NSSS **Oliver Martin (JRC)** **P8:** Passive systems **F. Mascari** **P9:** Severe Accidents, **P. Dejardin** **P10:** Modularity, **M. Marconi (Ansaldo)**	**P7**: PASI-CWC, **Riikonen etc (LUT) (TBC)** **P8**: COSMOS-H, **Stefan Gabriel (KIT)** **P9**: HFR / Pallas, **Ronald Schram (NRG)**	**P1:** French Digital Reactor Initiative, **XXX – EDF** **P2:** Combination between Digital Twin and AI for anomaly detection for industrial processes, **Aurélien Schwartz - Métroscope, EDF group** **P3:** Data-sharing technologies, connectivity in the nuclear sector, **Vincent Champain – Framatome**	**P1:** Euratom introductory address, **Seif Ben Hadj Hassine (EC)** **P2**: Fuel Handling and Waste issues for Molten Salt Reactors, **Jiri Krepel (PSI)** **P3**: Plutonium management in GENIV reactors, **Francisco Alvarez Velarde (CIEMAT)**
15:00	**P12:** Energy Well – Czech molten salt SMR concept, **Marek Ruščák**	**P10**: Czech research infrastructure for	**P4:** AI in requirements engineering, **Santeri Myllynen – FORTUM**	**P4:** Waste minimization /recycle through whole fuel cycle, **Paul Nevitt (NNL)**

	– CVR **P13**: Conceptual design of EUHTER (Polish experimental HTGR), **prof. Mariusz Dąbrowski**	supporting the implementation of the SNETP strategic research agenda, **Marek Mikloš (CVR)** **P11**: Open access of research infrastructures, **Rachel Eloirdi (JRC)**	**P5:** Digital Solution Projects, **A. Duchêne – Tractebel**	**P5:** Recycling and circular economy of metallics– advanced reprocessing
15:40	**Coffee Break**			
		TS4: R&D&I facilities **Moderators: Pavel Kral (UJV), Petri Kinnunen (VTT)**	**TS3: Digital & Robotics** **Moderators: Eero Vesaoja (FORTUM), Christophe Schneidesch (Tractebel), Elisabeth Guillaut (ORANO)**	**TS5: Waste minimization and fuel cycle** **Moderators: Erika Holt (VTT), Anthony Banford (NNL)**
16:00		**P12**: Education and training and facilities, **Leon Cizelj (IJS)**	**P6:** Modelling and simulation-assisted engineering of cyber-physical systems throughout their life cycle, **T. Ngugen – IAEA consultant** **P7:** Robotics and drone program, **Anders Wik – Vattenfall** **P8:** SHARK ROBOTICS, **Joseph PESME**	**P6:** Advanced Separation for the Optimum management of spent Fuel – portioning, fuel fabrication, secondary waste streams, **Christophe Bruggeman (SCK CEN)** **P7:** Unique for SMR spent fuel and waste management, **Timothy Schatz (VTT)** **P8:** SRA documentation development from projects SHARE and PREDIS, **Anthony Banford (NNL) and Erika Holt (VTT)**
17:00			**P9:** AERACCESS, **Jean-Luc AYRAL** **P10:** Robotics in VVER SG inspection/cleaning, **Ville Lestinen - Fortum**	Guided Discussion: going forward topics and plan (future collaboration ideas) **– chairpersons**
18:00				


FISA 2022
EURADWASTE'22

Tuesday 30 May to Thursday 2 June 22

SIDE EVENTS

Day 1 to 3 AM-PM

Face-to-face networking opportunities and B2B matchmaking

Poster (60 per day, Euratom projects, MSc/PhD/R&D, 180 in total)
-
Exhibition (20 per day, 20 in total)
-
B2B Matchmaking (estimated 200 in total)

Poster (60 per day, Euratom projects, MSc/PhD/R&D, 180 in total)

An opportunity to present your research results, within or related to the topics covered, at the conferences, to the Euratom and International Research Community. Euratom projects, PhD/MSc Students (under 35 years' old) are encouraged to submit abstracts related to the dedicated topics of the conferences, as well as R&D researchers from organisations not directly involved in projects co-funded by Euratom.

Exhibition (20 per day, 20 in total)

Exhibition booths will be set up for almost 20 organisations to showcase advancements in various cross-cutting innovative, engineering, industrial and high-tech technologies relevant to nuclear and non-nuclear applications, radiation protection, radioactive waste management and geological repository development. Exhibition booths will remain open during all sessions and breaks and will give the opportunity for intensive B2B meetings.

ENS-YGN events & B2B Matchmaking (estimated 200 in total)

ENS-YGN is a vibrant network connecting all Nuclear Young Generation Networks over Europe. These events, including Young Generation workshops, are a huge opportunity for Students, MSc/PhDs or young professionals to meet national / European / International leading managers, innovators and researchers from public and private research organisations.

Around 200 candidates will be selected after having submitted their CV. In depth 30 min face-to-face matchmaking interviews and networking opportunities will be organised for them with leading national / international managers, participating companies or even recruiters. This event will allow companies active in the nuclear industry, public and private research organisations or academia, to meet and interview students, graduates, engineers and experienced professionals to start or pursue their career within Europe and beyond. Institutions such as Nuclear Valley or GIFEN will take part in the event.

At the conference, an iOS and Android App

An iOS and Android App will be available to all confirmed registered participants at the conferences. The app will show the programme in an interactive manner and facilitates communication among the participants, sharing all information, also enabling scheduling B2B meetings, notifications and announcements.

Tuesday 30 May 22	**SIDE EVENT**
Day 1 PM 16:30 (2h)	**AWARD and PRIZE pitches** OPEN CALL – POSTER COMPETITION ➔ MSc/PhD awards, Student competition (10 in total) ➔ R&D Topics Awards (4 in total) ➔ Euratom Projects (2 in total) NUCLEAR INNOVATION PRIZES (7 in total) ENS High Scientific Council PhD Awards (2 in total)

The Programme Committee will invite MSc/PhD/R&D Award, ENS High Scientific Council PhD and Nuclear Innovation Prize winners the opportunity to present a compelling 180 seconds spoken presentation of their research topic to the international Research Community during a dedicated Session of FISA 2022 – EURADWASTE ’22

Tuesday 30 May to Wednesday 1 June 22

Day 1 to 2
AM-PM

Nuclear innovation prizes in Safety of reactor systems and in radioactive waste management

The first Nuclear Innovation Prize contest will be organised will be organized in the framework of the FISA 2022 and EURADWASTE ´22 Conferences in Lyon, France, on Monday 30 May to Friday 3 June, by the European Commission and the organizers of the international conferences.

https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/prizes/nuclear-innovation-prize_en

The 'Nuclear Innovation Prize' (**call closed**) is meant to give visibility to the most dynamic, forward-looking and innovative researchers, research teams or industrial contestants, with a prize planned to be delivered by European Commissioner Mariya Gabriel for Innovation, Research, Culture, Education and Youth (tbc).

Nuclear Innovation Prize in safety of reactor systems
1st place: EUR 50,000 / 2nd place: EUR 30,000 and 3rd place: EUR 20,000
Nuclear Innovation Prize in radioactive waste management
1st place: EUR 50,000 / 2nd place: EUR 30,000 and 3rd place: EUR 20,000
Six (seven in 2022) awarded Nuclear Innovation Prizes related peer-reviewed papers should be published within the international Open Access Journal (EPJ-N) topical issue on FISA 2022 – EURADWASTE '22 Awards and later within the conferences proceedings.

Euratom funded research in fission safety, waste management and radiation protection benefits from consistent success in pursuing excellence across a broad range of nuclear science and technologies.
Together with EU countries the programme has continuously helped maintain a high-level of competences, underpinned by sound and advanced research.
Nuclear researchers and engineers are constantly challenging state-of-the-art in the field and improving evolving technologies thereby creating conditions for innovations beyond technologies and scientific breakthroughs, towards a more dynamic and competitive European industry for the benefit of every citizen and the whole of society.

Wednesday 1 June 22

Day 2
AM-PM

16th ENEN PhD Event & Prize 2022

The 16th ENEN PhD Prize 2022 will be organized in the framework of the FISA 2022 and EURADWASTE ´22 Conferences in Lyon, France, on Monday 30 May to Friday 3 June, by the European Nuclear Education Network (ENEN) Association, in cooperation with the Joint Research Centre of the European Commission and the organizers of the international conferences.

Every year the ENEN PhD Event & Prize is organized to promote and support the work of young researchers in Europe (https://enen.eu/index.php/phd-events/).

ENEN PhD Event & Prize is an action of the European Nuclear Education Network to support the Research and Science in the Nuclear fields promoting the works of the young scientists and researchers who start their careers finishing their PhD. It takes place on a yearly basis in the framework of the international congress in the field of nuclear science.

ENEN PhD Event will consist of up to 12 PhD presentations nominated by ENEN Members and selected by the ENEN PhD Prize Jury. The event will be divided into several sessions according to the subjects. Participants will make a presentation of their research work for 25 minutes followed by 5 minutes of questions and discussion in a competitive but friendly environment.

All presentations will be judged by the Jury members taking into account the quality of the submitted paper as well as the quality of the presentation itself. Moreover, the participation in the discussion and the clarity in answering the questions received will also be taken into account in selecting the winners.

The **best three presentations** will be awarded the ENEN PhD Prize. And three awarded ENEN PhD Prizes related peer-reviewed papers should be published within the international Open Access Journal (EPJ-N) topical issue on FISA 2022 – EURADWASTE ’22 Awards and later within the conferences proceedings.

Tuesday 30 May and Wednesday 1 June 22

European Nuclear Society Young Generation Network workshops (ENS YGN)

ENS YGN will be organising three workshops, in the framework of the European Year of Youth 2022 and of FISA 2022 and EURADWASTE ´22 Conferences

Day 1 PM
14:00 (2h)

Kick-off of B2B sessions - Are you ready for the international job market?
This workshop provides attendees with information and practical advice that they can use to understand and access the international job market

Day 2 AM-PM
09:30 (2h)

2. Communicating science - Don't waste it!
This workshop will teach how to provide facts in an understandable way, using simple comparisons and handy references. Come and learn how to lead an engaging conversation!

15:30 (2h)

3. Nuclear for Climate - positive campaigning of nuclear topics
Imagine the enormous impact you, as a single individual, has in the climate change conversation. Your voice is powerful, and when directed in the right places, highly impactful. And now imagine what would happen if we compounded all our efforts, sharing the same message across the globe, to communicate to leaders and decision makers that 'enough is enough: we need action now'. It would be immense.
Join the Nuclear for Climate team as they guide you through this engaging, action-focused workshop. Open to all backgrounds, viewpoints, experiences. #Togetherisbetter

ENS YGN 1st Workshop – As a kick-off to the B2B sessions YGN proposes a workshop ***"Are you ready for the international job market?"***

31 May, Tuesday 14:00 – 16:00

Co-organised by Thomas Thor and ENEN

Attendees – young professionals with 1-10 years experience in the industry/research

Workshop overview

The session will be a joint insight of Thomas Thor Associates – recruitment consulting and young professionals who took a chance to start international careers in different sectors of nuclear science and industry.

The workshop will be enriched by the recent results of the global project measuring the attitude of young people towards nuclear jobs – the World Young Generation Nuclear Thermometer.

The aim of the workshop is to provide attendees with information and practical advice that they can use to understand and access the international job market.

Join us and ask everything you always wanted to know about a career in nuclear!

Moderators: Callum Thomas, Thomas Thor and Andrea Kozlowski, ENS-YGN

Programme

Introduction with career testimonials of young professionals

Session 1 – Understanding your own motivations & priorities (30 minutes)

Introduction, and then working in pairs to ask each other questions and create a picture of what each of you are looking for (example questions will be provided in the introduction)

Session 2 – Mapping your motivations & priorities to opportunities in the international job market (30 minutes)

Introduction, and then working in the same pairs again to create an outline of which countries, organisations and projects match each person's capabilities, motivations and priorities

Session 3 – Tools and techniques for successful international careers (30 minutes)

- Information sources that can help you gather relevant information

- How to find and work with mentors and sponsors
- Network building
- Getting involved in areas of interest and building your personal brand

Summary and Close – (10 minutes)

A recap on what has been covered and suggestions of follow up and next steps

ENS YGN 2nd Workshop - "Communicating science - Don't waste it! "

Wednesday, 1 June at 09:30 – 11:30

As scientists and nuclear professionals, we often have the opportunity to speak about nuclear and to share our passion for it. How do we best get this across? How can we communicate science?

Let's take the example of nuclear waste. We are often confronted with questions about it. Don't waste the opportunity and provide facts in an understandable way, using simple comparisons and handy references. Come and learn how to lead an engaging conversation!

Moderators: John C.H. Lindberg – author of a communications guide to conversations about nuclear.

Elsa Lemaitre, Chief Internal Auditor, CEA and Deputy Head of French YGN on Innovation

On the agenda: hands-on training on communications. We will all together develop a simple guide on communicating about nuclear waste.

What is important before you start

The magic of the first sentence

Facts about waste

Comparisons and visuals

Conclusion

ENS YGN 3rd Workshop - "Nuclear for Climate - Positive campaigning of nuclear topics"

Wednesday, 1 June 15:30 – 17:30

Imagine the enormous impact you, as a single individual, has in the climate change conversation. Your voice is powerful, and when directed in the right places, highly impactful. And now imagine what would happen if we compounded all our efforts, sharing the same message across the globe, to communicate to leaders and decision makers that 'enough is enough: we need action now'. It would be immense.

Global climate activism describes a growing movement of young people across the world taking action to halt the devastating effects of climate change. We are determined to reach net zero before 2050, and firmly believe that following the science and being technology inclusive is the best way to achieve this. Nuclear energy working alongside other clean energy technologies is essential to reaching this goal.

Using the 'I, us, we' principles of climate activism, this interactive, thought-provoking workshop will equip you with the necessary tools to communicate nuclear energy to friends, family, strangers, and everyone in between. This two-hour session will explore how trust, people and action lie at the heart of a successful climate campaign and how we can use the principles of compound interest to prepare for COP27. It will also give attendees the opportunity to explore their personal voice and contributions to the climate conversation, especially around discovering how to become bold, vocal climate champions.

We will draw on the experience and learnings of the hugely successful #NetZeroNeedsNuclear COP26 campaign, and workshop how we can build upon these achievements for November's COP27 conference.

Join the Nuclear for Climate team as they guide you through this engaging, action-focused workshop. Open to all backgrounds, viewpoints, experiences. #Togetherisbetter

Moderator: Sophie Zienkiewicz

Friday 3 June 22	
Day 4 AM-PM	**Technical visits** - JACOMEX - SILEANE - VELAN - CEA Marcoule - ANDRA Cigeo

JACOMEX

https://www.jacomex.com/

Jacomex is leader in the design and manufacturing of:

- inert gas purification units,
- glove boxes for the nuclear, R&D and industrial sectors,
- pharmaceutical isolators,
- customized containment enclosures of all sizes.

The company has a multi-skilled and established 75-years experience and has its main services, as design and production, located at Dagneux, close to Lyon.

Jacomex is worldwide renowned from having permanently focused on technique, strong tightness control and safety. Therefore, the company has developped a varied range of gloveboxes and systems designed for specific applications:

- gloveboxes and filtered containment enclosures operating in negative pressure under air or inert gas for the protection of operators and the environment,
- gloveboxes in positive pressure working under highly pure inert gas for the protection of air-sensitive products,
- standard and custom gloveboxes,
- climatic glove boxes,
- nuclear purified glove boxes.

The company has also developped specific nuclear ventilation safety equipment, like regulating and safety valves, filter housings and ventilation accessories which have been now in use for decades.

Terms of registration

Departure: 9:00 a.m at Lyon Perrache train station
Expected return: 12:15 p.m at Lyon Perrache train station
30 minutes journey by bus

Required: have your identity papers on the day of the visit.

SILEANE

https://www.sileane.com/en/

Siléane's men and women have been serving their customers since 2002. They give eyes and hands to "blank" robot arms and endow them with analysis capabilities for many industrial applications (agri-food industry, pharmacy, HPC, environment, plastics industry, micro-technology, automobile, etc.).

Handling, packing, assembling, … sorting waste, deconstructing for recycling, bin picking all kinds of objects, … these are all activities that our technologies serve efficiently for the automation of gestures in random or unknown contexts, where blind robots can no longer operate.

Our teams use all their enthusiasm to innovate in many disciplines (mechanics, mechatronics, robotics, cobotics, vision, artificial intelligence, etc.). So Siléane robots analyse their environment and adapt their gestures and movements in real time to act meticulously, accurately, delicately and speedily. This is what makes them so different!

At the crossroads of digital, optics and automation, Siléane's activity and R&D stimulates the industrial sectors, proof of which is seen in its market-leader products.

Located in Saint-Etienne, Siléane now has nearly 90 members of staff and has a turnover in the order of 11 million Euros.

Terms of registration

Departure at 8:30 a.m at Lyon Perrache train station
Expected return at 6:00 p.m at Lyon Perrache train station
50 minutes journey by bus

Required: have your identity papers on the day of the visit.

VELAN

https://www.velan.com/

Velan France was established in 1974 for supplying the newborn French Nuclear Industry. Located in Lyon (France) in a 20 000 m^2 plant, Velan France is specialized in the design and manufacture of High performance valves for Nuclear, Cryogenic and specific applications (300 people, 70 M€ turnover). With an installed base in 350 nuclear power reactors worldwide and with over 50 years of uninterrupted nuclear experience, Velan is the leading valve supplier for all nuclear reactor technologies: PWR, EPR, VVER, HUALONG, AP1000, BWR, PHWR, CANDU, FBR, AGR and HTR…

As an actor of upstream research and continuous innovation, Velan constantly develops new technologies in order to anticipate the technical and regulatory requirements of future generation of Nuclear Reactors such as GENIII PWR reactors, GENIV sodium cooled Fast Breeder and HTR reactors or GENV "TOKAMAK" fusion reactors.

Terms of registration

Compagnie at Lyon, meeting on site at 10:00 a.m (precise address communicated later)
Access by public transport (tram or metro)

Required: have your identity papers on the day of the visit.

Both CEA and CIGEO visit are submitted to security clearance

CEA Marcoule

https://www.cea.fr/Pages/le-cea/les-centres-cea/marcoule.aspx

The CEA is a key player in research, development and innovation in four main areas: energy transition, digital transition, technology for the medicine of the future and defense and security. Its research activities at Marcoule site are involved in circular economy for low carbon energies. This centre also carries out highly technical clean-up and dismantling projects. During these visits, you will discover 3 facilities: Atalante (fuel cycle), G2/G3 (dismantling projects), and a waste conditioning facility.

Terms of registration

Departure at 7:15 a.m at Lyon Perrache train station
Expected return at 6:30 p.m at Lyon Perrache train station
2 hours journey by bus

Required: if you register for this visit, you agree to send us a copy of your ID (both sides) by email before Thursday, May 19 at 3pm.

ANDRA - Cigéo

https://international.andra.fr/

Cigéo (Industrial Centre for Geological Disposal) is the deep geological disposal facility for radioactive waste to be built in France. Cigéo will serve for disposal of highly radioactive long-lived waste produced by France's current fleet of nuclear power plants, until they are dismantled. This waste results from the reprocessing of spent fuel from these plants. Until the disposal facility is built, the centre includes the Bure Underground Research Laboratory (URL). The scientific and technological research carried out within the Callovo-Oxfordian host clay layer at the Bure URL has supported the Cigéo project for more than 15 year today. Located at - 490 m depth, it now represents a 1,800-metre network of drifts, monitored by more than 11 000 sensors, where over 50 experiments and studies are conducted in real conditions. More than 1000 samples have been drilled for characterisation purposes.

Terms of registration

Departure on Thursday June 2nd afternoon (by bus, to be confirmed), from Lyon
4 hours journey by bus

Required: Please note that for the visit to take place you will be asked to confirm by Friday 13/05 and to provide the necessary information as soon as possible.

The participants will have to book a room in one specific hotel (further information will follow after confirmation of the visit). The participants will be back to Lyon on Friday afternoon (around 6:00 pm).


FISA 2022
EURADWASTE'22

EURADWASTE '22 SESSION 1 - Collaborative Research, Development and Demonstration in Radioactive Waste Management
176-inv-eurad-s01-abs-rev00-JALONEN_Tiina (IGDTP)
096-inv-eurad-s01-abs-rev00-MORICHI_Massimo
011-inv-eurad-s01-abs-rev00-HOLT_Erika
030-inv-eurad-s01-abs-rev00-ALTMAIER_Marcus
024-inv-eurad-s01-abs-rev00-CLARET_Francis
042-inv-eurad-s01-abs-rev00-LEVASSEUR_Severine
135-inv-eurad-s01-abs-rev00-SJOLAND_Anders

Predisposal conditioning, treatment, and performance assessment of radioactive waste streams

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Prior to final disposal of radioactive wastes, a variety of processes can be implemented to optimise the waste form. This can include different types of chemical and physical treatments, such as thermal treatment for waste reduction, waste conditioning for homogenisation and waste immobilisation for stabilisation prior to packaging and interim storage. Ensuring the durability and safety of the waste matrices and packages through performance and condition assessment is important for the waste owners, waste management organisations, regulators and wider stakeholder communities. Technical achievements and lessons learned from the THERAMIN and PREDIS projects focused on low- and intermediate-level waste handling will be shared in this presentation. The “THERAMIN: Thermal Treatment for Radioactive Waste Minimization and Hazard Reduction” project concluded in 2020 and made advances in demonstrating the feasibility of different thermal treatment techniques to reduce volume and immobilise different streams of radioactive waste (LILW) prior to disposal. Six different thermal treatment techniques were demonstrated, treated products were characterised and impact of treatment on the disposability was evaluated. In addition, generic disposability criteria were developed to enable evaluation of any products from any type of thermal treatment for disposal of any type of disposal facility. Results of the project showed clearly the benefits of thermal treatment for pre-processing of low and intermediate level waste (LILW) in order to reduce volume of waste to be disposed and improve the overall safety. The “PREDIS: Pre-Disposal Management of Radioactive Waste” project started in 2020, to address innovations on treatment of metallic materials, liquid organic waste and solid organic waste which can result from nuclear power plant operation, decommissioning and other industrial processes. The project also addresses digitalization solutions for improved safety and efficiency in handling and assessing cemented-waste packages in extended interim surface storage. PREDIS includes 47 partners from 17 countries, and an additional 25 companies as End User Group members. Both projects, through all of the predisposal treatment activities, waste acceptance criteria, environmental impact metrics and economic metrics that are critical parameters target to optimize the safe and efficient handling and minimisation of wastes over the whole life cycle.

011-inv-eurad-s01-abs-rev00-HOLT_Erika

MODELLING OF THE LONG TERM EVOLUTION AND PERFORMANCE OF ENGINEERED BARRIER SYSTEM

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Components of a so-called “multiple-barrier system” between the waste matrix and the biosphere include a combination of waste containers (e.g. metal canisters, concrete), engineered barriers such as bentonite or cementitious materials and natural barriers such as salt formation, clayey, volcanic or granitic rocks. The engineered Barrier System (EBS) is a crucial component for containment and isolation in a radioactive waste disposal system. The number, types and assigned safety functions of the various engineered barriers depend on the chosen repository concept, the waste form, the radionuclides inventory in the waste, the selected host rock, the hydrogeological and geochemical settings of the repository site among others. EBS properties will evolve with time in response to the thermo, hydro, mechanical, radiological and chemical gradients and interactions between the various constituents of the barriers and the host rock. Therefore, assessing how these properties evolve over long time frames is highly relevant for evaluating the performance of a repository design and safety function evaluations in a safety case. For this purpose, mechanistic numerical models are increasingly used. Such models provides an excellent way for integrating in a coherent framework scientific understanding of coupled processes and their consequences on different properties of the materials in the engineered barrier system. Their development and validation are supported by R&D actions at European level. For example, the aim of the HORIZON 2020 project BEACON (Bentonite mechanical evolution) is to develop, test and validate numerical models against experimental results in order to predict the evolution of the hydromechanical properties of bentonite during the saturation process. Also in relation to the coupling with mechanics, WP16 MAGIC (chemo Mechanical AGIng of Cementitious materials) of the EURAD Joint Programming Initiative focuses on multi-scale chemo-mechanical modelling of cementitious-based materials that evolve under chemical perturbation (including bacterial impact). Integration of chemical evolution in models of varying complexity (from complex description to its abstraction) is a major issue tackled in the WP2 ACED (Assessment of Chemical Evolution of ILW and HLW Disposal cells) of EURAD. WP4 DONUT (Development and improvement of numerical methods and tools for modelling coupled processes) of EURAD aims at developing and improving numerical models and tools to integrate more complexity and coupling between processes. The combined progress of those projects at a pan-European level will definitively improve our understanding of and our capabilities for assessing the long-term evolution of engineered barrier systems and will encourage collaboration between scientific communities.

024-inv-eurad-s01-abs-rev00-CLARET_Francis

LONG-TERM RADIONUCLIDE RETENTION IN THE NEAR FIELD: COLLABORATIVE R&D STUDIES WITHIN EURAD FOCUSING ON CONTAINER OPTIMISATION, MOBILITY, MECHANISMS AND MONITORING

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Within EURAD, targeted collaborative research activities are performed to further optimize understanding regarding the long-term behaviour of key components in the repository near-field, assess specific radionuclide retention processes as well as developing methods for monitoring safety relevant parameters of repository systems. In the development phase of each of the four EURAD Workpackages (WPs) discussed here, topics were jointly identified by WMOs, REs and TSOs which could be significantly advanced by a joint research effort performed at the European level. The ambition is to investigate topics to meet implementation needs and contribute to Safety Cases in Europe at the highest level of scientific excellence. Work is fully integrated into the EURAD concept, emphasizing interactions between different WPs, involvement of End Users, assuring the link to national programmes and contributing to overarching features like Knowledge Management, Training and Education, or European Integration. Comprehensive initial State-of-the-Art reports were prepared by the WPs or currently under development and are available at the EURAD website. Joint activities of WPs, like the joint session organized at past EURAD Annual Events between FUTURE, CORI and ROUTES, highlight new modes of interaction in EURAD not being available before.
Within this integrated research concept in EURAD, each WP presented focusses on specific important sub-topics. CONCORD contributes to the optimization of container performance and of its assessment and evaluates novel container materials. FUTURE investigates the transport and retention mechanism of radionuclides and provides mechanistic models for reactive transport simulation in “real” clay and crystalline rocks necessary for performance assessment studies. CORI research improves understanding of the role of organics and their influence on radionuclide migration in cement-based systems with high organics inventories, being mainly relevant to LAW/ILW waste disposal. MODATS works to consolidate the implementation strategy for monitoring systems by developing methods through which confidence can be

demonstrated in the data acquired and benefits derived for repository implementation.
The experimental and modelling work in the work by the EURAD WPs presented here is to a significant extent performed by young researchers and within PhD theses. This contributes to the continuing availability of highly trained specialists for implementers and regulators throughout Europe. EURAD contributes to European integration by bringing together experts from several European member states. The involvement from experts coming from countries at very different stages of implementation likewise poses a positive achievement, for instance in view of sharing of expertise and resources in Europe and integrating new member states.

Acknowledgement:
The projects leading to this application have received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847593. The authors want to thank all the respective WP partners, Task Leaders, User Group members and the EURAD PMO for the successful joint collaborative effort.

030-inv-eurad-s01-abs-rev00-ALTMAIER_Marcus

EURAD GAS AND HITEC: MECHANISTIC UNDERSTANDING OF GAS AND HEAT TRANSPORT IN CLAY-BASED MATERIALS FOR RADIOACTIVE WASTE GEOLOGICAL DISPOSAL

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Deep geological disposal aims to contain and isolate radioactive waste from the biosphere. Repository systems are made of multiple barriers working together, which typically comprises the natural geological barrier provided by the repository host rock and its surroundings and an engineered barrier system (EBS). Owing to their excellent properties for the confinement of contaminants including low permeability, high sorption capacity and swelling/self-sealing capacity, clayey materials are considered as engineered and/or natural barriers in most repository designs under development in Europe. During the life of the repository, clay barriers will be exposed to perturbations, among which those resulting from gas and heat production within the system. Indeed, considerable amounts of gas can be generated in a repository containing radioactive waste. Even though the gas production processes are generally slow it is important to verify that a possible pressurization and gas releases through clay barriers will not be detrimental to the good functioning of these barriers. The thermal transient has been exhaustively investigated these last decades. Nevertheless, a relative scarcity of scientific bases at higher temperatures has led to geological repository concepts for heat-emitting wastes that often limit maximum disposal container surface temperatures to about 100°C. Higher temperature limits could have significant advantages such as to allow the disposal of higher enrichment/burn-up spent fuels and shorter interim storage/cooling requirements. In this paper, it is shown how the two EURAD R&D work packages GAS and HITEC use a combination of experimental and modelling approaches to increase the understanding and predictability of the impact on clay barriers of the fundamental processes and their couplings related to gas and heat transport respectively, providing building blocks to support the evaluation of the robustness of the repository concepts.

042-inv-eurad-s01-abs-rev00-LEVASSEUR_Severine

THE MICADO, CHANCE AND PREDIS DEVELOPMENTS AND EXPERIENCES ON RADIOACTIVE WASTE CHARACTERIZATION

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All over the world the nuclear waste management sector is always part of the public debate. Independently from the origin of the waste, the main concerns are the radiation emission, which makes it a particular hazard for human health and environment, and the safety procedures adopted for the storage. The situation gets worse considering country dependent legislation, storage sites and final disposals that do not help simplifying the European waste management procedures. It is in this framework that MICADO, CHANCE and PREDIS projects are working, under the H2020 Euratom calls, aiming to demonstrate the feasibility to improve the characterization of nuclear waste packages and consequently improve safety of citizens.
This work will present the strategies actuated by the three projects for a deep and accurate waste characterization and investigation of the different nuclear packages considered. CHANCE, MICADO and PREDIS will present their goals as well technologies, results obtained or that are aiming at, procedures and strategies used or under evaluation to improve safety, security, data and information quality of the waste packages under analysis.
There will be also a specific focus on complementary approaches that enlighten the usability of the technologies, accessibility of the data and problem solving of the three projects within the European panorama.

096-inv-eurad-s01-abs-rev00-MORICHI_Massimo

SPENT NUCLEAR FUEL MANAGEMENT, CHARACTERISATION, AND DISSOLUTION BEHAVIOUR: PROGRESS AND ACHIEVEMENT FROM SFC AND DISCO

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SFC is a work package in Eurad that investigates issues related to the properties of the spent nuclear fuel in the back-end of the nuclear fuel cycle. Decay heat, nuclide inventory and fuel integrity (mechanical and otherwise), and not least the related uncertainties, are among the primary focal points of SFC. These have very significant importance for the safety and operational aspect of the back-end. One consequence is the operation economy of the back-end, where deeper understanding and quantification allows for significant optimization, meaning that significant parts of the costs can be reduced. In this paper SFC is described and examples of results are presented at about half-time of the work package which will finish in 2024. The DisCo project finished in November 2021, after 4.5 years of collaborative research. It

investigated if properties of modern fuel types, namely doped fuel and MOX, cause any significant difference in dissolution behaviour of the fuel matrix compared with standard fuels. Spent nuclear fuel experiments were complemented with studies on model materials as well as development of models describing the solid state, the dissolution process and reactive transport in the near field. This research has improved the understanding of processes occurring at the interface between spent nuclear fuel and aqueous solution, such as redox reactions. Overall, the results show that from a long-term, fuel matrix dissolution point of view, there is no significant difference between MOX fuel, Cr+Al-doped fuel, and standard fuels.

135-inv-eurad-s01-abs-rev00-SJOLAND_Anders

IGD-TP – TOWARDS OPERATING AND OPTIMIZATION OF GEOLOGICAL DISPOSAL FACILITIES

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Clear progress has been made towards the vision, formulated in 2009 by the IGD-TP at its foundation year, that by 2025, the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste would be operating safely in Europe. Posiva is preparing to start the operation of the final disposal facility constructed in Olkiluoto, Finland, SKB has been granted the license to construct a final disposal facility in Forsmark, Sweden, and Andra is not far behind Sweden in their final disposal programme in France.

To look even further in the future, the IGD-TP Waste Management Organisations (WMOs) formulated a new vision. Vision 2040 has been formulated to cover both the small and the large disposal programmes, whether in their initial or more advanced stages. The vision enhances industrialization of radioactive waste disposal in Europe via three pillars: (1) safe operation of the first geological disposal facilities in Europe; (2) optimisation and industrialisation of planning, construction and disposal operations; and (3) development of tailored solutions for disposal of the diverse radioactive waste inventories in Europe.

To make it happen and turn the vision into reality, a Strategic Research Agenda (SRA) has been agreed by the IGD-TP WMOs that identifies the remaining, currently foreseeable common scientific, technical and societal challenges in radioactive waste disposal programmes. Since the SRA identifies the key RD&D topics that have the greatest potential to support repository implementation through enhanced co-operation in Europe, it also provides valuable input to identifying topics for future calls for proposals issued by the EC Euratom Research and Training Programme.

The decades-long research and development work has produced even more detailed and realistic plans and more robust safety assessments than before. It forms a solid basis for moving towards construction and operation, enabling optimization of all aspects and still keeping safety as the top priority.

It requires a giant leap to turn the R&D results into an industrial and optimized final disposal facility which meets the nuclear safety requirements and current practices and constraints for construction and operation. As for the earlier phases, the implementation phase also requires well educated and trained people. All of these are seen to benefit from international cooperation. By working together, advanced and less-advanced programmes can benefit from each other by maintaining knowledge and by accelerating the development and implementation of decades-long disposal programmes.

176-inv-eurad-s01-abs-rev00-JALONEN_Tiina (IGDTP)

EURADWASTE '22 SESSION 2 – Strategic Research Studies in Radioactive Waste Management
162-inv-eurad-s02-abs-rev00-DETILLEUX_Valéry (SITEX Network)
083-inv-eurad-s02-abs-rev00-DIACONU_Daniela
055-proj-eurad-s02-abs-rev01-MARSAL_François (032-inv)

EURAD EC PROJECT – OVERVIEW OF THE WP ROUTES: IDENTIFIED KEY ISSUES AND OPEN QUESTIONS ABOUT WASTE MANAGEMENT ROUTES IN EUROPE, FROM CRADLE TO GRAVE

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The ROUTES Work Package (WP) is one of the seventeen technical WPs being conducted as part of the European Joint Programme on Radioactive Waste Management (EURAD). ROUTES' objectives are to provide a framework for European Union's Member States (MS) to share methodologies, experiences and knowledge in situations in which a waste management strategy is difficult to define as well as to compare national approaches and strategies of waste management. The work is considering national programmes at different stages of their development and dealing with different amounts and types of radioactive waste. The expected output is the identification of Research & Development (R&D) needs and opportunities for collaboration between MS, which need not be confined to ROUTES or EURAD. The initial work was devoted to gather data (on challenging waste, Waste Acceptance Criteria (WAC), past experiences on shared solutions etc...), then to compare approaches and strategies adopted by MS to cope with issues related to approaches and strategies of waste management. This was mainly achieved through case studies analyses, including both successful and unsuccessful experiences.

This work has enabled ROUTES partners to identify key issues and to raise questions which will be explored in the paper. Examples are: I) A number of MS are facing difficulties in retrieving poorly characterized legacy waste. How to escape the vicious circle *'to be characterized, waste needs to be retrieved and to be retrieved, a detailed inventory is needed"*? II) The absence of well-defined WAC has been identified as one

obstacle to the implementation of specific waste management solutions. How are situations where WAC are not available managed by different MS? What approaches are adopted to find acceptable trade-offs between early and postponed conditioning pending the definition of relevant WAC and disposal solutions? What is an acceptable level of flexibility to adapt to future waste management practices? III) Some MS, especially those with limited amounts of waste to manage, are also considering the opportunity for regional or shared solutions or facilities (including multi-national repositories) and/or managing dual track approach. The implementation of such shared solutions and/or facilities needs important and innovative developments (including cross-border legal and regulatory frameworks) and raises some issues related to public acceptance. What is the definition of a shared solution? How are responsibilities shared? How is Civil Society involved in the decision-making process? What are the underlying conditions for cross-border collaborations?
Discussion of these questions will be illustrated through some of the case studies identified and analyzed under the ROUTES WP.

055-inv-eurad-s02-abs-rev01-MARSAL_François(032-inv)

UMAN – A PLURALISTIC VIEW OF UNCERTAINTIES MANAGEMENT

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Decisions associated with Radioactive Waste Management (RWM) programmes are made in the presence of irreducible and reducible uncertainties. Responsibilities and role of each stakeholder, the nature of the RW disposal programme and the stage in its implementation influence the preferences of each category of actors in approaching uncertainty management. UMAN carries out a strategic study about the management of these uncertainties. This study is based on extended exchanges of the experience accumulated in the national RWM programmes by a broad range of stakeholders representing WMOs, TSOs, REs and Civil Society, as well as on a review of knowledge generated by past and on-going R&D projects, and findings of international organisations (such as IAEA, NEA, etc.). UMAN discusses the classification schemes and approaches applied in the uncertainties management, and identifies possible actions to be considered in the treatment of uncertainties. The relevance for safety of the uncertainties associated with waste inventory, spent fuel, near-field, site & geosphere and human aspects, as percieved by each type of the abovementioned stakeholders, and approaches used by these stakeholders to manage these uncertainties are explored via questionnaires, workshops and seminars, with the aim to reach either a common understanding on how uncertainties relate to risk and safety and how to deal with them along a RWM programme implementation, or, when agreement is not achieved, a mutual understanding of each individual view. As result of these activities, UMAN identifies uncertainties assessed as highly significant for safety and associated R&D issues that should be further investigated.

083-inv-eurad-s02-abs-rev00-DIACONU_Daniela

SITEX.Network: key activities, lessons learned and upcoming challenges

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As a result of the SITEX and SITEX-II European projects, the SITEX.Network was formally established as an association in January 2018 to enhance and foster cooperation in order to achieve a high quality Expertise Function in the field of radioactive waste management safety, independently from the Waste Management Organisations (WMO) and the waste producers. The Network, composed of experts from Technical Support Organisations (TSO), Nuclear Regulatory Authorities (NRA) and Civil Society Organisations (CSO), aims at supporting NRA as well as the Civil Society in radioactive waste management. The keynote lecture will cover the key accomplishments and lessons learned since the foundation of the SITEX.Network, as well as the upcoming challenges. For instance the following activities will be presented: the development and management of a serious game aiming at exchanging about the complexity of radioactive waste management (the Pathway Evaluation Process, PEP), a benchmark of safety case review approaches, training activities, the development and update of a Strategic Research Agenda including socio-technical issues, as well as a literature study about borehole disposal. An important upcoming challenge of SITEX.Network is the coordination of the TSO views, considering the views of NRA and CSO, in the process of a potential second implementation phase of EURAD.

162-inv-eurad-s02-abs-rev00-DETILLEUX_Valéry (SITEX Network)

EURADWASTE ’22 SESSION 3 - Knowledge Management in Radioactive Waste Management
043-inv-eurad-s03-abs-rev00-CARBOL_Paul_final
013-inv-eurad-s03-abs-rev00-THEODON_Louise
041-inv-eurad-s03-abs-rev00-TATOMIR_Alexandru
045-inv-eurad-s03-abs-rev00-FALTEJSEK_Jiri
028-inv-eurad-s03-abs-rev00-BELMANS_Niels
086-inv-eurad-s03-abs-rev00-VUORIO_Marja
144-inv-eurad-s03-abs-rev00-MAYER_Stefan

EURAD-PREDIS KNOWLEDGE MANAGEMENT INTERACTIONS

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Knowledge management (KM) is critical to ensure safe and efficient radioactive waste management over the whole lifecycle of the waste. The ongoing EURAD programme and PREDIS project aim to establish a well-organized and sustainable KM system, organized for, and populated through the active contribution of international stakeholders, as ultimate end-users, .

EURAD being at the mid-term of its Programme, and PREDIS, celebrating its first-year anniversary as a project, both ending in 2024, are exploiting similar and inter-linked KM structures. Both programmes builds on EURAD roadmap for implementation of radioactive waste disposal, as a structure to aggregate present knowledge, needed competences, necessary trainings and guidance, complemented with knowledge of large infrastructures (e.g. underground research facilities, research laboratories and computer centres) and a mobility programme for students to get there. Nonetheless, EURAD and PREDIS differ slightly depending on theinvolvement with different communities; while EURAD connects with links its colleges consisting of Waste Management Organisations (WMOs), Technical Support Organisations (TSOs) and Research Entities; PREDIS, in addition, connects with the waste generators community. These two groups of communities pursue different goals and consequently have different KM needs.

Nevertheless, both EURAD and PREDIS seek to collate all necessary information (recorded training modules, events, conferences, workshops and webinars) and processes (mobility, feedback, and networking) needed by the present and future students on their respective web pages. The final goal is to merge the information, in a retrievable and well-structured manner, on the EURAD School of Radioactive Waste Management. It All activities encompass the K M objectives, as identified in the EURAD founding documents and supported by PREDIS, which are dedicated to the enhancement and transfer of knowledge between generations, member states and organisations.

Furthermore, no such activities are defendable if they are redundant or come too late in time. This forces EURAD and PREDIS to be reactive and responsive to the needs of the radioactive waste community while developing proactive ideas for the knowledge management and networking needs of their partner and stakeholder communities. It has also been recognized that there is a need to coordinate their KM activities with the large international knowledge providers, such as IAEA and OECD/NEA, but also with the national WMO and TSO organisations.

Concretely, the KM end-users' needs are identified from a combination of identification of gaps using the EURAD Roadmap and Experts (top-down), and specific

needs raised directly by the wider community of stakeholders (bottom-up). This fruitful KM interaction also stimulates emergence of new working methods and ideas and will foster the importance of knowledge management in the field of radioactive waste management (RWM).
The goal of this joint poster is to reinforce the common objective that drives the KM work in both EURAD and PREDIS and to offer an overview of how KM-tasks are approached, and also share the main achievements and plans for the future.

013-inv-eurad-s03-abs-rev00-THEODON_Louise

TRAINING AND MOBILITY IN EU PROJECTS EURAD AND PREDIS

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In 2019, The European Commission asked the European Joint Programme on Radioactive Waste Management (EURAD - grant agreement N°847593) to achieve a step change in European collaboration towards safe radioactive waste management (RWM). In that frame, EURAD's Training & Mobility work package (WP) has set up a 'School of RWM', which was launched in 2020. In addition, in September 2021, the 'Pre-disposal of radioactive waste' project (PREDIS), dedicated to pre-disposal treatment of radioactive waste was launched. PREDIS also integrates a training and mobility WP that is closely interlinked to that of EURAD. As such, both WPs complement each other, which has been directly reinforced through the EURAD-PREDIS Joint Statement on knowledge management [1].
Currently, the School of RWM's end-user-driven activities focus on four pillars: organization of courses, hosting of webinars, coordination of a mobility programme, and actions to support the EURAD PhD community. The methodology followed in EURAD and the experience gained from the first School of RWM activities provided a template for the PREDIS training and mobility programme which was launched in December 2021.
To establish a portfolio of training courses, currently existing training initiatives in the field of RWM were mapped. PREDIS focused on predisposal activities and EURAD on RWM in general. The mapping was published on the School's website in November 2021. The School of RWM has organized two training courses. In addition, the School of RWM and PREDIS organized 23 webinars between October 2020 and March 2022. The average audience size was 85. These webinars covered RWM- & Predisposal-related themes, either specialized or more general themes. Webinars as well as recorded lectures on relevant topics for both projects are published online.
Both projects launched a dedicated mobility programme, which allows their beneficiaries and linked third parties to perform technical visits to infrastructures, undertake internships and set up exchange programmes between institutions within EURAD/PREDIS. PREDIS also supports the participation to training courses and events. To date, eight mobility applications were approved within EURAD and seven within PREDIS.
Finally, both projects support their respective student communities, including master students, PhD students, and postdocs. As potential future key figures in the field of RWM, students benefit from the possibilities of networking with their colleagues, peers as well as with RWM established experts early in their careers.

This presentation describes the driving forces behind the School of RWM, the PREDIS training and mobility programme as well as the results obtained and lessons learned so far.

References

[1] EURAD/PREDIS Joint statement on Knowledge management, https://predis-h2020.eu/wp-content/uploads/2021/10/Joint-Statement-on-KM_EURAD-PREDIS.pdf

028-inv-eurad-s03-abs-rev00-BELMANS_Niels

Capturing the state-of-knowledge in EURAD Knowledge Management

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For the safe management and disposal of radioactive waste, knowledge about a wide variety of aspects is fundamental. This importance of Knowledge Management (KM) is also recognised by EURAD, the European Joint Programme on Radioactive Waste Management (RWM), which brings together over 100 organisations from different countries and backgrounds (Waste Management Organisations, Technical Support Organisations, and Research Entities). This vast resource of expertise and experience feeds into several dedicated EURAD KM programme activities. One of these activities, led by Work Package 11 State-of-Knowledge (WP11 SoK), is capturing experts' views on the current State-of-Knowledge on topics relevant to RWM and making this knowledge accessible through dedicated documents. For this, EURAD has developed the "Goals Breakdown Structure" (GBS) which provides a framework in which topics are structured thematically, as well as a hierarchy of documents that allows accessing knowledge on different levels of detail (see EURAD Roadmap https://www.ejp-eurad.eu/roadmap). To make this knowledge available, EURAD is currently developing a Wiki (i.e., a web-based resource, which allows access to knowledge and collaborative interactions) and is drafting a sustainable Knowledge Management System and other supportive KM IT-tools while in parallel already feeding the tools with content. This article gives an insight into the general EURAD KM concept, the approaches used and the results obtained until EURAD's mid-term, after 2.5 years.

041-inv-eurad-s03-abs-rev00-TATOMIR_Alexandru

OVERVIEW OF KNOWLEDGE MANAGEMENT IN EURAD

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Keywords: EURAD, PREDIS, Knowledge Management, Roadmap, State-of-Knowledge, Networking, Lessons Learned, Training and Mobility, Guidance

Knowledge management (KM) is a core activity of the European Joint Programme on Radioactive Waste Management (EURAD), which aims to support Member States with their implementation of the Waste Directive (EC 2011/70/EURATOM). EURAD's KM activities are all inter-linked with the EURAD Roadmap for the implementation of radioactive waste management (RWM) leading to geological disposal, using the experiences of advanced national and EU programmes. Within the roadmap EURAD's KM activities are not only linked to all EURAD programme components such as the programme management office, the three KM WPs, R&D WPs as well as the Strategic Studies WPs, but also to projects complementing EURAD, such as the Pre-disposal

Management of Radioactive Waste (PREDIS), past and ongoing national R&D and international KM activities within IAEA and OECD/NEA.
EURAD's KM programme is governed through the Strategic Research Agenda and input from end-users (Waste Management Organisations at any stage of implementation phase, Technical Support Organisations as well as researchers in the Academia engaged through the Research Entities (universities, research establishments and technological centres)), using different types of targeted inputs (position papers, surveys, questionnaires, interviews, polls and inputs during workshops). Furthermore, through an active continuous feedback from end-users on EURAD's outputs (Roadmap, Strategic Research Agenda, State-of-Knowledge, Guidance, Trainings and Mobility's, R&D deliverables in form of scientific papers and State-of-the-Art publications, Strategic Studies workshop proceedings and synthesis), end-products are obtained that are quality assured and meeting end-users needs. The incorporation and interactions with the Civil Society creates a more complete programme being able to be scrutinised by the public.
PREDIS, as a complementary pre-disposal project, has KM activities fully aligned with those of EURAD and brings to the area of RWM a new category of actors, such as the Waste Generators. The foremost advantage of EURAD, in combination with PREDIS, is the opportunity to have all actors with their vast knowledge present within the programme. On the other hand, they also represent different disciplines and specialities, thus different perceptions of what is important. This mixture is an opportunity to mobilise the people (connecting people to people) through networking. Both programmes need to continuously adapt their KM strategies as response on feedback from their communities and challenges posed by end-user, students and civil society. This paper intends to describe the structure of the EURAD KM programme, interactions with organisations and people, networking initiatives, as well as lessons learned and outlook for a possible continuation past EURAD.

043-inv-eurad-s03-abs-rev00-CARBOL_Paul_final

DEVELOPMENT OF GUIDANCE DOCUMENTS IN THE EURAD AND PREDIS PROJECTS

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Particular emphasis is dedicated to Knowledge Management activities within the EURAD (European Joint Programme on Radioactive Waste Management) and PREDIS (Pre-disposal management of radioactive waste) projects to ensure the capture of existing knowledge, transfer of knowledge between Members States and management of the knowledge for future generations. The EURAD Guidance work package (WP12) is developing a comprehensive suite of specific guidance documents that can be used by Members States with RWM programmes that are at an early stage of development, but can be beneficial also to more advanced programmes. The PREDIS project does not have a specifically allocated work package for guidance development. Rather, such activities are integrated within deliverables produced as part of the Strategic Implementation and State of Knowledge actions of the Roadmap contributions on predisposal waste management. The EURAD guidance work is based on the existing PLANDIS guide on RD&D planning, developed by the Implementing Geological Disposal Technology Platform (IGD-TP). The guidance documents complement the State of Knowledge documents that explain what and why a certain disposal implementation process should be made. The differentiation is that guidance documents explain in more detail how the process can be established and performed, including illustrative examples. The guides are self-standing documents and integrated with the EURAD Roadmap. The target end user of the guidance is primarily programme owners and managers (i.e. governments/administrations, Waste Management Organisations, Research Entities and Technical Support Organisations) responsible for planning and implementing RD&D at a national level, even though

they might also be of use and interest to other interested stakeholders, such as representatives of civil society. To produce a first list of prioritised topics for guidance documents with the aim to select a topic for a pilot guide, the Guidance WP has developed a screening process that includes review by experts and end users. Based on the priority list, the first pilot guide was developed with the title “Cost Assessment and Financing Schemes of Radioactive Waste Management Programmes”. Experience gained during the selection of topics for the pilot guide and during its production are being incorporated into the procedure for identification of new topics for which guides will be developed. First, the degree of coverage of the EURAD Roadmap themes by suitable guide documents will be analysed by the WP 12 team. The analysis will be combined with feedback from experts verifying the needs for missing guides. Finally, the potential end user community representatives will be given the opportunity to comment on the prioritisation of selected guidance documents and make additional suggestions. The potential end users stay involved also during the production of the guides. This procedure aims to optimise the scarce expert resources in relation to the identified needs of guidance documents. This article explains the approach for selecting topics for guidance documents and the results obtained both in EURAD and PREDIS.

045-inv-eurad-s03-abs-rev00-FALTEJSEK_Jiri

ERDO - a road to sharing

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The ERDO Association (Association for Multinational Radioactive Waste Solutions), is an association of several national organizations with a mission to work together to address the common challenges of safely managing the long-lived radioactive wastes in their countries. Each Member State is responsible for ensuring the safety of spent fuel and other radioactive waste. For European countries with only small amounts of waste to manage, constructing their own repository is a major challenge. Article XI of the Joint Convention states that countries can under certain circumstances fulfil this responsibility by sharing a disposal facility. A multinational disposal facility is of particular interest to countries with relatively small inventories of radioactive waste. The obvious solution is for countries to share in the development of one or more regional repositories. As well as the technical advantages, partner countries would also save hundreds of millions of EUR by sharing development and operation costs. Many small-inventory states have therefore adopted a dual-track approach, where domestic and multinational solutions are pursued in parallel. Shared solutions have been researched over the last 20 years and much of the knowledge base lies within the ERDO Association. The founding feasibility studies for sharing disposal solutions in Europe were carried out by ERDO members in the European Commission SAPIERR projects. This led to the establishment of the ERDO Working Group in 2009. Over the following decade, both the fundamental concepts and the practical aspects of multinational waste management solutions were researched and promoted by the IAEA, with central involvement of ERDO members. The ERDO Association was established 2021 in the Netherlands by COVRA (NL), NND (NO), and DEKOM (DK), and to date ARAO (SI), Fond-NEK (HR), ENEA (IT), Ministry of Climate and Environment (PL) and ONDRAF/NIRAS (BE) have joined. ERDO is an association whose purpose is to act as a knowledge centre for both national and multinational solutions. ERDO envisages a long-term programme of shared activities that aim to spin-off concrete solutions to waste management problems and, eventually to enable progress towards shared facilities. As a relatively small, self-financed body, the ERDO Association can concentrate resources and manage projects effectively on modest budgets with efficient timescales.

086-inv-eurad-s03-abs-rev00-VUORIO_Marja

The IAEA approach to Information and Knowledge transfer on Radioactive Waste Management – Opportunity for Synergies with the international cooperation conducted under the EURAD and PREDIS projects

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The International Atomic Energy Agency provides for global cooperation towards implementing and improving the peaceful uses of nuclear technologies. This includes the responsible management of all radioactive waste arising from such peaceful uses – with a view to ensuring they remain sustainable. The IAEA strives to establish and transfer information and knowledge (I&K) relevant to RWM to support Member States understanding of the associated responsibilities, establishing a comprehensive national framework, planning needed resources and to launch or further progress addressing those radioactive waste management (RWM) responsibilities.

The Strategic Research (and Knowledge Management) Agenda developed for the European Joint Programming on Radioactive Waste Management (EURAD) and Pre-disposal management of Radioactive Waste (PREDIS) cover a comparably broad range of I&K topics on RWM, structured by a Roadmap and intended to support European Member States addressing their RWM responsibilities.

Frequent consultations between IAEA staff and the EURAD and PREDIS bureau, work package leads, or project leads allowed to:

- Maintain awareness and understanding of scope, objectives, level of detail and tools considered for establishing, collecting and/or transferring I&K on RWM;
- Mutually inform each other when scope and objectives align; and
- Identify opportunities for cooperation when, further to scope and objectives, the level of detail and/or tools used to deliver the programme of work are similar.

Ensuring that such opportunities will yield effective cooperation efforts further requires due consideration that IAEA, as well as the EC co-funded programmes EURAD and PREDIS each have specific mandates and serve a different range of Member States.

Building on a brief review of recent and planned work conducted by IAEA to provide I&K relevant to RWM and referring to similar reviews provided for EURAD and PREDIS, a few of the envisioned opportunities for closer cooperation are suggested. An

obvious opportunity is focused on the development of higher-level guidance or state-of-art review on select topics fundamental to RWM. Furthermore, a pro-active use of the IAEA Nuclear Wiki could provide for the timely and systematic dissemination of recent contributions to I&K, such as from specific R&D results, national case studies, or detailed introductions to RWM applications or technologies. Finally, the shared objective to effectively transferring I&K between national programmes, organizations as well as generations could call for closer cooperation in the development and delivery of introductory and professional training.

144-inv-eurad-s03-abs-rev00-MAYER_Stefan


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CHANCE	022-proj-eurad-s01-abs-rev00-RICARD_Denise
PREDIS WP5	051-proj-eurad-s01-abs-rev00-PANCOTTI_Federica

H2020 CHANCE PROJECT "CHARACTERIZATION OF CONDITIONED NUCLEAR WASTE FOR ITS SAFE DISPOSAL IN EUROPE"

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The European project CHANCE aims to address the specific issue of the characterization of conditioned radioactive waste (CRW). The project is funded by the EU's Horizon2020 research programme; it started on June 1st 2017 and runs until March 31st 2022. The project consortium consists of 11 partners from 7 countries. The main objective of CHANCE is to further develop, test and validate three techniques for CRW characterization : (1) Calorimetry to detect radioactive material generating heat, like alpha emitters, while being insensitive to radiation attenuation in the waste package; (2) Muon Tomography to characterize the content of large and dense nuclear waste packages; and (3) Cavity Ring-Down Spectroscopy (CRDS) to characterize the outgassing of radioactive waste, namely of ^{14}C and ^{36}Cl. An overview of the end-users needs for the characterization of conditioned radioactive waste beyond the techniques employed today was also produced in the framework of the project. The development and construction of the following technological equipment: a new calorimeter to host a 200L drum, a large muon tomography system and a new sampling line to be used in connection with a ^{14}C CRDS prototype were achieved. Calibration and experimental measurements with mock-up drums have been carried out for the calorimeter and muon detectors. A series of Monte Carlo modelling has been performed for muon tomography to: a) evaluate the position and volume of hydrogen bubbles in radioactive waste drum b) identify material in heterogeneous waste drums and c) identify possible defects (like a missing assembly) in a CASTOR drum holding spent nuclear fuel. Monte Carlo simulations and experimental tests were also carried out to estimate the reduction of uncertainties due to gamma and neutron attenuation effects (mainly resulting from the poor knowledge of matrix properties and plutonium location) owing to a combination of gamma spectrometry

with passive neutron coincidence counting and calorimetry. Measurement of ^{14}C outgassing from graphite samples were performed by CRDS, and it will be measured soon from ion exchange resins. The development of an instrument for detection of $H^{36}Cl$ is under progress.

022-proj-eurad-s01-abs-rev00-RICARD_Denise

DEVELOPMENT OF FORMULATIONS FOR DIRECT CONDITIONING OF RADIOACTIVE LIQUID ORGANIC WASTES – PREDIS WP5

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Work Package 5 (WP5) of the H2020-PREDIS project aims at addressing the key issue of Radioactive Liquid Organic Waste (RLOW), which is the lack of a disposal or treatment route, by investigating, developing and assessing (especially regarding disposability) direct conditioning solutions based on alkali-activated materials (AAM). This includes the choice of aluminosilicate precursors, alkaline activators, possible blended binder systems and additives facilitating the organic waste emulsification (surfactants), to achieve waste forms with good rheological and mechanical properties.

Different AAM formulations, based on metakaolin, blast furnace slag, volcanic tuff, fly ash or their mixes as aluminosilicate solid precursors, were proposed and tested by the PREDIS Task 5.3 partners (NUCLECO/SOGIN, NNL/USFD, CIEMAT, POLIMI, SCK-CEN, KIPT, RATEN) during the first year of the project. The use of NaOH, KOH or alkali silicates (sodium or potassium based) as alkaline activators were evaluated with different RLOW surrogates at different incorporation rates. The main goal of the preliminary R&D stage was to select three optimised reference formulations for RLOW encapsulation with the target to achieve an incorporation rate of at least 30% by volume. The robustness of the reference formulations and the durability of conditioning matrix will be further studied within PREDIS Task 5.3 and Task 5.4.

This work presents the main findings of the partners involved in the experimental work which led to the selection of the reference formulations.

051-proj-eurad-s01-abs-rev00-PANCOTTI_Federica (PREDIS WP5)

EURADWASTE '22 SESSION 2 – Strategic Research Studies in Radioactive Waste Management	
ROUTES	032-inv-eurad-s02-abs-rev00-LEONI_Elisa (055-proj)
EURAD ROADMAP	147-proj-eurad-s02-abs-rev00-BEATTIE_Tara
EURAD ETKM UPDATE	151-proj-eurad-s02-abs-rev00-DETILLEUX_Valéry
PREDIS WP5	037-proj-eurad-s02-abs-rev00-HAMADACHE_Kahina
EURAD & PREDIS (WAC)	029-proj-eurad-s02-abs-rev00-DEBOCK_Chris
EURADSCIENCE	121-proj-eurad-s02-abs-rev00-BRUGGEMAN_Christophe
HARPERS	170-proj-eurad-s02-abs-rev00-SZOKE_Reka

Cooperation between the EC projects EURAD and PREDIS on the subject of waste acceptance criteria

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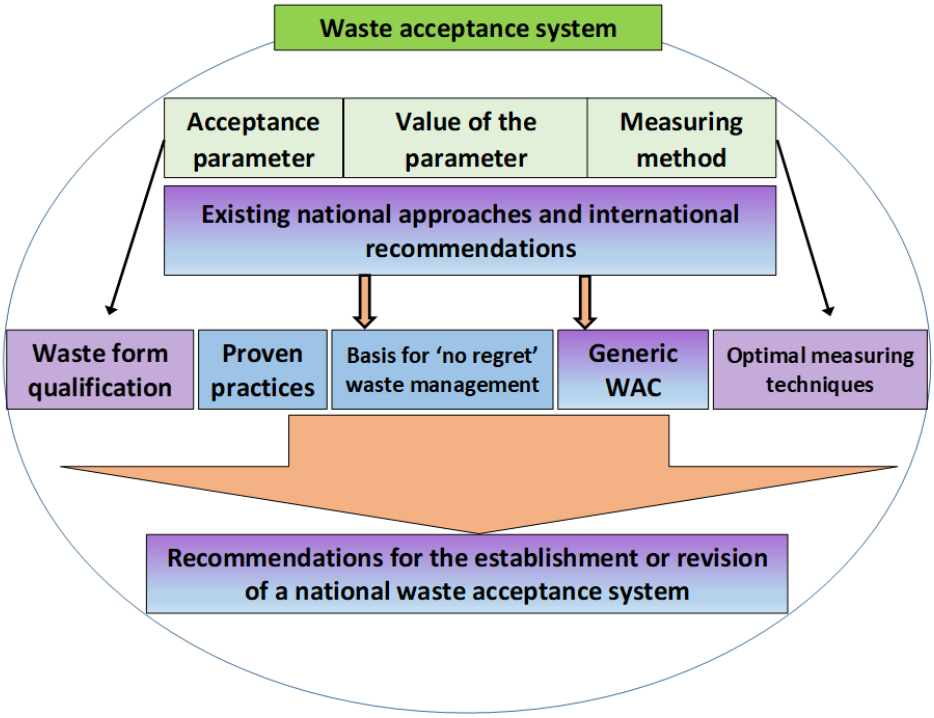
EC projects like EURAD and PREDIS are publicly funded initiatives, aimed at fostering synergy and cooperation in order to most efficiently improve knowledge and practices across EU Member States. Alongside other ongoing international initiatives, both EURAD and PREDIS are examining different aspects relating to waste acceptance criteria (WAC), and the pivotal role WAC play in radioactive waste management. This poster will summarise cooperation and collaborative activities conducted to facilitate information exchange and ensure the two projects will deliver complementary outputs that progress understanding in the development of WAC and their application. It will also summarise notable project outputs to-date.

Within the EURAD work package 'ROUTES', Task 4 is devoted to WAC and their impact on the definition of full lifecycle waste management approaches, thus covering both pre-disposal and disposal steps. The aim is to share experience on WAC use in order to inform development of WAC in countries without WAC and/or disposal facilities. Within PREDIS work package n°2, the objectives of Task 2.3 are to establish guidance on the selection of optimal waste form characterisation methods, the formulation of generic WAC (in the absence of a disposal facility) and the waste form qualification process. The waste form qualification process provides proof that a selected waste form is compatible with its designated disposal system.

The bases for the outcomes of both projects were laid down by collecting information about waste acceptance approaches in EU Member States and some other countries [2] [3]. Both projects are aiming at the formulation of recommendations for national programmes wishing to establish or improve their waste acceptance systems. The figure below indicates the specific and common areas of interest of both projects.

[2] L. Harvey, C. De Bock, C. Bucur (2020), *Milestone 88: Current use of Waste Acceptance Criteria (WAC) in European Union Member-States and some Associated Countries*, European Commission EURAD ROUTES (WP9) Milestone MS88, November 2020. Available here.

[3] L. Nachmilner, L. Karásková-Nenadálová, *International approaches to establishing a waste acceptance system*, PREDIS Deliverable 2.4, August 2021. Available here.



ROUTES started about one year before PREDIS. In its preparatory stage, PREDIS therefore harmonised its scope and goals with the approved ROUTES implementation plan. Since then, cooperation between both the projects has materialised primarily through contributions to each other's webinars and workshops, e.g., two joint PREDIS / ROUTES / ERDO webinars in April and May 2021 [4] [5] and a ROUTES Task 4 workshop in June 2021 [6]. Similar initiatives are envisaged in future and opportunities for further cooperation will be pursued. These could include joint actions, like conducting surveys to stakeholders. A particular emphasis will be placed on 'lessons learned' from applied methods and insights gained from feedback by end users or stakeholders.

EURAD & PREDIS (WAC) 029-proj-eurad-s02-abs-rev00-DEBOCK_Chris

[4] Summary available in https://predis-h2020.eu/wp-content/uploads/2021/06/Predis_WAC1_Webinar_Summary_14-6-2021.pdf

[5] Summary available in https://predis-h2020.eu/wp-content/uploads/2021/06/Predis_WAC2_Webinar_Summary_14-6-2021.pdf

[6] Materials available in https://www.ejp-eurad.eu/publications/routes-workshop-subtask-42-sharing-experience-waste-management-without-wac

EURAD EC PROJECT – OVERVIEW OF THE WP ROUTES: IDENTIFIED KEY ISSUES AND OPEN QUESTIONS ABOUT WASTE MANAGEMENT ROUTES IN EUROPE, FROM CRADLE TO GRAVE

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The ROUTES Work Package (WP) is one of the seventeen technical WPs being conducted as part of the European Joint Programme on Radioactive Waste Management (EURAD). ROUTES' objectives are to provide a framework for European Union's Member States (MS) to share methodologies, experiences and knowledge in situations in which a waste management strategy is difficult to define as well as to compare national approaches and strategies of waste management. The work is considering national programmes at different stages of their development and dealing with different amounts and types of radioactive waste. The expected output is the identification of Research & Development (R&D) needs and opportunities for collaboration between MS, which need not be confined to ROUTES or EURAD. The initial work was devoted to gather data (on challenging waste, Waste Acceptance Criteria (WAC), past experiences on shared solutions etc...), then to compare approaches and strategies adopted by MS to cope with issues related to approaches and strategies of waste management. This was mainly achieved through case studies analyses, including both successful and unsuccessful experiences.

This work has enabled ROUTES partners to identify key issues and to raise questions which will be explored in the paper. Examples are: I) A number of MS are facing challenges in retrieving poorly characterized legacy waste from a predisposal or disposal facility. How to escape the vicious circle *'to be characterized, waste needs to be retrieved; but to be retrieved, a detailed characterization of inventory is needed"*?

II) The absence of well-defined WAC has been identified as one obstacle to the implementation of specific waste management solutions. How are situations where WAC are not available managed by different MS? What approaches are adopted to find acceptable trade-offs between early and postponed conditioning pending the definition of relevant WAC and disposal solutions? What is an acceptable level of flexibility to adapt to future waste management practices? III) Some MS, especially those with limited amounts of waste to manage, are also considering the opportunity for regional or shared solutions or facilities (including multi-national repositories) and/or managing dual track approach. The implementation of such shared solutions and/or facilities needs important and innovative developments (including cross-border legal and regulatory frameworks) and raises some issues related to public acceptance. What is the definition of a shared solution? How are responsibilities shared? How is Civil Society involved in the decision-making process? What are the underlying conditions for cross-border collaborations?
Discussion of these questions will be illustrated through some of the case studies identified and analyzed under the ROUTES WP.

EURAD ROUTES 032-inv-eurad-s02-abs-rev00-LEONI_Elisa
055-proj-eurad-s02-abs-rev02-MARSAL_François (032-inv) (EURAD WP ROUTES)

Innovations in liquid organic waste treatment and conditioning within the PRE-DISposal management of radioactive waste (PREDIS) European collaboration project

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The PREDIS project targets the development and implementation of activities for pre-disposal treatment of metallic, solid organic, liquid organic and cemented waste streams other than nuclear fuel and high-level radioactive waste. A significant amount of Radioactive Liquid Organic Waste (RLOW) needs to be processed prior to storage and disposal and this waste category is addressed by PREDIS WP5. A group of representative Waste Management Organizations and Waste Producers classified RLOW and identified oils contaminated with alpha-emitters, organic solvents, scintillation cocktails and decontamination liquids, which can result from nuclear power plant operation, decommissioning and other industrial processes, as main constituents of this waste category. 19 European partners from 8 countries join forces to develop and implement geopolymers and related alkali-activated materials as innovative RLOW direct conditioning solution. Optimisation of the direct conditioning process, testing the performance of conditioning matrix - as well as technical, economic and environmental analysis are ongoing. They will allow to optimize, assess robustness and investigate upscale feasibility of the conditioning matrix formulations. Latest outcomes have defined the experimental guidelines and protocols, which have led to develop geopolymer matrix formulations that are currently being tested to incorporate RLOW. Indeed, formulations based on metakaolin, slags and mixes of raw materials have shown very promising results improving waste loadings and wasteform properties in comparison with traditional cementitious waste forms. This innovation is intended to provide a reliable solution for the direct conditioning of RLOW, allowing access to storage, transportation or disposal of this waste stream, while complying with technical, economic and safety requirements.

PREDIS WP5 037-proj-eurad-s02-abs-rev02-HAMADACHE_Kahina

ESTABLISHING EURADSCIENCE AS A SUSTAINABLE NETWORK FOR RESEARCH ORGANISATIONS IN RADIOACTIVE WASTE MANAGEMENT

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When EURADSCIENCE was established in December 2017, it was comprised as a loose network of about 20 research organisations recognizing the need to become self-organised in view of impacting and supporting the Research Entity College within the first European Joint Programming on radioactive waste management and disposal. Since then, 20 more research organisations joined in a continuous effort to streamline visions from the diverse landscape of science and technology underpinning safe radioactive waste management. Through the EURADSCIENCE network and concerted activities, several position papers were developed that provided insights into the research organisations' view on EURAD activities, including RD&D and knowledge management. Now, a next phase and new morning is dawning that will bring EURADSCIENCE to the next level of cooperation. Indeed, considerable efforts have been made to develop a Consortium Agreement between EURADSCIENCE partners detailing the Terms of Reference (ToR) that will be maintained between the different partners. With the Consortium Agreement comes also a lumped sum contribution (membership fee), allowing to develop a (part-time) secretary for the network, which will greatly aid in the professionalism that is expected for the future network activities going forward to EURAD-2. In this poster, we will show the main items in the Terms of Reference, inviting also new and other organisations interested in the EURADSCIENCE network to come and join as partners.

EURADSCIENCE 121-proj-eurad-s02-abs-rev00-BRUGGEMAN_Christophe

THE EURAD ROADMAP – A ROADMAP FOR IMPLEMENTING RADIOACTIVE WASTE MANAGEMENT, LEADING TO GEOLOGICAL DISPOSAL

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Keywords: EURAD, Knowledge management, Roadmap, Implementation

Knowledge Management (KM) is a core activity of the European Joint Programme on Radioactive Waste Management (EURAD) which has driven the development of the EURAD Roadmap, a roadmap for the implementation of radioactive waste management (RWM) leading to geological disposal, using the experiences of the advanced EU programmes. Because these programmes have developed over more than 40 years and have adopted different technical and strategic approaches to deep geological repository (DGR) development, the roadmap has been structured to capture largely generic best practice in its presentation of programme Phasing and Thematic goals breakdown structure:

- 5 Phases of Implementation: Initiation, Site Selection, Site Characterization, Construction, and Operations and Closure. For each phase the roadmap explains how activities and existing knowledge is used to fulfil generic safety and implementation goals common across RWM programmes.
- 7 Themes: Programme Management, Predisposal, Engineered Barrier Systems, Geoscience, Design and Optimisation, Siting and Licensing, and Safety Case. Each theme is further elaborated into sub-themes and domains.

The intention of the EURAD roadmap is to provide information and guidance to three primary user groups:

1. Organisations that are developing or updating their national RWM programmes with the objective of moving towards deep geological disposal of some of their wastes and requiring information on the steps involved;
2. Organisations with advanced RWM and DGR programmes that require an informative training tool for new staff and a means of propagating knowledge across the groups involved in diverse activities;

3. All organisations concerned with identifying potential future gaps in capabilities that could hinder implementation of their DGR programmes in decades to come.

We recognize that there is not a unique route through the roadmap – like any roadmap, it can be used to stimulate consideration of alternative options and can be adapted by each Member State to suit national priorities. Because of its generic nature, the EURAD roadmap will be populated with content that is common to all programmes, creating a basis and strategy for a long-term project of Knowledge Management and Networking in RWM.

EURAD Strategic research and knowledge management agenda: an update process preparing future joint actions

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The Bureau of the EURAD General Assembly is composed by representatives from each EURAD College and acts on behalf of the General Assembly, in close interactions with the EURAD Programme Management Office. The Bureau notably elaborates and proposes strategic decisions and developments to the General Assembly. For instance, the Bureau is responsible for implementing a process for the update of the Strategic Research and Knowledge Management Agenda (SRA) of EURAD. This update, planned to be finalized in February 2023, will fundamentally serve two purposes, (i) to take stock and reflect on progress made since 2019 and capture emerging needs from across the Colleges (e.g. what has changed, what is new…), and (ii) to prepare as an input for a potential new EC joint programme. Throughout the update process exchanges between the EURAD Colleges and PREDIS are organized (PREDIS will bring in the views of the Waste Generators). Towards the end of the update process a wider engagement and review of the updated SRA is envisaged within EURAD Colleges and other external key stakeholder groups. The Keynote lecture will present the developed and on-going SRA update process and the role of the SRA in the selection (or filter) process of issues requiring and enabling joint actions by the EURAD community in a new EC joint programme, with the required level of quality and support.

EURAD ETKM UPDATE 151-proj-eurad-s02-abs-rev00-DETILLEUX_Valéry

HARPERS: HARMONISED BEST PRACTICES, REGULATIONS AND STANDARS IN WASTE MANAGEMENT AND DECOMMISSIONING

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Activities associated with nuclear facility decommissioning and the predisposal management of radioactive waste involve applications of international safety standards and European Union (EU) directives which can vary from one country to another as they are adapted to local considerations and national policies. Examples include waste classification, waste acceptance and the specific criteria for material clearance and exemption from regulatory control. These national differences can create difficulties in interpreting 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), while simultaneously hindering communication (and therefore also public acceptance) as to waste management practices nationally and internationally. A greater convergence and harmonization of national standards would allow for increased international cooperation among all relevant actors in nuclear decommissioning and radioactive waste management.

The overall goal of the HARPERS project is, therefore, 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 MS. Obstacles and issues preventing implementation of a more common regulatory framework will also be identified. The high-level benefits of more aligned and harmonised regulations are related to 1) larger degree of implemented sustainability,

2) greater business opportunities, 3) better understanding between diverse groups serving wider markets, 4) improved cost efficiency, 5) waste minimisation and 6) 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 is running for three years, starting from June 2022 and includes 25 institutes from 13 countries, and strives to have wide stakeholder engagement including regulatory agencies, governments, researchers and companies to meet the project objectives

HARPERS 170-proj-eurad-s02-abs-rev00-SZOKE_Reka

EURADWASTE '22 SESSION 3 - Knowledge Management in Radioactive Waste Management	
SoK	074-proj-eurad-s03-abs-rev00-BEATTIE_Tara

EURAD Key achievements at mid-term

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The European Joint Programme on radioactive waste management is a step change in European collaboration and involves both advanced and early-stage programmes on radioactive waste management and disposal from 23 countries through the participation of 51 mandated organisations, 61 linked third parties, 3 international partner and representatives from civil society. The mandated organisations are waste management organisations ('implementers'), technical support organisations (supporting the regulatory process) or research entities delivering cutting-edge science; each of these three entities forms a college, with the colleges being represented equally in the different governance issues.

The biggest change compared to earlier EC-funded projects and the real opportunity of EURAD is to have the three colleges joining forces to define and work on a shared research and knowledge management programme. Joint programming has now become a reality with the creation of a community which fosters mutual understanding and trust between the partners including civil society and the colleges all cooperating towards the implementation of a robust and sustained scientific and technological programme.

Most work packages have now reached their third year of implementation and are delivering encouraging results and the launch of the second wave of projects has been timely implemented by taking into account lessons learned from the first years of the programme. The scientific excellence developed in EURAD created new knowledge, educated scientists and allow to broaden the capabilities.

With the publication of a shared knowledge management (KM) and networking programme, the sustainability of the knowledge and its delivery to help Member States in their timely implementation of disposal solutions is assured in EURAD. Main outcome in the first half of the programme is the finalized Goals Breakdown Structure

Roadmap: a generic roadmap for implementing radioactive waste management, leading to geological disposal with a wide range of KM related documents already published and more in production.

Finally, the development of a process for the update of the Strategic Research Agenda to guide future work and to maintain and/or broaden the competencies and to ensure inclusiveness continues over 2022, aiming at its publication beginning of January 2023 and should be an important input for defining a follow-up programme to EURAD if this will happen.

The ambitious goals of EURAD require a long-term perspective over another ten or more years. The building of confidence, trust and common understanding among the various categories of actors is a cornerstone of future success with the implementation of disposal solutions.

SoK 074-proj-eurad-s03-abs-rev00-BEATTIE_Tara


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Open Call EURADWASTE ’22 MSc/PhD/R&D and Prizes FOR Session 1-2-3	
s01 PhD	012-call-eurad-s01-abs-rev01-IBRAHIM_layla
s01 PhD	014-call-eurad-s01-abs-rev01-YUAN_Tao
s01 PhD	016-call-eurad-s01-abs-rev01_STIETZ_Janina
s01 PhD	017-call-eurad-s01-abs-rev00-PITZ_Michael
s01 PhD	018-call-eurad-s01-abs-rev00-TOLNAI_Istvan (idem 019)
s01 R&D	019-call-eurad-s01-abs-rev00-FABIAN_Margit (idem 018)
s01 PhD	020-call-eurad-s01-abs-rev01-DEWITTE_Charlotte
s01 R&D	025-call-eurad-s01-abs-rev01-SCHINTGEN_Tom
s01 R&D	026-call-eurad-s01-abs-rev00-LOPEZ-GARCIA_Marta
s01 PhD	027-call-eurad-s01-abs-rev01-RIVONKAR_Aditya
s01 R&D	035-call-eurad-s01-abs-rev01-KATONA_Richard
s01 PhD	038-call-eurad-s01-abs-rev00-GUPTA_Abhishek
s01 R&D	047-call-eurad-s01-abs-rev00-RUDYCHEV_Yegor
s01 PhD	048-call-eurad-s01-abs-rev00-LLABJANI_Qazim
s01 PhD	049-call-eurad-s01-abs-rev01-ZERVA_Dimitra
s01 R&D	054-call-eurad-s01-abs-rev01-FRASCA_Benjamin
s01 R&D	056-call-eurad-s01-abs-rev00-VERNAY_Alienor
s01 R&D	058-call-euradwaste-s01-abs-rev00-SHULHA_Oleksii (idem 059 and 150)
s01 R&D	059-call-euradwaste-s01-abs-rev00-KUBA_Ihor (idem 058 and 150)
s01 PhD	060-call-eurad-s01-abs-rev01-YANIKOMER_Neslihan (ENEN PhD Applicant)
s01 R&D	062-call-eurad-s01-abs-rev01-NARKUNIENE_Asta
s01 PhD	066-call-eurad-s01-abs-rev01-SAMMALJARVI_Juuso
s01 R&D	069-call-eurad-s01-abs-rev00-DIDIER-LAURENT_Regis
s01 PhD	070-call-eurad-s01-abs-rev00-BRABANTS_Lowie
s02 R&D	071-call-eurad-s02-abs-rev00-PROSKURA_Ganna
s01 PhD	072-call-eurad-s01-abs--rev00-NOLDEN_Markus
s01 R&D	075-call-eurad-s01-abs-rev01-LAGZDINA_Elena
s01 PhD	077-call-eurad-s01-abs-rev01-ZENG_Hao
s01 PhD	078-call-eurad-s01-abs-rev00-GONZALEZ-BLANCO_Laura
s01 PhD	082-call-eurad-s01-abs-rev00-BONDARIEVA_Antonina
s02 R&D	087-call-eurad-s01-abs-rev01-NIEDERLEITHINGE_Ernst (UPDATED)
s01 R&D	088-call-eurad-s01-abs-rev01-RENTSCHLER_Eric
s01 R&D	090-call-eurad-s01-abs-rev00-LE_Trung
s02 R&D	091-call-eurad-s01-abs-rev00-PLUKIENE_Rita
s01 PhD	092-call-eurad-s01-abs-rev01-BRUNEEL_Yaana
s01 PhD	094-call-eurad-s01-abs-rev01-QIAN_Yanting
s01 PhD	097-call-eurad-s01-abs-rev01-GAJST_Tamara

s01 PhD	101-call-eurad-s01-abs-rev01-KOZLOWSKI_Andrea
s01 PhD	104-call-eurad-s01-abs-rev00-SHANG_Chengming (ENEN PhD Invited)
s01 R&D	105-call-eurad-s01-abs-rev00-MARGIT_Fabian (NIP HLW-MATRIX, see 018-19)
s01 PhD	106-call-eurad-s01-abs-rev00-DE-HITA-FERNANDEZ_Maria-Jimena (idem 155)
s01 PhD	111-call-eurad-s01-abs-rev01-GALLUCCIO_Francesco (ENEN PhD Applicant)
s01 R&D	113-call-eurad-s01-abs-rev01-COQUARD_Laurent (NIP QUANTOM, Win-2)
s01 R&D	114-call-eurad-s01-abs-rev00-FOURNIER_Maxime (NIP DEM MELT)
s02 PhD	116-call-eurad-s01-abs-rev00-BOURDON_Jeremy
s01 R&D	128-call-eurad-s01-abs-rev00-KHERADMAND_Mohsen (NIP KH2021)
s01 R&D	131-call-eurad-s01-abs-rev00-CEDERWALL_Bo (NIP ARCTERIX, Win-1)
s01 R&D	136-call-eurad-s01-abs-rev00-LOPEZ-GARCIA_Marta
s01 R&D	137-call-eurad-s01-abs-rev01-THORNBER_Stephanie
s01 PhD	138-call-eurad-s01-abs-rev00-ROBIN_Mathurin
s01 R&D	140-call-eurad-s01-abs-rev00-MUNOZ-TIRADO_Juan-Antonio
s01 R&D	141-call-eurad-s01-abs-rev00-SANTOS_Pedro (NIP ROBBE, Win-3)
s01 PhD	143-call-eurad-s01-abs-rev01-ZAVORKA_Jiri (NIP ENSBEF)
s01 R&D	150-call-eurad-s01-abs-rev00-SHULHA_Oleksii (idem 058 and 059)
s01 R&D	152-call-eurad-s01-abs-rev00-DAVID_Olivier
s01 PhD	155-call-eurad-s01-abs-rev01-FERNANDEZ_Maria-Jimena (idem 106)
s01 R&D	163-call-eurad-s01-abs-rev00-ALBERT_Marc (NIP TRITUM REM SYS)
s01 R&D	167-call-eurad-s01-abs-rev00-RIBBA_Olga
s01 R&D	168-call-eurad-s01-abs-rev00-PIZZOCRI_Davide
s01 PhD	172-call-eurad-s01-abs-rev00-SUAREZ_Francisco (ENS YGN)
s01 R&D	173-call-eurad-s01-abs-rev00-MINCU_Monica
s01 R&D	174-call-eurad-s01-abs-rev00-HANSEN_Joanna
s01 R&D	175-call-eurad-s01-abs-rev00-OKSA_Maria (PREDIS INCO)
s01 R&D	178-call-eurad-s01-abs-rev00-GULIK-Volodymyr (R&D)

CHEMO-MECHANICAL COUPLING FOR MODELLING OF REINFORCED CONCRETE DISPOSAL UNDERGROUND STRUCTURES

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Concrete structures durability is one of the most vital topics in civil engineering, especially when related to the safety of radioactive waste disposal structures. The purpose of this work will consist of establishing a multi-physical behaviour model of reinforced concrete, enabling to simulate on a long scale time the structural behaviour of a tunnel subjected to mechanical loading and physicochemical degradation induced by the groundwater. For the first time, the chemical evolutions of the concrete from hydration until the chemical degradation at long term (for instance leaching of calcium) will be implemented in a mesoscopic model. This model will consider the kinetics of dissolution/precipitation of cement matrix and reflect these phenomena on the mechanical and transfer properties of concrete. Among others, the evolution of mechanical resistances, elasticity modulus, creep characteristics, permeability, and chemical diffusion properties will be considered. Then, this model will be extended to the case of reinforced concrete. This chemo-mechanical model should also allow predicting the progress of the corrosion of steel bars as a function of the chemical state of the concrete at the interface and the crack's openings. The development framework of each model component is the non-linear analytical homogenisation, which allows the mesoscopic phenomena (dissolution/precipitation of cement matrix) to be upscaled to the macroscale of concrete considering the influence of aggregates and rebars. Once the model is implemented in the finite element code Cast3M of CEA, it will be validated through the experimental results from the MAGIC WP (EURAD project). Finally, the model will be used to calculate the "Base Case" of this project, a slice of a tunnel, from the construction stage to the long-term repository of nuclear wastes. The tunnel modelling stage should allow experts and users to optimise the disposal structures design allowing comparison of several cement matrices.

Acknowledgements
The authors acknowledge the European Joint Programme on Radioactive Waste Management for its funding (EURAD). We thank the CEA/DMT/SEMT/LAMS for providing the finite element code Cast3M.

s01 PhD 012-call-eurad-s01-abs-rev01-IBRAHIM_layla

THE INFLUENCE OF MICROBIAL ACTIVITY ON SUBSURFACE TRANSPORT PROCESSES IN CEMENT AT THE PORE SCALE

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Accurate estimation of contaminant transport in cement and concrete material using numerical tools plays a key role in the risk assessments of radioactive waste disposal. At the pore scale, the increase of microbial activity on cement causes changes in solid surface topography, pore network geometry, and pore water chemistry, which affects the contaminant transport at the core scale and above. Consequently, a meaningful estimation of contaminant migration in the subsurface requires a pore-scale investigation of the influence of microbial activity on the transport processes. This study carried out as part of the MAGIC Work Package (WP) (EURAD) provides a pore-scale reactive transport model to simulate the physicochemical processes owing to microbial activity occurring at the biofilm-mineral interface in cementitious porous media. The model includes solid (cement)-biofilm interaction, solid-fluid interaction, and biofilm-fluid interaction. The numerical investigations focus on modeling the reactive transport in a flow-through cell and parameterizing rock properties (e.g. porosity and permeability) and hydrodynamic parameters (e.g. dispersivity) based on the induced modification of pore network geometry. The rock permeability of the cement is quantified using the Stokes-Brinkman model based on multi-scale digital rock physics. The advection-dispersion model is used to quantify the dispersivity based on the fit of the model to the measured data. The results show the temporal evolution of the surface topography caused by biofilm and surface interaction, which is quantified by a surrogate parameter, surface nanoroughness. The determined parameters with the influence of microbial activity contribute to the simulation of transport at larger scales to improve the predictability of contaminant transport at the core scale and above.

Acknowledgments
We gratefully acknowledge funding by the H2020 EURAD Work Package (WP) MAGIC under the grant no. 28 45219 039

s01 PhD 014-call-eurad-s01-abs-rev01-YUAN_Tao

INFLUENCE OF GLUCONATE ON THE SORPTION OF TH(IV) / PU(IV) ON HARDENED CEMENT PASTE

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In a deep geological radioactive waste repository, organic ligands can be present as cement additives in the technical barrier or as components of long-lived, low- and intermediate-level waste. Due to cement degradation over time, organic substances might be released and could influence the sorption and migration behaviour of actinides in the near field of the radioactive waste repository. Gluconate (GLU) is used as plasticizer in cement and was found to be a strong complexing component of many cement and concrete admixtures. The competition and synergetic effects in the binary system GLU / cement and the ternary system An(IV) / GLU / cement were investigated by batch experiments with hardened cement paste (HCP; degradation state I, pH > 12.5) using artificial cement pore water (ACW; 0.11 M NaOH & 0.18 M KOH) as background electrolyte. Since reducing conditions are expected in the repository, the experiments were performed with Pu(IV) and its redox stable analogue Th(IV). In experiments of the binary system (0.5 – 50 g HCP/L, c(GLU) = 1 x 10^{-2} M), an increase in the sorption of GLU on HCP up to 92% at 50 g HCP/L was observed. The sorption isotherms of GLU (c(GLU) = 1 x 10^{-1} - 1 x 10^{-9} M, 5 g HCP/L) are nearly linear. The isotherm flattens at high GLU concentrations, indicating a saturation of the sorption sites of HCP with GLU. In experiments with the ternary system, the influence of GLU on the sorption of ^{232}Th(IV) and ^{239}Pu(IV) on HCP was investigated as a function of addition order of the actinide and the organic ligand. The experiments with ^{232}Th(IV) showed that ^{232}Th was leached from HCP. This can be explained by the content of 2.8 ppm ^{232}Th in the Ordinary Portland Cement used for the HCP preparation. For the same reason, a higher ^{232}Th concentration was detected in the HCP suspensions after the addition of GLU. In the samples where Pu(IV) was added first, a sorption of about 84% and almost no sorption (S% < 1%) of Pu(IV) was observed when GLU was added first or simultaneously during a contact time of 72 h, indicating strong kinetic effects. It can be concluded that GLU has a significant impact on the sorption of An(IV) on HCP.

Acknowledgment

This work was performed within the EURAD project - WP CORI, which receives funding from the EU Horizon 2020 Research and Innovation Programme under grant agreement No 847593.

s01 PhD 016-call-eurad-s01-abs-rev01_STIETZ_Janina

THE IMPACT OF DIFFUSIVE GAS TRANSPORT ON THE GAS PRESSURE BUILD-UP IN HLW REPOSITORIES

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In the context of the disposal of radioactive, high-level waste (HLW) in underground repositories constructed in clay rocks, the generation of gas due to the corrosion of waste canisters and other metallic components is the driving force of various processes, which affect the safety of the facility. High gas production rates may lead to a gas pressure build-up, which might in turn create dilatant pathways or enhance permeability in the geologic or geotechnical barrier – the higher the gas pressure, the stronger this hydro-mechanical coupling. High gas production rates may also lead to a concentration gradient of gas dissolved in pore water, driving diffusive gas transport. In initially fully saturated clayey host rocks, these two modes of gas transport are triggered at different stages during gas pressure build-up: The advective gas transport is driven by the gas pressure gradient and requires the existence of a distinct gas phase – either by displacement of water in existent pore space or by the creation of new pathways associated with dilatancy, both of which require a significant gas pressure (Marschall et al., 2005). Diffusive gas transport, however, can take place in the water phase after the gas is dissolved and can thus occur below the gas entry pressure. In a repository with a large surface and volume –i.e. with a smaller gas source term relative to the repository size – a considerable amount of gas could be removed from the repository by dissolution and transport in the pore water, thus delaying and attenuating the gas pressure peak in the repository. Common laboratory scale gas injection tests take place on spatial scales and at pressures fundamentally different from those expected in a repository. Subsequently, gas diffusion might prove less important in a laboratory experiment but at the same time might play an important role at the repository scale. Numerical tools are ideal to address issues related to such large temporal and spatial scales. Here, we present an analysis of gas diffusion and advection at the aforementioned scales. We use the open-source finite element code OpenGeoSys-6 (Bilke et al., 2019) with two-phase two-component flow simulations to estimate and compare diffusive and advective gas flow rates as a function of gas pressure build-up, repository size and temporal scale. We analyse to what extent the transport of dissolved gas can act as an attenuator of gas pressure build-up.

Bilke, L., Flemisch, B., Kalbacher, T., Kolditz, O., Helmig, R., Nagel, T., (2019): Development of open-source porous media simulators: principles and experiences. Transp. Porous Media 130 (1), 337 – 361
Marschall, P., Horseman, S. and Gimmi, T. (2005): Characterisation of gas transport properties of the Opalinus Clay, a potential host rock formation for radioactive waste disposal. Oil and Gas Science and Technology, 60121–139

CHARACTERIZATION OF URANIUM DOPED BOROSILICATE GLASS MATRICES FOR CONDITIONING OF HIGH LEVEL RADIOACTIVE WASTES

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High-level radioactive waste produced by spent fuel reprocessing is currently incorporated into an inert host material as it mainly contains long-lived actinide elements such us Th, U, Np, Pu, Am and Cm in different chemical qualities and quantities. Borosilicate glasses are generally accepted as proper HLW isolating media [1], as they are satisfying the following major requirements: the radioactive elements become immobilized as part of the host material structure; the leaching rate of radioactive elements is acceptably low, and the encapsulation cost is acceptable. Understanding of the incorporation of actinides in borosilicate matrix used for nuclear waste storage is of a great importance for radioactive waste immobilization. This study carried out on matrix glasses doped with UO_3. New glassy samples were synthesized [2,3] with compositions (100-*x*)wt%[SiO_2-B_2O_3-Na_2O-BaO-ZrO_2] +*x*wt%UO_3, x=10,20,30,40; with the aim to clear up the correlation between structural characteristics and their thermal and glass stability. For the study of the short- and intermediate range order we have performed neutron diffraction measurements at the 10 MW Budapest research reactor using the PSD diffractometer [4] and at the 7C2 diffractometer in LLB/Saclay [5]. For data treatment the combination of the direct sine-Fourier transformation of the structure factor, S(Q) and the reverse Monte Carlo (RMC) modeling [4] have been applied to calculate the partial atomic pair correlation functions and most of the corresponding coordination number distributions. The BO_3 and BO_4 units are linked to SiO_4, forming mixed $^{[4]}$Si-O-$^{[3]}$B and $^{[4]}$Si-O-$^{[4]}$B bond-linkages. Concentration dependence was found for the BO_4/BO_3 fraction in case of high U concentration. Significant second neighbour atomic pair correlations have been revealed between uranium and the network former (Si,B) atoms. Uranium ions are incorporated into interstitial voids in the essentially unmodified network structure of the starting host glass. The μ-XRF measurements prove the homogeneity of the U-doped glasses. Concerning the release rate of uranium in the studied glass waste forms leaching tests were conducted. The leaching characteristics of the samples are similar, the leached amount of matrix elements decreased as UO_3 content increased. The results suggest that the compositions at long-term can be a good choice for waste stabilization.

The research activities presented were partly supported by the European Joint Programme on Radioactive Waste Management (EURAD) Assessment of chemical evolution of ILW and HLW disposal cell (ACED) workpackage (EU grant agreement number: 847593).

[1] K.S.Chun, S.S. Kim, C.H. Kang *Journal of Nuclear Materials* 298 (2001) 150
[2] M. Fábián, E. Sváb, Gy. Mészáros, Zs. Révay, Th. Proffen, E. Veress *J. Non-Cryst. Solids* 353 (2007) 2084
[3] M. Fábián, E. Sváb, Gy. Mészáros, Zs. Révay, E. Veress *J. Non-Cryst. Solids* **353** *(2007)* 1941
[4] E. Svab, Gy. Meszaros, F. Deak *Mater. Sci. Forum* 228 (1996) 247
[5] G.J. Cuello, J. Darpentigny, L. Hennet, L. Cormier, J. Dupont, B. Homatter, B. Beuneu *J. of Phys: Conf. Series* 746 (2016) 012020
[6] Gereben O, Jovari P, Temleitner L, Pusztai L (2007) *J Optoelec Adv Mat* 9 (2007) 3021

s01 PhD 018-call-eurad-s01-abs-rev00-TOLNAI_Istvan (idem 019)

CHARACTERISTICS OF A GLASS/STEEL/CLAY MODEL SYSTEM UNDER REPOSITORY CONDITIONS

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Deep geological disposal is considered as the safest way of long-term management of actinide containing nuclear waste (vitrified waste or spent fuel). Geological disposal involves removal of the waste from the biosphere by placing it in stable deeply inaccessible host rock formations.
Long-term exposure to repository-like conditions could result in significant alterations in the materials of engineered and natural barriers during service life. Our work aimed (i) to conduct a limited series of specific experiments to study the chemical evolution of a borosilicate glass/steel/claystone system and compare it with HLW-characteristic systems and (ii) to gain information about a system operating under conditions representative for a deep geological repository (temperature, groundwater).
A scale model system was built using close to real repository conditions, to understand the characteristics, applicability, and stability of the whole system, starting from the structural properties of the vitrified waste (in borosilicate glasses) towards the clay response in the repository. The glass/steel/clay experiments were conducted at 80°C, for 3, 7 and 12 months.
SEM/EDX investigations were focused on the composition and the nature of alteration products formed on the borosilicate glass surface, on the Fe-filling and within the clay. No variation was detected on the surface of glass grains. All main elements of borosilicate glass except B were identified after each reaction time. No secondary phases were identified. The SEM images show that the glass particles were not altered significantly due to the presence of Fe-fillings or clay.
The composition of the leaching solution is determined predominantly by the dissolving of glass and clay particles, which was investigated using ICP-OES/IC. Regarding glass particles, the obtained dissolution rate of Si and Na changed non-linearly with time, while the boron release, had a very little difference in time.
On the solid samples, X-ray fluorescence and X-ray diffraction analysis was performed. Crystalline phases connected to iron-oxide were not detected.
Details of the phase characteristics and trends of the dissolution rates will be presented.

The research activities presented were supported by the European Joint Programme on Radioactive Waste Management (EURAD) Assessment of chemical evolution of ILW and HLW disposal cell (ACED) workpackage (EU grant agreement number: 847593).

s01 R&D 019-call-eurad-s01-abs-rev00-FABIAN_Margit (idem 018)

CHEMO-MECHANICAL CHARACTERIZATION OF CEMENT PASTES IMMERSED IN MAGNESIAN SOLUTION

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Cementitious materials supposed to be used in a radioactive waste geological repository are designed to withstand various attacks or stresses for several hundred years. However, a magnesium enrichment may occur in the cement matrix at the interface with clayey rock. This enrichment has been characterized by precipitation of magnesium containing phases including magnesium silicates hydrates (M-S-H). The formation of M-S-H arises from calcium silicates hydrates (C-S-H) decalcification and raises the question of the concrete mechanical integrity where M-S-H precipitate. Characterizing physical and mechanical behavior of M-S-H formed during degradation in cement pastes is thus needed. To achieve this purpose, model cement pastes, composed by Portland cement (CEMI) and colloidal silica, were produced and placed in magnesian solutions. The magnesium enriched zones were next characterized. The mineralogical composition of the paste along the degradation has been characterized by XRD. Associated with a SEM/EDS analysis, it appears that the degradation front increases over time and consists of M-S-H precipitation only. Two concentrations of magnesium were tested (5 and 50 mmol/L). The increase of magnesium content accelerates the decalcification process and the magnesium enrichment. After 4 to 6 months of immersion in $MgCl_2$ solution, microindentation has been carried out to characterize the Young modulus of the paste along the degradation. A marked decrease in mechanical properties in the magnesium enriched zone was observed. In order to study the correlation between the microstructure evolution in the degraded zone and the decrease in mechanical properties, a characterization of the porosity (by B.E.T, mercury intrusion porosimetry, µ-tomography and autoradiography) has been achieved. The Mg-enriched zone, corresponding to the decalcified zone, has microstructural properties similar to those previously observed on pure M-S-H pastes and shows a weakened Young's modulus compared to the sound cement matrix. To distinguish the impact of M-S-H precipitation versus the impact of pure leaching on the loss of mechanical properties, it is planned to study the mechanical and microstructural properties of leached cement pastes.

s01 PhD 020-call-eurad-s01-abs-rev01-DEWITTE_Charlotte

MODELLING OF GAS PRESSURE EVOLUTION IN HLW REPOSITORIES OVER LARGE SPACE AND TIME SCALES

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Hydrogen gas generation and pressure build-up due to the corrosion of steel components in radioactive waste repositories is a major issue for the safe containment of radioactive waste in the deep underground at repository-scale over the geological time scale of one million years. The objective of the EURAD work package GAS (Mechanistic understanding of gas transport in clay materials; Task 4) is a more comprehensive understanding of gas impact on repositories, which requires the analysis of the geometries, material properties and key locations (e.g. seals) of the various national disposal concepts summarized in a generic repository exercise. Our approach consists in the identification of the technical boundary conditions of a specific repository concept and its key components like deposition tunnels, connection galleries and gallery/shaft seals with regard to their impact on gas transport processes. To assess the hydro-mechanical behavior of a HLW repository as well as of its geological and geotechnical barrier(s) in response to gas generation and pressure build-up, we model the main gas transport processes of gas diffusion and gas advection by means of the open-source finite element code OpenGeoSys-6 (OGS6). We use distinct numerical model setups and approaches to capture various processes and effects at different temporal and spatial scales. The gas pressure evolution and its peak value depend on the containment capability of and technical demands on the repository host rock and connection gallery/shaft seals. Ideally, diffusive gas transport into the host rock attenuates the gas pressure peak, whereas gas transport at pressures close to and above the confining pressure should lead to fracturing and subsequently to advective transport, which should be avoided in the safety assessment. The preliminary study of the distinct repository concepts reveals that the geometries, as well as the setups and related gas generation rates, are significantly different in space and time. These circumstances might have a noticeable effect on the magnitude of gas pressure build-up locally in deposition tunnels and galleries, at the gallery/shaft seals and at the scale of a whole repository. Here, we present our first results based on thermo-hydro-mechanical modelling considering unsaturated single-phase flow according to Richards' approximation. We kindly acknowledge funding of the EJP-EURAD project under the EC grant agreement No. 847593.

s01 R&D 025-call-eurad-s01-abs-rev01-SCHINTGEN_Tom

INTERACTIONS OF RADIONUCLIDES, ORGANICS AND CALCIUM SILICATE HYDRATES

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Organic compounds are routinely present in radioactive wastes of low and medium activity. Sources include cellulose, its derivatives and associated degradation products, waste from effluent treatment, ion exchange resins, and PVC materials and their degradation products. These compounds may form complexes with radionuclides present in the waste, enhancing their mobility by (i) increasing their solubility and (ii) decreasing their sorption onto cement-based materials. Current knowledge of cement-organic reactions in waste repository scenarios is limited despite their implications for ensuring the safe storage of nuclear waste. In this work, we study the interactions of three organic compounds, α-isosaccharinic acid (ISA), phthalate, and adipate as well as uranium with calcium-aluminium-silicate-hydrates (CASH), a hydration product of Al-rich blended cements. ISA is a principal degradation product of cellulose, an important organic component in radioactive residues of low and intermediate activity. Phthalate and adipate are produced from the hydrolysis and radiolytic degradation of PVC. All materials were prepared and handled under a N_2 atmosphere. Sorption of organic molecules was performed with a solid:liquid ratio of 10 g/L and initial concentrations of 10^{-2}, 10^{-3}, and 10^{-4} M. Two CASH phases were prepared, with initial Ca:Si and Al:Si ratios of 1.2 and 0.05 or 0.2, respectively (hereafter CASH 1.2-0.05 and CASH 1.2-0.2). No appreciable adsorption of adipate and phthalate to either CASH phase was observed over the duration of the experiment. For ISA, sorption to CASH 1.2-0.2 was limited but appreciable for CASH 1.2-0.2. Adsorption of uranium to both CASH phases at initial concentrations of 10^{-6} – 10^{-8} M indicated a log K_d value of > 5.5. In solid-free experiments, the measured solution concentration of uranium in samples originally spiked with 1×10^{-6} M uranium was ~4×10^{-7} M. The presence of ISA at initial concentrations of 10^{-3} and 10^{-2} M increased this concentration appreciably, indicating the formation of a uranium-ISA complex. This was consistent with speciation modeling of uranium and ISA in our systems. However, the commensurate addition of 10^{-2} M ISA to uranium sorption experiments did not result in a detectable increase in uranium solution concentration. Our results further highlight the complexity associated with predicting the fate of radionuclides and organics in cementitious systems.

s01 R&D 026-call-eurad-s01-abs-rev00-LOPEZ-GARCIA_Marta

STUDY OF EXISTING CHEMICAL DECONTAMINATION METHODS OF RADIOACTIVE METALS WITH A VIEW ON THEIR OPTIMIZATION

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Nuclear Power is a decarbonized method of power generation and is currently our best option in the fight against climate change. However, the radioactive waste generated from nuclear power plants and their facilities are cause of concern. Though the high level and intermediate level activity wastes are contained in small volumes (≤ 10%), significant volumes of lower activity wastes are generated. Metallic wastes are a major component of these radioactive wastes, generally made of Stainless steel 316 alloy or Inconel 600. These make up the majority of the primary circuit of a PWR plant. Under the effects of the primary circuit water and irradiation, these components undergo corrosion and the corrosion products can be carried into the reactor where they can be activated, and be transported throughout the circuit, and deposited back on the surface of other metal components, causing contamination of the latter. The contamination can be adsorbed on the surface but can also diffuse in the oxide corrosion layers. The oxide layer is multi-layered composed of an inner layer of Cr oxide under a layer of Ni and Fe oxide. Chemical decontamination is the preferred form of treatment due to the possibility of decontamination of difficult geometries found in the circuit. In order to decontaminate these materials, it is important to dissolve the oxide layers and a few microns of base metal. Some existing chemical methods including Chemical Oxidation Reduction Decontamination (CORD) and Metal Decontamination by Oxidation using Cerium (MEDOC) are studied and a few parameters to be optimized are identified to improve their efficiency. Surrogate steel and Inconel samples will be tested to optimise the processes. These samples are prepared by SORC, as a part of the PREDIS European project, using water vapour and high temperature, some in presence of boric acid after sample preparation. The effects of changing concentration on the number of cycles were seen with changes in contact times in the pipeline. A consequence of the chemical decontamination is the generation of volumes of secondary effluent waste stream that needs to be optimized. A strategy to reduce the volumes is to precipitate the metals present in solution to hydroxides or sulphides phases forming a compact sludge that can be further processed. These different precipitations need to be optimised in order to remove a maximum of metals while accounting for the Waste Acceptance Criteria (WAC) for nuclear waste.

s01 PhD 027-call-eurad-s01-abs-rev01-RIVONKAR_Aditya

EFFECTS OF AP-CITROX DECONTAMINATION TECHNOLOGY TO NI-ALLOYS

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According to the World Nuclear Waste Report of 2019 approximately 6.6 million m^3 of nuclear waste is generated over the lifetime of the European nuclear fleet. France is the lead on the list of the estimated unconditioned nuclear waste volume (operational, spent nuclear fuel, decommissioning) from European nuclear power plant fleet with 2 million m^3, followed by United Kingdom with 1.3 million m^3. The decommissioning of nuclear facilities in Europe will create 1.4 million m^3 of low- and intermediate level wastes. The successful nuclear waste management requires safe, effective, cost-effective, easy feasible and low-waste decontamination technology. In this study, the AP-CITROX decontamination technology was investigated. The effectiveness of the technology was analysed electrochemically (TAFEL, Cyclic Voltammetry) with non-radioactive stainless steel and Inconel alloy 690 samples. Before carrying out the decontamination process, oxide-layer was formed on the surface of metal samples at high-temperature in water vapour conditions. The composition of the formed oxide-layer was investigated by X-Ray Diffraction and Scanning Electron Microscope. On the basis of the results it can be concluded, that the structure of the formed, non-radioactive oxide-layer is similar to the industrial and the effect of AP-CITROX technology to the different type of metal samples is distinct. The efficiency of the technology is better in case of stainless steel sample. This results from the fact that the standard potential of the reaction was lower, the amount of the current in equilibrium was higher and the oxidizing agent reacts at lower potential in case of stainless steel. The future objective is the investigation on optimising the AP-CITROX decontamination technology of Ni-alloys.
This project has received funding from the European Union's Horizon 2020 research and innovation programme for Nuclear Fission and Radiation Protection Research (Call NFRP-2019-2020) under grant agreement No. 945098 (PREDIS).

s01 R&D 035-call-eurad-s01-abs-rev01-KATONA_Richard

Gas mixture flow modelling in a nuclear waste repository

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In a deep geological nuclear waste repository, copper waste packaging canisters positioned in saturated bentonite can corrode and, during that process, generate hydrogen gas. Hydrogen accumulation can adversely affect the integrity of an Engineered Barrier System (EBS). This study presents a numerical framework to model gas mixture flow (air, hydrogen or other gas and vapour) in thermal, hydraulic, and mechanical (THM) conditions similar to that of the repository.
The presented framework is an extension to the finite element code Thebes[2, 3] incorporating EURAD[1] specification for water retention and gaseous advective and diffusive flow behaviour.
The paper presents verification of the framework based on several simplified 2D (1x1 m^2 geometry) test simulations results obtained in Thebes and COMSOL. Each trial case is customized to focus on individual gas flow mechanisms, type of loading condition or gas mixture composition. Presented results show a good match against the trial cases and give an insight into important gas flow mechanisms.
The paper further presents an investigation of a hydrogen gas flow in a 2D model of a deposition tunnel from Zone B as per EURAD[1] specification under thermal, mechanical and hydraulically coupled repository like conditions. The results give an estimate of hydrogen production and flow throughout a repository life. Further, it shows the influence of other coupled mechanisms (hydraulic, air, thermal and mechanical) on the gas flow and overall repository behaviour.

Key Words: nuclear waste repository, Engineered Barrier System, hydrogen gas, gas mixture, thermal, mechanical and hydraulic, Comsol

Reference

1. EURAD Milestone 61 – Technical Note defining a generic repository configuration, sets of parameters, conditions and relevant indicators (2021).
2. Abed AA, Sołowski WT (2017) A study on how to couple thermo-hydro-mechanical behaviour of unsaturated soils: Physical equations, numerical implementation and examples. Comput Geotech 92:132–155. https://doi.org/10.1016/j.compgeo.2017.07.021
3. Abed AA, Sołowski WT (2020) Applications of the new thermo-hydro-mechanical-chemical coupled code “Thebes.” Environ Geotech 7:3–16. https://doi.org/10.1680/jenge.18.00083

s01 PhD 038-call-eurad-s01-abs-rev00-GUPTA_Abhishek

REDUCTION OF RADIATION DOSE WHEN STORING A LARGE AMOUNT OF RADIOACTIVE WASTE IN SURFACE STORAGE FACILITIES

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During normal operation and decommissioning of nuclear power plants, large amounts of solid (SRW) and liquid radioactive waste (LRW) are generated. To reduce their volume, LRW is evaporated, SRW is pressed, and combustible SRW is burned and then also pressed. Pressed waste, including salt melt, is placed in cylindrical containers. The activity of such containers, especially those loaded with compressed ash, is very high. To reduce the radiation dose, up to four cylindrical containers are loaded into rectangular reinforced concrete containers (RCCs). RCCs are displaced either to geologic repository or for intermediate storage to surface storage facilities.
The authors have proposed a method for reducing the radiation dose by means of specific placing of cylindrical containers in RCCs with taking into account their measured radiation characteristics. In order to increase the efficiency of waste storage and reduce radiation from the RCCs, the possibility of filling the gaps between the cylindrical containers with low-active radioactive waste, for example, salt melt, has been considered.
In addition, a combined method for calculating the radiation of □ quanta from a large source, consisting of dozens of irradiation elements of the same geometry and different activity, has been developed. Based on Monte Carlo methods, the characteristics of the radiation, produced by individual radionuclides of the RW around the RCC, have been determined taking into account the shielding by neighboring RCCs for different versions of their placement.
Versions of the storage with more than 100 RCCs in four tiers along its perimeter have been considered. A technique has been developed for minimizing the dose loads along the perimeter of the storage area at different activity of RCCs. The method of pairwise placement (mirror arrangement) of RCCs on the perimeter of the storage has been proposed to reduce the dose rate from a large-sized storage facility. The essence of the method is that primary packages with radioactive waste are loaded with a shift towards one of the corners of the container (asymmetric loading). The suggested methods have been shown to provide the radiation safety of a storage facility of about 1500 RCCs located on the territory of a nuclear power plant without any protective structures. In this case, it is sufficient to apply only a disciplining fence.

s01 R&D 047-call-eurad-s01-abs-rev00-RUDYCHEV_Yegor

Insights into the hydro-mechanical behaviour of undisturbed and remoulded Opalinus Clay subjected to gas transport processes

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Opalinus Clay formation is under consideration to serve as the host rock for the underground disposal of radioactive waste in Switzerland. Over the lifespan of the repository, the hydro-mechanical (H-M) state of Opalinus Clay will be affected by significant amounts of generated gas that are expected to migrate from waste repositories into the surrounding host rock. A comprehensive understanding of the relevant phenomena that characterize the H-M behaviour of Opalinus Clay when subjected to gas transport is required to assess the long-term safety of a repository. Despite experimental evidence that gas transport in water saturated undisturbed Opalinus Clay is controlled by the microstructure, the role of the connectivity of the macropores and heterogeneity of the intact rock matrix, as well as the nature of gas invasion in the fault gouge within factures has been poorly investigated. In this framework, we investigate the response of intact and remoulded Opalinus Clay during water and gas injection tests, in order to assess the gas breakthrough, the volumetric response and the gas-induced evolution of the microstructure. The experimental campaign uses a high-pressure oedometric cell with the possibility to perform water/gas injection tests while assessing the vertical displacement. Results on undisturbed Opalinus Clay highlight the role of the bedding planes on the H-M response of Opalinus Clay subjected to water and gas injection. A lower water permeability is observed in the direction perpendicular to bedding plane. Significant differences are highlighted regarding the gas transport properties, such as higher gas breakthrough pressure and its dependency on the gas injection rate, and lower gas flow rate in the direction perpendicular to bedding. The volumetric behaviour was characterized by expansion above a threshold gas pressure, where higher deformation was observed when gas injection was performed perpendicular to bedding. Further injection tests are being performed on remoulded material to better understand the role of the fracture gouge on the water and gas transport properties of Opalinus Clay.

s01 PhD 048-call-eurad-s01-abs-rev00-LLABJANI_Qazim

DIFFUSION AND RETENTION OF SURFACE COMPLEXING RADIONUCLIDES IN DIFFERENT IONIC FORMS OF COMPACTED ILLITE

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Clay minerals and clay rocks are both considered as natural and engineered barriers for the safe geologic disposal of radioactive waste because (among other beneficial properties) solute transport is dominated by diffusion and thus very slow. However, there are still open questions related to the underlying mechanisms of diffusive behavior of charged solutes in clays, such as the influence of pore water composition on the microstructure or on surface diffusion effects (1). According to our working hypothesis regarding a surface diffusion model involving an electrical double layer, the background electrolyte concentration has an influence on the extension of the electrical field at the basal clay surfaces and influences the mobility of cation surface species. The mobile species enriched in diffused double layer are not retarded and contribute to the diffusive flux and eventually the radiological doses. The effect of surface diffusion is expected to depend on the concentration ratio between the mobile surface species and the species in the bulk aqueous phase. The affinity of a given cation for a surface complexes in the Stern layer depends on its hydration energy (2). A set of experiments in which the type of the index cation with different hydration energy are systematically used to test our concept. Diffusion experiments with HTO and $^{36}Cl^-$ in homoionic Na^+ and K^+ illite gave a first indication that the degree of the surface charge neutralization depends on the hydration enthalpy of the background cation. Here we present the results of in-diffusion experiments with $^{57}Co^{2+}$ tracer using compacted homoionic forms of Na-, Li- and Cs-illite in variable electrolyte concentrations (0.03-0.5M) at pH ~5.5. Our results demonstrate the influence of the background cation on the distribution of mobile and immobile tracer species in the EDL. The effective diffusion coefficient of $^{57}Co^{2+}$ decreased in the order Li ≈ Na > Cs illite. As shown by auxiliary experiments, the anion accessible porosity increased in the same order, whereby approaching the value of the total porosity in the case of Cs_illite.

References:

(1) Glaus M. et al. (2015) Cation diffusion in the electrical double layer enhances the mass transfer rates for Sr2+, Co2+ and Zn2+ in compacted illite. Geochim. Cosmochim. Acta 165, 376–388.
(2) Van Loon, L.R., Glaus, M.A., 2008. Mechanical compaction of smectite clays increases ion exchange selectivity for cesium. Environ. Sci. Technol. 42, 1600–1604.

s01 PhD 049-call-eurad-s01-abs-rev01-ZERVA_Dimitra

INNOVATIVE PROGRAM FOR RADIOACTIVE WASTE DECOMMISSIONING MANAGEMENT OPTIMIZATION IN FRANCE

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In France, large-scale decommissioning program (many NPPs) planned for 2030-2040 represents a global industrial challenge by generating a potential significant volume of radioactive waste. To preserve existing radioactive waste disposal capacities, in particular volume and radiological capacities, a reflection about the overall waste management routes (characterization, sorting, processing, etc.) is ongoing between the main actors of the French radioactive waste management and decommissioning program. Within this framework, Andra, as operator of an innovative program, is supporting 29 R&D projects through a national call for proposal launched in 2015. This national call is funded by the French governmental program "Investments for the future" which aims to encouraging innovation in priority sectors to increase the growth potential of the French economy. The objective of the call is to promote innovation on the optimization of radwaste management from dismantling. Three issues are addressed: (i) preservation of disposal volume capacities thanks to radioactive waste sorting and recycling processes; (ii) treatment and conditioning of radioactive waste that are difficult to handle in disposal, such as reactive metallic waste, tritium conditioning or organic effluents processing; (iii) optimization of in situ measurements (development of new tools, or improvement of sensitivity and precision). Most of the projects will be completed by the end of 2023. The article will present an overview of these projects and their achievements, with a specific focus on their effective valorization. The article will also focus on some examples of innovative projects to illustrate, through their attainments, how this program could improve, or make easier, current radwaste management.

s01 R&D 054-call-eurad-s01-abs-rev01-FRASCA_Benjamin

In-Can Vitrification of ALPS Slurries from Fukushima Daiichi Effluent Treatment Waste using DEM&MELT Technology

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After the accident in the Fukushima Daiichi Nuclear Power Station, a large amount of contaminated water has been treated using several decontamination systems. Different natures of adsorbents and chemicals have been used in these systems and resulting wastes, called Fukushima Effluent Treatment Wastes (FETW), have been stored in Fukushima Daiichi site. The vitrification could be the most promising treatment method to package these wastes. The consortium gathering CEA (French Alternative Energies and Atomic Energy Commission), Orano, ECM Technologies and ANDRA (French national radioactive waste management agency), implemented an insitu, robust, simple and versatile In-Can vitrification process, the DEM&MELT technology. In 2021, studies have been conducted on one particular waste, coming from ALPS system (Advanced Liquid Processing System-Multi Radionuclides Removal) which generates around 70%vol. of the whole FETW volume. This waste is composed of two types of co-precipitation slurries: an iron hydroxide slurry, and a calcium carbonate and magnesium hydroxide slurry, which are treated in mixture in this study. The purpose of this paper is to highlight the feasibility of the vitrification of ALPS slurries in the In-Can process DEM&MELT, showing tests realized at laboratoryscale up to full-scale. Macroscopically homogeneous glasses were elaborated on DEM&MELT, with a waste loading in dry mass of 60%. Leaching tests and microstructural analyses were performed on the final wasteform. It gives promising results for the conditioning of FETW with DEM&MELT process. This study has been performed through a funding from the Japanese Ministry of Economy, Trade and
Industry as The Subsidy Program “Project of Decommissioning and Contaminated Water Management”.

s01 R&D 056-call-eurad-s01-abs-rev00-VERNAY_Alienor

Preliminary water purification from surfactants and organic compounds through ozone oxidation, intensified by electrical impulses

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A lot of radioactive waste (RAW) is generated by NPP during exploitation. Part of RAW is liquid radioactive waste (LRW). Now a days evaporator technology of reprocessing LRW at Ukrainians NPP is ineffective, due to LRW include surfactants (SA) and organic pollutants (OP). Research is target on purification LRW from OP and SA with using oxidation by ozone. Electrical discharges or ultrasound used for amplified effect of oxidation by ozone. Model solutions of sodium lauryl sulfate, as SA, and ethylenediaminetetraacetic acid, as OP are used in researching. The regularities of the influence of pH in the process of electrodischarge and cavitation treatment of OS solutions in the presence of ozone on the quantitative indicators of their destruction were established. The influence of the duration of the treatment process on the persistence of contaminants. The oxidation process was investigated at various concentrations of the initial materials. It has been established that the destruction of surfactants and drugs proceeds better when ozone is combined with the effects of electropulse, at high pH values. The result shows possibility to change evaporate technology to sorption with organic and inorganic sorption materials, it can be influent for decrease electricity consumption or amount of evaporation equipment.

s01 R&D 058-call-euradwaste-s01-abs-rev00-SHULHA_Oleksii (idem 059)
s01 R&D 059-call-euradwaste-s01-abs-rev00-KUBA_Ihor (idem 058)
s01 R&D 150-call-eurad-s01-abs-rev00-SHULHA_Oleksii (idem 058 and 059)

Multiscale Modelling of Radiation Induced Microstructure Evolution: Assessment of Spent Fuel Element Integrity for Prolonged Interim Storage

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Due to ongoing delays in final disposal programs, the safe and secure storage of the spent nuclear fuel (SNF) elements has become an increasingly crucial and critical aspect. The integrity of the SNF rod cladding is currently maintained by limiting hoop stress-strain and maximum temperature to certain levels. The safety function of cladding as a structural barrier may be impaired by the radiation damage and resulting radiation-induced cladding degradation in a prolonged dry storage period.
This work aims to demonstrate how radiation-induced microstructure evolution starting at the atomistic level affects the SNF cladding integrity in the long term. In this context, a multiscale simulation approach was adopted, which is entirely hierarchical and passes information and control mechanisms from atomic to microscale for radiation damage and its consequences on the macroscopic level. A computationally efficient modelling sequence has been developed and applied for microstructure evolution on irradiated cladding material (zircaloy). The results of simulations have been compared with the Transmission Electron Microscopy (TEM) measurements on the irradiated cladding material (Zircaloy-4) to verify the complex modelling sequence.
With respect to characteristic the correlations between the macroscopic material properties and microstructure configuration, the change of the material parameters like yield strength and geometrical elongation (resulting from the multiscale simulations) were investigated and compared with the structural-mechanical measurements for verification purposes. Concerning the material degradation and its impact on the integrity of the SNF cladding structure in the extended dry interim storage period (100 years), the material hardening and radiation growth resulting from the radiation-induced microstructure formation and development has been studied based on the multiscale simulation.

s01 PhD 060-call-eurad-s01-abs-rev01-YANIKOMER_Neslihan (ENEN PhD Applicant)

Analysis of impact of elevated temperature on hydro-mechanical regime in the vicinity of High-level waste disposal tunnel

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Heat load from high-level radioactive waste (HLW) packages will results in the elevated temperature around the disposal tunnel. Due to differences in thermal expansion of rock and water the redistribution of stresses will be induced subsequently. Assessment of hydro-mechanical regime is necessary to evaluate the potential of fracture development. For this it is important to evaluate the nature and extend of induced strains (reversible, irreversible), their impact on rock permeability which subsequently is important for radionuclide transport. This work is related to the benchmark activities within European joint programme EURAD work package "Influence of temperature on claybased material behaviour (HITEC)" on the near field of disposal tunnel (R=1.25 m.). Within this benchmark exercise different stress conditions and material properties (isotropic, anisotropic) were analysed with thermo-elastic material model for the Callowo-Oxfordian (Cox) clayrock in 100 m x 100 m domain. The overall clayrock system THM response to heat load is performed with COMSOL Multiphysics (USA) software. The evolution of temperature, porewater pressure, total stresses, displacements were analyzed and presented in this work.
Preliminary modelling results showed that under isotropic stress conditions and with isotropic material properties the highest temperature did not exceed 76 degrees of Celsius and was observed at the tunnel wall. Elevated temperature led to large increase in pore water pressure due to heating at the boundary of disposal tunnel from 4.6 MPa up to 10.8 MPa by the end of 10 years. Porewater pressure evolution resulted in stress redistribution and reduction of the effective compressive stresses, the modelled domain remained in compressive state except the region less than 1.5 radius away from tunnel boundary where tensile stresses occur. The displacement of tunnel boundary (wall) was 2.73 mm towards its center.
Elevated temperature under anisotropic stress conditions and anisotropic rock THM properties led to anisotropic distribution of porewater pressure, stresses. The potential for regions with tensile stress state was observed too. Simulated maximal porewater pressure at tunnel wall was higher by ~0.5 MPa compared to isotropic case. The larger displacements (3.14 mm) of tunnel boundary towards its center were observed in vertical direction than in horizontal (3.075 mm). Due to anisotropy the excavation induced porewater pressure was higher at the points close to the tunnel boundary (at distance of 2 radius), but there was no significant impact at points at larger distance (at distance of 5 radius). The temperature at tunnel boundary was also observed higher than in isotropic case by ~4 degrees of Celsius, the difference of temperature between observation points on the tunnel wall was less than 0.003%. Overall temperature distribution in the clayrock was anisotropic.

Modelling results will serve for further investigation of COx clay behavior under elevated temperature conditions.

Acknowledgement: This project has received funding from the European Union's Horizon 2020 research and innovation programme 2014-2018 under grant agreement N°847593

s01 R&D 062-call-eurad-s01-abs-rev01-NARKUNIENE_Asta

CHARACTERISATION OF THE POROSITY EVOLUTION OF CEMENTITIOUS MATERIALS IN CONTACT WITH CALCAREOUS AND MAGNESIUM-ENRICHED WATERS BY C-14-PMMA AUTORADIOGRAPHY (EURAD MAGIC)

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High-level radioactive waste is planned to be deposited into repositories constructed into deep geological formations. Cementitious materials used in the construction of nuclear waste repositories are going to be in contact with surrounding geological formations. This will result in rock pore waters of various compositions interacting with the alkaline cement pore water and the solid phases of the cement matrix via rock-water-interaction. The interactions between solid and liquid phases take place in the pore space of the materials. This interaction can lead to chemical reactions, which can affect the mechanical and structural properties of the cement, including porosity. This study is a part of two separate experiments in the framework of EURAD MAGIC, where the chemo-mechanical behaviour of cement in contact with either calcareous environment, or magnesium-enriched environment is studied. Cement samples with different interaction times from these experiments were studied with the C-14-PMMA autoradiography method to characterise possible changes in porosity. The results indicate that there were porosity changes near the interface between the cement and the surrounding waters. The porosity changes can be the results of different reactions, such as leaching of existing cement phases and precipitation of new phases. Especially in the case of a magnesium-enriched environment, the porosity in the interface zone was often twice as high as the porosity in the sound zone, with a gradual increase towards the edge of the sample. Electron microscopy was performed to confirm that these changes are concurrent with mineralogical changes. Further analysis of the porosity-mineralogical connection is planned to be studied with Stimulated Emission Depletion Microscopy, which can image porous structures on a nanometre scale, where most of the cement porosity is found. The data obtained in this work can be used as input for the chemo-hydro-mechanical modelling of cement material behaviour.

s01 PhD 066-call-eurad-s01-abs-rev01-SAMMALJARVI_Juuso

In-Can Vitrification of SPENT MINERAL SORBENTS Using DEM&MELT Technology

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The numerous constraints associated with the management of highly active nuclear waste lead to the consideration of thermal treatment solutions given that these offer multiple advantages. Thermal treatments such as vitrification processes enable volume reduction, chemical stabilization of the waste, and efficient containment of radioelements in a glassy or glass-ceramic matrix. Moreover, vitrification processes have proven their adaptability to intermediate and high-level waste and can be flexible enough to accommodate a varied waste stream. In this context, Orano, the CEA and ECM Technology, with the support of Andra through the French governmental program "Programme d'Investissement d'Avenir" have developed a new In-Can vitrification tool, called DEM&MELT. DEM&MELT is an innovative compact thermal treatment process developed and designed to match the requirements and constraints of waste streams arising from remediation or decommissioning and dismantling operations. DEM&MELT is flexible enough to accommodate uncertainties in waste composition and has been developed with a modular design adaptable to nuclear operators' needs. The process allows a significant volume reduction in addition to safe radionuclides containment with moderate investments and operating costs. This process can deal with a wide range of nuclear waste ranging from intermediate to high-level waste with different compositions and forms, including one of the most common dismantling wastes: mineral sorbents used for the radiological decontamination of effluents such as zeolites or silicotitanates. This waste must be conditioned in a safe and durable manner and its powdery nature eliminated. This poster presents the most significant results of demonstration tests performed for mineral sorbents conditioning. The results are presented with an emphasis on the process parameters, the waste loading achieved, the wasteform properties and the radionuclides volatility. The up-scaling methodology implemented to demonstrate the applicability of the DEM&MELT process to this specific waste, from laboratory-scale tests up to full-scale pilot tests, is also highlighted.

s01 R&D 069-call-eurad-s01-abs-rev00-DIDIER-LAURENT_Regis

DEPTH PROFILING OF 137CS CONTAMINATED CONCRETE: ASSESSING ERRORS THROUGH COMPUTED TOMOGRAPHY IMAGES OF CONCRETE

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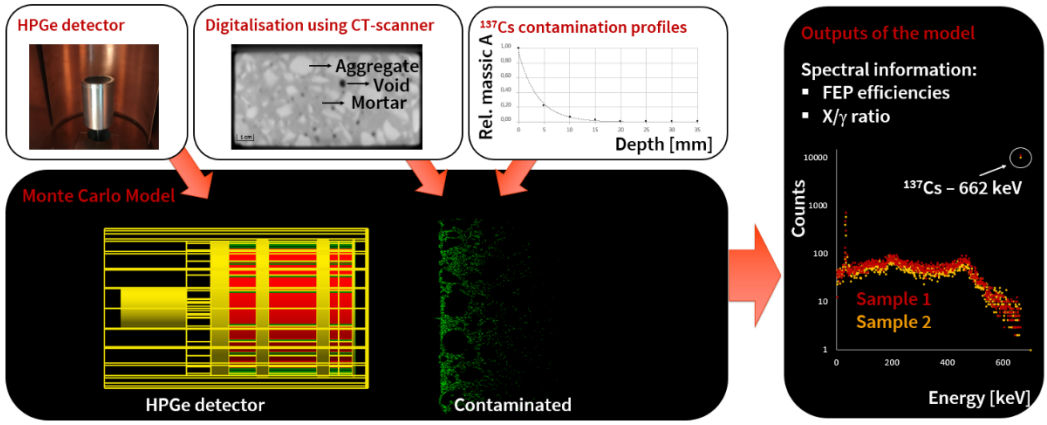
GRAPHICAL ABSTRACT



ABSTRACT

Concrete is one of the main fractions of waste resulting from D&D of nuclear installations. In order to keep decommissioning costs low, decontamination campaigns are executed to separate radiologically contaminated from non-contaminated concrete. This is achieved by firstly performing radiological characterizations, aimed at quantifying the contamination type and depth. In the next step, the concrete is decontaminated where the top layer of the concrete is removed, leaving only non-contaminated concrete behind. The success of the decontamination is determined by the performance of the used characterization technique. Underestimating the contamination depth might lead to a time-consuming second round of characterization and decontamination, whilst overestimating the contamination depth might lead to an overproduction of radioactive waste. The depth profiling technique that is the subject of this research is the relative linear attenuation model (RLA), which uses spectral data of key radionuclide ^{137}Cs to derive a contamination depth. Although this technique has been successfully applied in both decommissioning projects and environmental soil analysis, the technique has its

limitations when applied to concrete. These limitations are linked to the complex inner structure of concrete, which consisting of a mixture of voids, aggregates and mortar. Current research uses computed tomography (CT) images of concrete samples to visualize the inhomogeneous internal structure of concrete. The CT images are used in a Monte Carlo model and combined with a contamination profile. The spectral output of the MC model is used to study fluctuations in the X-ray to □-ray ratio and the detection efficiency and link back these fluctuations to the internal concrete structure. Results show that by not taking into account the internal structure, errors of up to 10% are made in both the detection efficiency and the X/□ ratio leading to a misjudgement of the contamination depth. By correcting for the internal structure, more accurate depth estimations will be possible, leading to a more cost efficient D&D.

s01 PhD 070-call-eurad-s01-abs-rev00-BRABANTS_Lowie

DEVELOPMENT OF WAC METHODOLOGY FOR GEOPOLYMER MATRICES

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The need to find new methods of radwaste disposal is due to the need to preserve and restore the environment and ensure environmental safety. One of the most promising ways to dispose of the liquid organic radioactive waste is by its conditioning in geopolymer matrices. These binders are produced by a chemical reaction between an aluminosilicate precursor and an alkaline solution to produce solids. With proper design and curing, geopolymers develop key properties to make the material highly impermeable. Geopolymer matrices have shown a high capacity to retain radionuclides in many studies.

Therefore, in our opinion, we can identify the following uses of geopolymers:
- mixing of the liquid radioactive waste in the alkaline activation solutions used for the geopolymer material;
- formation of a thin layer of geopolymer material in containers for storage of radioactive waste;
- use of geopolymer material in combination with cement to create containers.
- The practical achievement of the ability to protect the soil in the event of radioactive fallout from the atmosphere by covering the soil surface with a polymer film remains problematic.

Waste acceptance system (WAS) using geopolymer matrices is used in the PREDIS project in Work Package 2 (WP2). Work Package 5 (WP5) is developing and optimizing innovative conditioning matrices based on geopolymers for radioactive liquid organic waste, and focuses on the potential use of geopolymers. Both, WP2 and WP5 indicate that the use of geopolymer matrices is effective for safe disposal. However, the issue of waste acceptance conditions remains controversial today. Moreover, in accordance with the IAEA recommendations, the conditions for accepting waste for disposal should be specified in the waste acceptance criteria of the repository in operation or planned. Since the packaging of radwaste or the form of waste is considered as one of the engineering barriers, the criteria for acceptance of radwaste for disposal need to be established. There are general criteria for the acceptability of radwaste and specific criteria for their acceptance into a specific repository. General criterion for the acceptability of waste for disposal is a list of those parameters and characteristics of radwaste and waste packaging that need to be considered in the formulation of specific criteria for acceptance of waste in storage. Specific requirements for parameters and characteristics - acceptance criteria - are set by the operator based on the overall safety assessment of the repository.

The main constraints for the acceptability of radwaste for disposal include restrictions on the specific activity and the total amount of radionuclides in the composition of radwaste, which are determined based on storage safety assessment. It is especially important to establish quantitative limits on the content of radionuclides in a single package.

Thus, we can conclude that, except for a few countries where the waste conditioned in geopolymer are already accepted for disposal (i.e. Czech Republic, Slovakia) the use of geopolymer matrices is not broadly reflected in the criteria for waste acceptance for final disposal. Most applications of geopolymers are still under development, while others are already patented and applied at industrial scale. Therefore, it may need further research and consolidation to get geopolymers broadly accepted as waste matrix.

The PREDIS project has received funding from the Euratom research and training program 2019-2020 under grant agreement No 945098.

s02 R&D 071-call-eurad-s02-abs-rev00-PROSKURA_Ganna

SIMULATION BASED RADIOLOGICAL CHARACTERISATION OF NUCLEAR REACTORS FOR DECOMMISSIONING: DEVELOPMENT AND APPLICATION OF A HIGH–DIMENSIONAL MODEL FOR ACTIVITY ANALYSIS

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The phasing of nuclear energy utilisation in Germany results in complex decommissioning and dismantling activities at the shut-down facilities. The decommissioning process demands detailed modelling efforts in order to optimise the quantification and characterisation of nuclear waste as well as to enable radiation protection measures. During the operation, the components surrounding the reactor core such as the pressure vessel and the biological shielding are activated. The activated components are of significant effect on the amount of the radioactive waste and the dismantling strategy during decommissioning. Therefore, a detailed radiological characterization of the activity inventory is required in advance to optimise decommissioning process and waste treatment and management aiming at the minimization of radioactive waste.
Within the framework of the joint project “Development of a methodology for precise activity analysis and dose rate mapping”, funded by the Federal ministry of Education and Research, approaches the objective to develop a standardized and highly resolved method to calculate time–dependent activity of components and structures near the reactor core based on operation history of a nuclear power plant and neutron fluence distribution. The approach requires the development of a detailed model for Monte– Carlo simulations which provides the basis to neutron fluence, neutron spectra and dose rate simulations. To calculate the nuclide specific 3–Dimensional (3D) activity distribution of the entire facility, a facility–dependent activation cross section library is produced which focuses on recent nuclear databases. A highly resolved and space– dependent 3D activity distribution of the entire facility is obtained using a program package, develop at ELS RWTH Aachen University, and the activation code ORIGEN2.
The results of the activity analysis are available as 3D activity atlas for different time steps. Thus, this method can also be applied as decommissioning activity is advanced. Additionally, the results of the activity analysis are the basis for determining radiation protection measure for decommissioning.

Acknowledgement: The joint project is funded by the Federal Ministry for Education and Research (BMBF) within the framework of Research for decommissioning of nuclear facilities under the contract number 15S9409B.

s01 PhD 072-call-eurad-s01-abs--rev00-NOLDEN_Markus

DISCRIMINATION OF SURFACE AND VOLUME ACTIVITY IN METALLIC WASTE SAMPLES BY USING EXPERIMENTAL MEASUREMENTS AND MCNP MODELLING OF γ-SPECTRA

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One of important tasks for smooth and successful nuclear power plant (NPP) decommissioning process is optimization of nuclear facility metallic radioactive waste (MRW) management by applying grouping and separation of MRW. For efficient characterization of very low-level metallic waste the determination of surface contamination part is needed by simple nondestructive γ-spectrometry measurement or combination of dose rate/γ-spectrometry measurement application. The aim of this work is to investigate the γ-spectra of ^{60}Co (in case of activation) and ^{137}Cs (in case of surface contamination) sources in different metal shields environment and to find out parameters which could be used for surface and volume activity discrimination by non-destructive gamma measurement. The preliminary experiments using HPGe semiconductor and $CeBr_3$ scintillation detectors measurements of the same known-home-made different geometry metallic waste samples with ^{60}Co and ^{137}Cs sources have been performed. MCNP6 modelling of both detectors and different sample geometries of the experiments are carried out for comparison reasons. Modelling, inter-comparison of γ-spectra and analysis of the nuclide peaks and Compton scattering edges for samples with sources of ^{60}Co and ^{137}Cs in different iron shielding conditions are presented.

This work is carried out in frame of EU-funded PREDIS (PRE-DISposal management of radioactive waste) project under grant agreement No. 945098.

s01 R&D 075-call-eurad-s01-abs-rev01-LAGZDINA_Elena

GAS TRANSPORT IN MX-80 TYPE GRANULAR BENTONITE AND MICROSTRUCTURAL OBSERVATION

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In deep geological repositories for radioactive waste disposal, gases will be produced progressively due to anaerobic corrosion of metallic canister overpacks, radiolysis of water, degradation of organic matter and other processes. Thus, bentonites as a buffer/backfill material in the engineered barrier system may withstand gas accumulation and undergo gas transport. Previous studies have reported that relatively high gas pressures can accumulate in fully saturated bentonites with a monomodal pore size distribution and prepared from a slurry, leading to gas breakthrough and the consequent formation of pathways. Consequently, the isolation capacity of the bentonite for radionuclides and contaminants might be jeopardised. This problem could be improved by adopting granular bentonites GBs with an extended particle size distribution (maximum grain sizes of the order of mm). These emplaced or compacted GBs present a higher initial macroporosity than monomodal bentonites. They are more easily permeated by gas at lower pressures, impacting their pore size distribution less. However, to date, few investigations on these aspects limit in-depth understanding of the gas transport properties of GBs. For this purpose, multi-scale experiments were conducted on MX-80 type GB, including gas injections at different hydraulic states and microstructural observations before and after injection using mercury intrusion porosimetry and X-ray micro-tomography. The results show a bi-modal porosity (micro and macropores) in the as-compacted state of the GB, which does not entirely vanish even after full saturation at constant volume, although the macroporosity reduces. Furthermore, increasing the as-compacted degree of saturation causes an increase in micropores and a decrease in macropores. This reduction decreases the effective gas permeability, with the more marked effect observed in the highly saturated samples (initial degree of saturation higher than > 0.87). Even at these high saturations, the GB displays a higher effective gas permeability than monomodal powder bentonite at an equivalent dry density. Furthermore, the effective gas permeability at high degrees of saturation of GB is comparable to sand/bentonite with a mass ratio of 20/80 at equivalent porosity. This phenomenon is attributed to the granular-type nature of the tested bentonite, with many large and connected pores even at high degrees of saturation.

s01 PhD 077-call-eurad-s01-abs-rev01-ZENG_Hao

A MULTI-SCALE INSIGHT INTO BOOM CLAY SELF-SEALING ABILITY AFTER GAS EXPERIMENTS

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The understanding of the long-term behaviour of the engineering barriers in high-level radioactive waste disposals is becoming a major focus. Prominent among the more relevant long-term processes is the generation of significant amounts of gas. The accumulation and release of gases and their consequences will vary with the waste type and repository concept but need to be addressed in safety cases for all repositories. Boom Clay, an argillaceous rock candidate to host the wastes in the Belgian concept, was experimentally studied concerning the barrier integrity after gas transfer. Gas injection experiments under oedometer conditions with lateral stress measurements were performed on Boom Clay samples at different bedding orientations within a multi-scale perspective. Firstly, gas transfer was evaluated. Gas flow through preferential pathways (fissures) was deduced from the expansions recorded during the injection stages and the increase of the effective permeability. Microstructural analyses before and after gas injection revealed the opening of fissures during the gas migration and allowed getting insight into the prevailing failure mechanisms including geometric descriptors of the pore and fissure network of the damaged material. In a second stage, the self-sealing capacity of the rock, which is associated with the swelling of the clay's minerals during re-saturation, was evaluated using the same test configuration but including a final re-saturation stage. The results showed that water permeability values after this re-saturation stage were analogous to those before the gas injection, indicating no loss of the hydraulic barrier function thanks to the good self-sealing. Furthermore, the microstructural observations confirmed the closure of the gas pathways, although some small increase at the macroporosity scale was quantified, probably related to gas exsolution.

s01 PhD 078-call-eurad-s01-abs-rev00-GONZALEZ-BLANCO_Laura

SORPTION PURIFICATION OF THE AQUATIC MEDIUM FROM RADIONUCLIDES AND HEAVY METALS

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The development of efficient sorption materials is an essential and priority task for solving environmental problems linked with the concentration and migration of radionuclides, organic and inorganic heavy metal complexes. Nowadays, inorganic sorbents, which have benefits over synthetic organic ion exchangers, are increasingly being for purification water systems from radionuclides. That is explained by their strong chemical and radiation resistance, adsorption capacity. Another key indication is sorption material selectivity, which can be improved by various ways of modifying. One of these methods is based on modifying inorganic matrix by iron compounds, which increases its static volume capacity in relation to radionuclides. The most promising in this regard are aluminosilicate materials. For example, aluminosilicates of two-dimensional layered structures (clay minerals like montmorillonite, vermiculite, and others), as well as three-dimensional frame structures (natural and synthetic zeolites), can be used to remove radionuclides. Research conducted by our research group at Igor Sikorsky Kyiv Polytechnic Institute allowed the development of a number of effective sorbents for the extraction of uranium and different heavy metal compounds from natural water bodies and wastewaters. In particular, reactive permeable barriers installed on the way in the soil for groundwater flows have been used to treat contaminated groundwater. Such technologies are effective for the removal of dissolved toxic metals, radionuclides, neutralization of acidic mine waters and technological solutions, organic substances. As active loading for them, it is possible to use iron in the metallic state and its compounds (for the reduction of mobile forms of U (VI) to sparingly soluble forms of U (IV) due to redox reactions), zeolites, glauconites (sorption of mainly cationic forms of uranium), etc. One of the most important factors determining the duration of such barriers is their loss of hydraulic permeability, primarily due to the siltation of colloidal particles of organic and inorganic origin. Due to the high hydraulic permeability, the materials developed by us with a layer of iron and zeolite can significantly solve this problem. In addition, scientific bases for modification of natural clay minerals and proposed technological schemes of production of highly efficient sorbents based on them for removal compounds of Co(II), Cr(VI), U(VI), As(V) from aquatic medium.

s01 PhD 082-call-eurad-s01-abs-rev00-BONDARIEVA_Antonina

Management of cemented LL/IL waste: new tools developed and improved in PREDIS

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The EURATOM PREDIS project (www.predis-h2020.eu) targets the development and implementation of activities for pre-disposal treatment of radioactive waste streams other than nuclear fuel and high-level radioactive waste. The technical work packages align with priorities formulated within the Roadmap Theme 2 of *EURAD* (https://www.ejp-eurad.eu/), the Nugenia Global Vision (https://snetp.eu/nugenia/) and with those identified by the project's industrial End Users Group (EUG). In PREDIS WP 7, which is titled "Innovations in cemented waste handling and pre-disposal storage", several instruments and digital tools are evaluated and improved to provide better means for a safe and effective monitoring of cemented waste packages. Safety enhancement (e.g. less exposure of testing personnel) and cost effectiveness are part of the intended impact as well as improved prediction to assess the future integrity development during pre-disposal activities. The work has been triggered for example by reports on degradation of various types of packages in intermediate or final storage, e.g. by corrosion of the outer metal skin of by expansion effects of in package content caused again by corrosion or (Alkali Silica Reaction (ASR).
The work includes but is not limited to inspection methods such as muon imaging, wireless sensors integrated into waste packages as well as external. The sensors applied go beyond radiation monitoring and include proxy parameters important for long-term integrity assessment (e.g. internal pressure). Sensors will also be made cost effective to allow the installation of much more sensors compared to current practice. First prototypes are meanwhile available and are currently tested. The measured data will be used in digital twins of the waste packages for specific simulations (geochemical, integrity) providing a prediction of future behavior. Machine Learning techniques trained by the characterization of older waste packages will help to connect the models to the actual data. All data (measured and simulated) are collected in a joint data base and connected to a decision framework to be used at actual facilities. First prototypes are available here as well and will be presented.

s02 R&D 087-call-eurad-s01-abs-rev01-NIEDERLEITHINGE_Ernst

EMOS - Development of a mobile, automated, optical inspection system for radioactive drums

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Due to the delayed construction and commissioning of a German repository for low- and intermediate- level radioactive waste, waste inventories dating back several decades are now located at interim storage sites, and their safekeeping must be ensured even for an indefinite period of interim storage.
The usual practice in the interim storage facilities is recurrent inspections, which are almost exclusively carried out manually and without electronic comparative recordings or machine documentation and archiving. The remote or automated inspection does not take place. The inspections are carried out visually and are therefore very subjective and therefore subject to errors. Manual performance is labor intensive and requires the use of personnel exposed to radiation. Neither are uniform inspection criteria of the visual inspections applied, nor are the inspections performed uniformly between sites.
Based on these facts, the Institute for Technology and Management in Construction, Department of Deconstruction and Decommissioning of Conventional and Nuclear Buildings, is developing an automated drum inspection system within the framework of the funding measure FORKA - Research for the Deconstruction of Nuclear Facilities and in cooperation with the Institute of Photogrammetry and Remote Sensing (IPF) of KIT. This procedure makes it possible to determine and document the current condition of individual drum containers in a uniform reproducible manner. Research and development work within the project will help to increase the safety of extended interim storage.
The new inspection system EMOS - Development of a mobile, automated, optical inspection system for radioactive drums - is listed under the “Bundesministerium für Bildung und Forschung” funding and will be processed in the period from 2020 to 2022.

s01 R&D 088-call-eurad-s01-abs-rev01-RENTSCHLER_Eric

Microbial composition of the 3-years-old low-pH SURAO concrete used as an input material for the EURAD WP MAGIC

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Deep geological repositories (DGR) for radioactive waste must fulfil the highest demands on the long-term safety. The whole architecture should provide a chemical and physical barrier against the deterioration up to a thousand years. One of the main construction components of the DGR is concrete. The increasing mechanical strength of concrete in early stage need to be maintained also in post-closure phase. Alterations in chemistry of concrete caused by siliceous aggregates or ettringite formation might significantly impair the mechanical strength of concrete. Moreover, the presence of microbes might play a significant role in the maintenance of safety levels in DGR, too. The underground water, buffer and backfill matrix (e.g. bentonite) have unique chemistry and are also primary and long-term sources of bacteria that are transported via the pore system and cracks in concrete and might affect the mechanical strength of the concrete samples. EURAD work package MAGIC is focused on the chemo-mechanical behavior of concrete under different conditions. The Czech team uses pieces of hardened low-pH concrete samples (3 years aged at Underground Research Laboratory Bukov) which are further subjected to artificial aging in different environments in *in situ* conditions in Bukov. Our aim is to evaluate the microbial changes in and on the concrete samples in respect to the different environments. Here, we introduce the Czech project and show preliminary data on microbial composition of the aged concrete samples.

s01 R&D 090-call-eurad-s01-abs-rev00-LE_Trung

METALLIC RADIOACTIVE WASTE CLASSIFICATION FOR THE DIFFERENT TYPES OF REACTORS CONSIDERED IN PREDIS

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The radioactive waste management and disposal strategy are the major issues, which are important for each member state having operating nuclear power plants (NPP) or NPP under decommissioning. Depending on reactor type and also NPP operation, metallic radioactive waste (MRW) usually has a wide list of radionuclides of different concentrations. General estimations suggest that up to two-third of the NPP waste resulting from decommissioning and dismantling is radiologically unrestricted material i.e. exempt waste. The remaining one-third is radioactive material with different activity levels. The MRW has to be collected, segregated between different MRW types, characterized, treated, stored and finally disposed of in special disposal facilities.

The main aim of the 4.5.1 subtask of PREDIS is to provide a scheme for the classification of the reactor metallic materials regarding the level of activation: highly activated, intermediate, low activation metal constructions and non-activated materials in order to facilitate decision on the detailed procedures of decontamination and clearance or declassification. The studied and recommended methodology for characterization of the metallic waste is similar for all reactors and bases on nuclide vector (NV) determination. An essential part of the characterization is the separate determination of activation activity and contamination activity to identify the best way of management.

The main steps include:

- Pre-dismantling: classification of MRW using (MCNP6/SCALE6.2) modelling obtaining neutron activation map in the 3D of reactor core and peripheral hardware (experience in RBMK, PWR reactors).
- Detailed characterization: measurements of MRW during dismantling applying nondestructive and destructive measurement techniques (for validation of modeling and for surface contamination and radioactivity induced by activation analysis).
- Optimized characterization: determination of Nuclide Vectors (NV) for MRW stream.

The analysis of modeling and experimental data of different reactors (the RBMK (IAE), the BWR (KKP1) and PWR (GKN I)) helped to reveal the main components of classification scheme which could be improved. Together, modeling and experimental measurements allowed separating waste streams to homogeneously activated MRW,

mixed (bulk and surface contaminated) MRW and surface contaminated metallic waste (RBMK example).
The optimized classification scheme of MRW will contribute to development of safer, more efficient, cost-effective, and environmentally friendly handling of radioactive wastes. At the end of the project recommendation for optimized classification of the metallic waste will be assessed including determination of activation and surface contamination activity terms (applying new nondestructive technique from 4.5.2 subtask), estimation of possibility of decontamination: clear or declassify after specific decontamination process (radiochemical treatment from 4.5.3 subtask).

s02 R&D 091-call-eurad-s01-abs-rev00-PLUKIENE_Rita

INTERACTIONS AND MIGRATION OF ORGANICS (EDTA & PHTHALATE) IN CEMENT BASED MATERIALS IN WEATHERING STATE II AND IV

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Analysing the fate of organics in cementitious environments is a key requirement in order to understand and model the behaviour or radionuclides (RN) in cementitious barriers in radioactive waste disposal. Cement-based materials will degrade over time and induce a large range of alkaline pH conditions while organics are released from radioactive waste. This can cause a shift in RN solubility and decrease RN sorption. This study investigates the interaction and migration of EDTA (Ethylene-Diamine-Tetra-Acetic Acid) and phthalic acid in hardened cement paste (HCP) CEM V/A in weathering State II (corresponding to the portlandite, $Ca(OH)_2$ buffer, pH = 12.5) and State IV (carbonated state, pH = 9.5). The interaction and migration of organics ligands were studied using ^{14}C labelled organics tracers in batch sorption and in through-diffusion experiments, respectively. The batches with State II are performed in a CO_2-free glovebox and those for State IV in air. Two diffusion cells are setup in through-diffusion mode in artificial cement-porewater (ACW) State II. One reference cell contains the epoxy-glue used to attach the HCP discs in the sample-holder. The second cell contains an HCP disc with HTO as diffusion reference tracer and ^{14}C-EDTA. In addition, the systems were modelled with PhreeqC[1] (geochemical modelling) and I-MODE (Interpretation Model of Diffusion Experiment, numerical tool developed at CEA[2]). A distribution ratio (R_D) of 80-90 L/kg was measured for EDTA and phthalate in HCP State II after 30 days. The R_D is a factor 4 lower, ranging between 20-25 L/kg, in State IV. The R_D decreases with a factor 3-4 above 10^{-5} M for both for EDTA and phthalate in both HCP states. The kinetics are more pronounced for EDTA. In the reference diffusion cell no significant activity was measured at the downstream compartment after 60 days. In the second cell, the activity of HTO has reached the downstream reservoir after 2 months, however, far from steady state of diffusion. First data treatments leads to a prediction of the apparent diffusion coefficient $D_{app(HTO)}$ 7.3 10^{-13} m²/s. In conclusion, the sorption of the organics to the HCP decreases with an increase in the weathering state and concentration of organics. Future work will focus on experiments in ternary mode HCP-RN-ORGA and addition of RN, ^{238}U or ^{63}Ni in presence of organics in diffusion cells.

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847593, EURAD WP3 CORI.

References

[1] Parkhurst, D. L., and C. A. J. Appelo. (1999) “User’s Guide to PHREEQC (Version 2) - a Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations.” Rapport U.S. Geological Survey. Lakewood, Colorado (U.S.A
[2] Macé, N., P. Fichet, S. Savoye, J. Radwan, C. Lim, S. Lefèvre, J. Page, and P. Henocq. (2019) “Use of Quantitative Digital Autoradiography Technique to Investigate the Chlorine-36-Labelled Radiotracer Transport in Concrete.” Applied Geochemistry 100: 326–34

RETENTION OF REDOX-SENSITIVE TC(VII) ON FE(II)/FE(III) BEARING CLAY MINERALS

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Clay minerals are the main component of the engineered barriers and the argillaceous host rocks considered in several deep geological repository concepts. Clay minerals may contain significant amounts of Fe^{II}/Fe^{III} incorporated into mineral structure or adsorbed on the surface. Some fraction of this iron can act as redox partner for redox sensitive radionuclides affecting their mobility and (bio)availability in specific oxidation states. Here, we will systematically address the retention of the redox-sensitive fission product ^{99}Tc by clays with varying Fe^{II}/Fe^{III} ratio and total Fe amount. Tc in its most oxidized heptavalent anionic form (TcO_4^-) is highly mobile, whereas it easily precipitates as rather insoluble $TcO_2{\cdot}nH_2O$-like species in its most reduced (in water), tetravalent oxidation state. A few studies have shown that Fe-bearing minerals are able to catalyse this reduction/precipitation process, but the exact nature of the (surface) precipitates, the geochemical formation conditions as well as the mechanism of the redox reaction are not fully understood [1-3]. Therefore, this study focuses on the Tc sorption and electron transfer behind the redox reaction. A family of 2:1 di-octahedral clays with different Fe content, nontronite (20 wt_{Fe}%), Wyoming montmorillonite (2.6 wt_{Fe}%), and Texas montmorillonite (0.5 wt_{Fe}%), were reduced to different Fe^{II}/Fe^{III} ratios. As expected, no Tc sorption was observed on non-reduced clays, whereas strong sorption was observed on all reduced clay minerals. The sorption was observed to increase with increasing Fe content. By combining Tc K-edge extended X-ray absorption fine structure (EXAFS) spectroscopy, mediated oxidation and reduction experiments (MEO/MER), Mössbauer spectrometry, and (high-resolution) transmission electron microscopy, we aim at discriminating the contributions of the different Fe^{II}/Fe^{III} ratios to the overall adsorption process and the

reduction of Tc and at identifying the surface products. The results of this study are expected to improve our understanding of the Tc retention on Fe^{II}/Fe^{III} bearing clay minerals, and thus contribute to a more reliable prediction of the Tc retention in radioactive waste repositories.

References:

1. Jaisi, D.P., et al., Reduction and long-term immobilization of technetium by Fe(II) associated with clay mineral nontronite. Chemical Geology, 2009. 264(1): p. 127-138.
2. Brookshaw, D.R., et al., Redox Interactions of Tc(VII), U(VI), and Np(V) with Microbially Reduced Biotite and Chlorite. Environmental Science & Technology, 2015. 49(22): p. 13139-13148.
3. Peretyazhko, T., et al., Heterogeneous reduction of Tc(VII) by Fe(II) at the solid–water interface. Geochimica et Cosmochimica Acta, 2008. 72(6): p. 1521-1539.

s01 PhD 094-call-eurad-s01-abs-rev01-QIAN_Yanting

RADIOLYTIC AND HYDROLYTIC DEGRADATION OF A POLYARYL ETHER SUPERPLASTICIZER

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Superplasticizers are organic cement admixtures often used in construction to improve the properties of concrete. The engineered barriers in radioactive waste repositories frequently include cementitious materials. Consequently, superplasticizers considered to be used as additives in concrete barriers in repositories, represent a concern in the long-term safety assessment of radioactive waste disposal as their degradation products might affect the transport properties of radionuclides. This study presents the radiolytic and hydrolytic degradation of a commercially available PolyAryl Ether (PAE) superplasticizer. Raw and freeze-dried superplasticizer samples were irradiated in the Jožef Stefan Institute TRIGA reactor in shutdown conditions to gamma doses up to 3.2 MGy. Sample aliquots were taken at different doses to determine the degradation process of the irradiated superplasticizer. In addition, a hydrolytic degradation study was performed in 0.1 M NaOH to investigate the effects of an alkaline environment on the studied superplasticizer. Raw and degraded samples were characterized by Fourier-Transform InfraRed spectroscopy (FTIR), Nuclear Magnetic Resonance (NMR) and Size-Exclusion Chromatography (SEC). The results suggest that at an accumulated dose of 0.6 – 0.8 MGy, crosslinking of the backbone occurs, visually observed as gelation of the liquid superplasticizer sample. Crosslinking is followed by cleavage of PolyEthylene Glycol (PEG) side chains at 2 MGy. Similarly, the PEG side chains were cleaved off the superplasticizer's backbone during the hydrolytic degradation.

s01 PhD 097-call-eurad-s01-abs-rev01-GAJST_Tamara

Replacing Pulversized Fly Ash in cement with natural and anthropogenic geomaterials identifying the corresponding physico-chemical properties used for the encapsulation of Low-Level Waste

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Clinker substitutes are frequently used in the cement and concrete industries to reduce CO2 emissions associated with production, improve physico-chemical properties and performance, and reduce costs. Pulversized Fly Ash (PFA), a fine waste residue produced in coal-fired power stations, is the commonly used partial clinker substitute in Ordinary Portland cement (OPC) for cements for the immobilisation of low-level radioactive waste (LLW). Because of the global trend to shut-down coal-fired power stations, the production of PFA is decreasing and will eventually cease. Alternative sustainable clinker substitutes can be used and must meet strict performance standards for the safe enclosure of LLW for the final disposal. These include physical, chemical, and mechanical properties, performance and suitability for use. This study investigates the suitability of different materials (natural and anthropologic) as a substitute of PFA in OPC in LLW immobilisation, and compares the behaviour of these substituted cements to those of the current standard. The focus of the study is on the cementing and physico-chemical properties of the cement, and the interaction between groundwater, the cement, and the encapsulated waste. Here we present the characterisation of the standard PFA+OPC (samples provided by Low-Level Waste Repository Ltd.) using X-ray computed tomography (XCT), and the latest data from the ongoing analysis elemental composition of the alternative materials and the leaching tests. Over the leaching period the samples undergo repeated XCT analysis to link structural changes to the chemical evolution. Future work will include studying the long-term leaching effects and the interaction of the LLW (usage mock waste formulation) with concrete. These studies will allow us to identify changes to the cement microstructure and physico-chemical properties arising from the PFA substitutes, and the chemical and physical interaction of the cements, especially with groundwater Such understanding is critical for the adoption of clinker alternatives in LLW encapsulation.

s01 PhD 101-call-eurad-s01-abs-rev01-KOZLOWSKI_Andrea

FORMATION OF TERNARY ALKALINE EARTH/URANIUM/CARBONATE COMPLEXES. THERMODYNAMIC DATA AND THEIR INFLUENCE ON URANIUM SPECIATION AND SOLUBILITY IN DIFFERENT GEOCHEMICAL ENVIRONMENTS

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The formation of carbonato complexes of uranyl(VI) is of great importance for the understanding of the chemistry and transport of uranium. The ternary alkaline-earth triscarbonato-uranyl complexes, $M_n[UO_2(CO_3)_3]^{(4-2n)-}$ ($M = Mg^{2+}$ and Ca^{2+}), evidenced in the late 1990's, can control the uranium chemistry and its solubility and adsorption properties in various environments, including deep geological disposal, surface waters, and seawater. However, thermodynamic data for these ternary complexes are still a matter of debate. In addition of alkaline-earths, the influence of alkaline cations is not clearly settled between the ionic strength effect and the influence on the structure of complexes. The aim of this research is to clarify the existence domains of $M_n[UO_2(CO_3)_3]^{(4-2n)-}$ complexes as a function of ionic strength by studying the additional influence of alkali ions. Time-resolved laser spectrofluorimetry (TRLFS), a highly sensitive technique to probe the characteristic features of uranium species, was chosen as the analytical technique. The quantification of $M_n[UO_2(CO_3)_3]^{(4-2n)-}$ complexes from luminescence measurements was done for laboratory analysis. The presence of the studied complexes in the synthetic samples can be verified by their characteristic bands and decay times. In this work, the thermodynamic data with respect to temperature and ionic strength for the $(Mg/Ca)_nUO_2(CO_3)_3^{(4-2n)-}$ complexes in NaCl et $NaClO_4$ media are very useful for estimating the effects of temperature and salinity on the speciation of U(VI), especially in nuclear waste repositories, and for filling in the gaps in the thermodynamic database for these complexes.

s01 PhD 104-call-eurad-s01-abs-rev00-SHANG_Chengming (ENEN PhD Invited)

DEVELOPMENT OF A SIMPLE GLASS MATRIX FOR RADIOACTIVE WASTE CONDITIONING

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High level radioactive actinides are produced as a side product during reprocessing spent nuclear fuel, for which safe, long-term and inert immobilizer matrices are needed. Such a technology in radioactive waste management is called vitrification, and most commonly uses various borosilicate glasses for matrix [1]. Therefore, developing new borosilicate glasses is of great importance in the research aiming to find the most suitable inert materials for radioactive waste immobilization.

To achieve this, understanding the effects caused by adding a large amount of actinides to a borosilicate glass matrix is one of the most important research goals in this field. Here we present a new, simplified borosilicate glass-matrix [2] –SiO_2-B_2O_3-Na_2O-BaO-ZrO_2 – together with studies of the structure when loaded with UO_3 and various lanthanide (Ln-) oxides: CeO_2, Nd_2O_3, Eu_2O_3 [3,4]. Such a study serves to investigate the effects of uranium, while the lanthanides (Ln) are taken as chemical surrogates for actinides.

In order to synthesize such a novel glass matrix, first we studied the atomic structure of these new glass compositions and investigated the possible routes to incorporate various actinides/lanthanides combinations into the matrix. To obtain the most accurate information about the structure, information collected from different methods (X-ray and neutron diffraction, Nuclear Magnetic Resonance spectroscopy) were combined, and the atomic parameters were calculated via Reverse Monte Carlo simulations. Furthermore, the morphology was investigated by SEM/TEM microscopy, the leaching of the components was exploited by ASTM protocol. The elemental compositions of the multi-component glasses were verified by Prompt Gamma Activation Analysis. The effect of uranium oxide and lanthanide oxides (as chemical surrogates of actinides) on the structure of borosilicate host glasses has been studied as well with similar methods.

It is shown that the new borosilicate-matrix composition is able to incorporate both actinides and Ln ions in high concentration, opening a new and economical way to radioactive waste immobilization.

Details of the structural characteristics and chemical properties will be presented.

[1] K.S. Chun, S.S. Kim, C.H. Kang *J. of Nucl. Mat.* 298 (2001) 150
[2] M. Fábián, E. Sváb, Gy. Mészáros, Zs. Révay, Th. Proffen, E. Veress *J. Non-Cryst. Solids* 353 (2007) 2084
[3] M. Fabian, F. Gergely, J. Osan, T. Cendak, S. Kesari, R. Rao *Sci. Rep.* 10 (2020) 7835
[4] M. Fabian, F. Pinakidou, I. Tolnai, O. Czompoly, J. Osan *Sci. Rep.* 11 (2021) 13272

s01 R&D 105-call-eurad-s01-abs-rev00-MARGIT_Fabian (NIP HLW-MATRIX, see 018-19)

IMMOBILIZATION OF SPENT NUCLEAR GRADE RESINS IN LOW CARBON CEMENT: STUDY OF THE REACTION KINETICS.

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Ion exchange resins are widely used to purify liquid effluents from nuclear power plants, representing the largest contribution in volume and activity to the inventory of intermediate- and low-level radioactive waste in Spain. Once saturated, the spent resins are managed by their immobilization in Ordinary Portland cement (OPC) matrixes. However, OPC production entails significant energy costs and a carbon footprint, as well as an environmental impact due to the mines necessary to extract its raw materials (limestone and clay). For this reason, this work studies a more sustainable immobilization solution by replacing 100% of the Portland clinker with other sources of aluminosilicates that are by-products of other industries (blast furnace slag from steel production and fly ash from coal combustion). In absence of the Portland clinker, it is necessary the use of an alkaline activator to obtain a material with good binding properties, in this work powder sodium silicate (7% by weight). These greener and alternative formulations are called Alkali-Activated cement. Ion exchange resins can be incorporated into the main reaction product (gel) structure or locked in the lattice of zeolites or secondary reaction products. To assess the behaviour of these new formulations in the presence of spent resin, the kinetics of the reaction is analysed by isothermal calorimetry. Three different slag/fly ash blend proportions have been evaluated (100% slag, 85% slag-15% fly ash, 70% slag-30% fly ash). The percentages of spent resin incorporated are set with the logistics requirement of setting must initiate in the first 24h, so setting time of the different formulations has also been evaluated through Vicat needle test. The maximum amount of spent resin with viable setting is 12.5% resin/binder for 100% slag formulation, 10% for 85% slag-15% fly ash, and 5% for 70% slag-30% fly ash. The heat release curves show that the acceleration/deceleration peak corresponding to gel formation shifts to longer times with lower intensities and broader peak shapes as fly ash and resin content increase. The location and the intensity of the acceleration peak have been modelled using lineal regression, in order to enable the simulation of the reaction with other requirements.

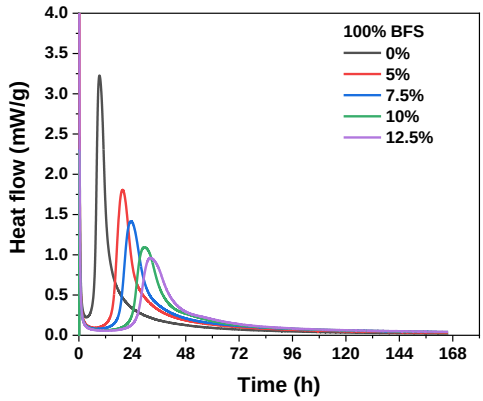

Figure 1 – Heat flow of the alkali-activated 100% slag paste with an incorporation of 5, 7.5, 10 and 12.5% of spent ion-exchange nuclear grade resin.

s01 PhD 106-call-eurad-s01-abs-rev00-DE-HITA-FERNANDEZ_Maria-Jimena (idem 155)
s01 PhD 155-call-eurad-s01-abs-rev01-FERNANDEZ_Maria-Jimena (idem 106)

INNOVATIVE OXIDATIVE TREATMENT AND GEOPOLYMER. ENCAPSULATION OF SPENT MIXED BED ION EXCHANGE RESINS

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Several nuclear industrial applications are currently using ion-exchange resins (IERs). Organic cationic and anionic resins are mainly employed for chemical control of water and radioactivity removal during power plant operations, but also for decontamination of liquid waste streams during decommissioning stages. Upon used, IERs are usually replaced to reduce the amount of generated radioactive liquid waste. However, this approach is involving the production of large volumes of exhausted organic resins. To safely dispose of this low or intermediate level waste, processes more reliable than direct encapsulation of spent IERs in Ordinary Portland Cement (OPC) are being developed. They point to overwhelm the challenging nature of the waste due to swelling, flammability, dispersivity, and potential radionuclides leachability, and to minimize volumes of the final waste package, processing costs and environmental footprint.

The focus of this work is on the development of a Fenton-like wet oxidation process that consists of an exothermic reaction of a catalyst and an oxidant by the production of reactive radicals that decompose organic matter. It is being considered more attractive due to low oxidation temperature (< 100 °C), non-toxic catalyst and green oxidant. The appropriate tuning of catalysts ($FeSO_4 \cdot 7H_2O$, $CuSO_4 \cdot 5H_2O$) and oxidant (H_2O_2) amounts allowed the treatment of a mixed resin bed system. The successful decomposition of about 100 g of a surrogate waste loaded with Cs, Co, Sr, Ni, Cl, and I as representatives of activation and fission products contamination, has led to a scaleup of the process (about 200 g of resins). The temperature and colour shift of the solution have been helpful to monitor the oxidation evolution. The moist and brownish residue downstream of the evaporation process underwent a geopolymeric encapsulation. The sustainable formulation involves the activation with sodium hydroxide of highly zeolitized tuff and recycled industrial by-products, to provide high pozzolanic reactivity, high durability, chemical and thermal stability in compliance with the Waste Acceptance Criteria. The process showed promising weight reduction rates and organic matter decomposition as proved by Chemical Oxygen Demand measurements. Besides, inorganic compounds have been identified in the final residues by X-Ray Diffraction, Fourier Transform Infrared, and Raman analyses, while a satisfactory retention of the contaminants was demonstrated by ICP-MS. In the future, a new process scale-up will be pursued to manage 1 kg of spent resins.

Acknowledgement
This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 945098.

NON-DESTRUCTIVE MATERIAL CHARACTERIZATION OF RADIOACTIVE WASTE PACKAGES WITH QUANTOM®

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The nuclear and non-nuclear industry has produced a considerable amount of low and intermediate level radioactive wastes during the last decades. The material characterization of waste packages recently became more and more important in order to dispose of these waste packages in a final underground repository. Material characterization remains an indispensable criterion to prevent pollution of the ground water with toxic materials and is required in Germany by the national licensing and supervisory authorities.
Information on the nature of waste materials can be obtained on the basis of existing documentation or, if the documentation is insufficient, on further destructive or non-destructive analysis. Non-destructive methods are to be preferred to minimize radiation exposures of operating personnel as well as costs. An innovative non-destructive measurement system called QUANTOM® (QUantitative ANalysis of TOxic and non-toxic Materials) has been developed. It is based on the prompt and delayed gamma neutron activation analysis (P&DGNAA). This technology is able to identify, verify and quantify the amount of hazardous and non-hazardous substances (Cd, Cu, B, Pb, Hg, Fe, Al …) in radioactive packages such as 200-l radioactive drums, which is required for a final disposal characterization. The technology can also be applied for other smaller or larger volumes.
The first prototype of QUANTOM® is already in operation since 2020. The validation phase has been performed in 2021: non-radioactive drums filled with different reference materials have been measured and analyzed with QUANTOM®. Samples of these reference materials have also been analyzed by means of the same technology (P&DGNAA) at the research reactor of Budapest. A comparison of those results for several materials is presented. First results show a good agreement between QUANTOM® and standardized reference analyses.
The main benefits of QUANTOM® are summarized below:

- Non-destructive multi-element analysis with high sensitivity (ppm-range) of the entire matrix
- Fast measurement process (2h-4h per waste drum) with high measurement precision
- No repackaging and no increase of waste volume
- Reduction of costs (min. 50% per waste drum) compared to destructive analysis processes

- Minimizing the transportation of radioactive waste drums and radiation exposure of the operation staff.

The DEM&MELT Technology: a robust, simple and versatile process for the in situ vitrification of D&D waste

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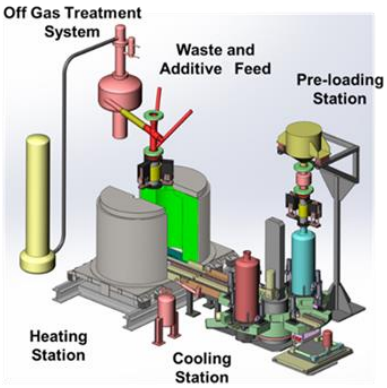
DEM&MELT is a new robust, simple and versatile *in situ* vitrification process designed to meet the requirements and constraints of decommissioning and dismantling (D&D) projects. It is suitable for the treatment of intermediate to high level waste and is compact enough to be implemented in an existing installation or near the waste to be treated. DEM&MELT provides significant waste volume reduction, waste stabilization and safe containment of radionuclides in a dense, stable and durable glass matrix. DEM&MELT treats solid, powdery, liquid, sticky and pasty waste and is flexible enough to accommodate uncertainties in waste composition. It is designed to produce a small amount of secondary waste. During the thermal treatment, the waste canister is heated by a robust resistive furnace offering a wide operating temperature range up to 1150°C and the canister is directly used as a melter, making DEM&MELT an “In Can” process. It provides efficient temperature control and excellent volatility management thanks to a high-performance off-gas treatment system. DEM&MELT benefits from mature, proven and qualified technologies, from upstream to downstream functions, and is based on more than 40 years of high-activity operation by Orano and the CEA. DEM&MELT has a modular design, fully adaptable to the requirements of nuclear operators and has low investment and operating costs. The process can be operated hands-on or remotely: all nuclearization aspects have been taken into account in order to propose two industrial designs depending on the waste activity. A DEM&MELT scale 1 pilot unit was built on the CEA Marcoule site and commissioned in November 2020. The technology has been tested with surrogate waste of various types: α-contaminated effluents, fission products, zeolites, various mineral adsorbents, ash and sludge.



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MODEL-BASED APPROACH FOR THE STUDY OF NUCLEAR WASTE TREATMENT SCENARIOS

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In the context of the nuclear industry, engineering of dismantling and waste management projects remain difficult to master and drive. These are increasingly complex from a technical and organisational point of view for a variety of reasons, (large number and multiple roles of the domain actors, long duration) but especially because of the complexity to gather, characterize and freeze a set of dimensioning input data (evolution and change of stakeholders' expectations, knowledge of facility, …). To secure the delivery of decommissioning and waste management projects, it is necessary to identify and respond quickly to changing input data. To address this complexity Model-Based Systems Engineering (MBSE) approaches can replace today's traditional document-centric engineering approach and ease change management during a project. They promote modelling, models and data management principles that are largely used in several other domains with success. Moreover, these approaches enables creation of a structured set of data, organized through various criteria, and above all, enabling request and extraction. Subsequently, those processes enabled us to develop a rule engine automatically computing some of dismantling process key parameters from input data. By applying these principles to nuclear waste management infrastructure projects, we have developed a model-based approach for the study of nuclear waste treatment scenarios. Based on a meta-model and through shared languages we have been able to experiment a 40% time saving on the treatment of changes impacting the design. It represents 10% time saving on the whole project. Based on this first proof of concept and the encouraging results, the scope of the approach will be extended to simulate all types of properties of the scenario under study.

s02 PhD 116-call-eurad-s01-abs-rev00-BOURDON_Jeremy

DEVELOPMENT OF CONCRETE BLOCKS REINFORCED WITH MICRO/NANO PARTICLES, FOR DUAL PROTECTION AGAINST GAMMA AND NEUTRON RADIATIONS

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The fabrication and arrangement of convenient radiation shielding materials is usually considered as a crucial step toward the protection of staff, public and environment from the harmful effects of ionizing radiations. Due to the deep penetrative property of the neutron and gamma, the current shield design in nuclear reactor and waste disposal facilities is very massive and bulky, required a lot of concrete. However, a compact shield design is very beneficial both technologically and economically. The main objective of the current idea is dedicated to the development of innovative nano particles as an additive to reinforce the radiation shielding properties of the concrete as a common main shield material. These micro or nanoparticles are mostly selected among the high density absorbent elements and their compounds are used to enhance the radiation shielding properties. In mixed neutron and gamma fields, an innovative nanoparticle contains simultaneous neutron and gamma absorbers as a single material leading to an in situ absorption and saves the required shielding material. On the other hand, in gamma and X ray fields the reinforced concrete blocks can be employed instead of the current environmentally toxic lead blocks. The proposed idea reduces the volume and thickness of required shield, which is economically attractive for the industry. Simulation as well as experimental studies endorsed that the employment of PbO particles in pure photon fields and PbO-H3BO3 in mixed neutron and gamma fields enhances the radiation properties of the ordinary concrete.

s01 R&D 128-call-eurad-s01-abs-rev00-KHERADMAND_Mohsen (NIP KH2021)

ADVANCED RADWASTE CHARACTERISATION BASED ON TOMOGRAPHICALLY ENHANCED RADIATION IMAGING WITHOUT X-RAYS (ARCTERIX)

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We present a newly developed technique for non-destructive assay (NDA) of radioactive waste called ARCTERIX (Advanced Radwaste Characterisation based on Tomographically Enhanced Radiation Imaging without X-rays). The concept is based on a novel 3D radiation imaging modality for special nuclear materials (SNM) - neutron-gamma emission tomography (NGET)[7] , [8]. ARCTERIX takes the NGET principle from its original application area of nuclear security systems into the realm of radioactive waste assay with its special characteristics and challenges. By adding localisation and imaging of SNM inside shielded waste containers to the array of existing techniques used for radioactive waste characterisation, ARCTERIX aims to complement the state of the art in passive and active NDA interrogation methods. It is aimed primarily at the class of mixed, long-lived radioactive waste that is commonly called “legacy” or “historic waste” which has special safety, security and safeguards concerns due to its mixed composition, commonly poor documentation, and the frequent presence of SNM. However, a detection system featuring the NGET imaging modality might be applied to radioactive waste characterisation in general, potentially including verification of spent nuclear fuel and other types of high-level waste suspected of containing SNM. An advantage of the ARCTERIX concept is that it provides rapid imaging and characterisation of nuclear materials in radioactive waste that enables a high degree of automation and high throughput capabilities. This would make it possible to quickly scan large radioactive waste inventories for the presence of special nuclear materials with minimal manual intervention.
The first ARCTERIX prototype system has demonstrated a high technological readiness to implement the technique in a commercial stand-alone system for rapid assessment of radioactive waste drums or in a system operating in conjunction with established techniques.

s01 R&D 131-call-eurad-s01-abs-rev00-CEDERWALL_Bo (NIP ARCTERIX, Win-1)

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[7] Jana Petrović, Alf Göök, and Bo Cederwall, “Rapid imaging of special nuclear materials for nuclear nonproliferation and terrorism prevention”, Science Advances, Vol. 7, No. 21, eabg3032 (2021). https://doi.org/10.1126/sciadv.abg3032

[8] R. Stone, *“New type of imager could help spot smuggled nuclear materials”*, Science, 19 May 2021, https://doi.org/10.1126/science.abj5464

INTERACTIONS OF RADIONUCLIDES, ORGANICS AND CALCIUM SILICATE HYDRATES

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Organic compounds are routinely present in radioactive wastes of low and medium activity. Sources include cellulose, its derivatives and associated degradation products, waste from effluent treatment, ion exchange resins, and PVC materials and their degradation products. These compounds may form complexes with radionuclides present in the waste, enhancing their mobility by (i) increasing their solubility and (ii) decreasing their sorption onto cement-based materials. Current knowledge of cement-organic reactions in waste repository scenarios is limited despite their implications for ensuring the safe storage of nuclear waste. In this work, we study the interactions of three organic compounds, α-isosaccharinic acid (ISA), phthalate, and adipate as well as uranium with calcium-aluminium-silicate-hydrates (CASH), a hydration product of Al-rich blended cements. ISA is a principal degradation product of cellulose, an important organic component in radioactive residues of low and intermediate activity. Phthalate and adipate are produced from the hydrolysis and radiolytic degradation of PVC. All materials were prepared and handled under a N_2 atmosphere. Sorption of organic molecules was performed with a solid:liquid ratio of 10 g/L and initial concentrations of 10^{-2}, 10^{-3}, and 10^{-4} M. Two CASH phases were prepared, with initial Ca:Si and Al:Si ratios of 1.2 and 0.05 or 0.2, respectively (hereafter CASH 1.2-0.05 and CASH 1.2-0.2). No appreciable adsorption of adipate and phthalate to either CASH phase was observed over the duration of the experiment. For ISA, sorption to CASH 1.2-0.2 was limited but appreciable for CASH 1.2-0.2. Adsorption of uranium to both CASH phases at initial concentrations of 10^{-6} – 10^{-8} M indicated a log K_d value of > 5.5. In solid-free experiments, the measured solution concentration of uranium in samples originally spiked with 1×10^{-6} M uranium was ~4×10^{-7} M. The presence of ISA at initial concentrations of 10^{-3} and 10^{-2} M increased this concentration appreciably, indicating the formation of a uranium-ISA complex. This was consistent with speciation modeling of uranium and ISA in our systems. However, the commensurate addition of 10^{-2} M ISA to uranium sorption experiments did not result in a detectable increase in uranium solution concentration. Our results further highlight the complexity associated with predicting the fate of radionuclides and organics in cementitious systems.

s01 R&D 136-call-eurad-s01-abs-rev00-LOPEZ-GARCIA_Marta

PLUTONIUM DISPOSITION IN THE UK: IMMOBILISATION BY HOT ISOSTATIC PRESSING

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The UK has the largest inventory of civil separated plutonium oxide material in the world and determining a long-term solution for dealing with the material is a complex challenge for the UK government and the Nuclear Decommissioning Authority [1]. Key options are to *reuse* the material as fuel in future nuclear reactors, or to *immobilise* it into a "beyond reach" form suitable for long-term storage and eventual geological disposal. Immobilisation is expected to be required for a small fraction of the inventory even if reuse is selected, but there is potential that the entire inventory will be immobilised if reuse is not pursued. One immobilisation option being developed is to thermally treat the oxide powder into monolithic ceramic products using hot isostatic press (HIP) technology. HIP using heat and pressure to consolidate and densify ceramic materials inside hermetically sealed containers, which are then suitable for long-term storage and disposal. The overall objective for the UK is to put the plutonium material beyond reach to subsequently reduce security risks and the burden of safe and secure management for future generations. Ceramic based materials incorporate plutonium into the crystal structures and are highly tolerant to radiation damage and groundwater leaching. This makes them advantageous as potential host matrices for immobilising plutonium oxide material. This poster presents an overview of PhD research [2] and production of small scale plutonium active samples [3], as well as a summary of ongoing efforts developing the HIP technology for plutonium active operations [4] in support of the wider plutonium disposition programme in the UK.

[1] NDA Strategy, Nuclear Decommissioning Authority, March 2021
[2] PhD Thesis: The development of zirconolite glass-ceramics for the disposition of actinide wastes, S. M. Thornber, University of Sheffield, 2018
[3] NNL15168 HIP1 Phase2: Fabrication, synthesis and characterisation of active cold pressed and sintered samples, S. M. Thornber, C. Sellars, NNL, 2020
[4] Plutonium disposition in the UK: technological advancement of ceramic wasteforms and hot isostatic pressing, S. M. Thornber, Nuclear Futures, 18.1, 2022

s01 R&D 137-call-eurad-s01-abs-rev01-THORNBER_Stephanie

DEVELOPMENT OF DECONTAMINATION PROCESSES FOR METALLIC RADIOACTIVE EFFLUENTS

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Nuclear power is an important method of generating electricity, producing very little environmentally damaging carbon waste. However, other types of waste are produced during its operation, radioactive waste. It is categorized according to the half-life and activity of the radionuclides that compose it. Almost all of the radioactivity produced is concentrated in high-level waste (≈95%) but represents only a very small volume (less than 5%). Most of the waste produced is low or medium level, generated during maintenance and dismantling operations, and largely composed of contaminated metals. One of the components of the primary circuit generates a significant amount of waste, the steam generator. It consists of a tubular part made of stainless steel or Inconel, in direct contact with the water of the primary circuit. The water will corrode its surface and deposit metallic components activated by irradiation, causing contamination of the material. To safely recycle or reuse these materials, decontamination is necessary. When carried out chemically (CORD and MEDOC processes), the contaminated oxide layer is dissolved and removed from the metallic materials. These techniques are very effective but generate a very large quantity of radioactive effluent, which must be treated and decontaminated before conditioning. For this purpose, it is possible to use specific resins that will separate and isolate the different radionuclides in the solution. However, this process is very costly because of the specificity of the resins and the complexity of the effluents, which are composed of many radionuclides (^{54}Mn; ^{55}Fe; ^{60}Co; ^{63}Ni; ^{65}Zn; ^{144}Ce and more). Therefore, the objective is to reduce the volume of effluent and the quantity of metals as much as possible before passing through the resin. To do this, it is possible to precipitate and co-precipitate the metals in the solution in the form of hydroxides ($M^{n+}(OH)_n$) by adjusting the pH of the radioactive solution. Initially, the tests were carried out on synthetic samples. Subsequently, real effluents from the decontamination of steam generators will be tested. The removal efficiency of the different metals present was studied according to two different precipitation pH values (8.5 and 12). Further precipitation tests are planned to optimize this metal decontamination to best meet the waste acceptability criteria (WAC). This subject is part of the European PREDIS project about the metallic material treatment.

s01 PhD 138-call-eurad-s01-abs-rev00-ROBIN_Mathurin

DEVELOPMENT OF A TRACEABILITY SYSTEM FOR RADIOACTIVE WASTE IN NUCLEAR FACILITIES

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One of the critical points in Nuclear Power Plants decommissioning is waste management. Radioactive waste must be managed in compliance with current regulations to ensure the protection of people and the environment; and for this, their traceability must be always maintained. The traceability of waste is a current problem internationally due to the limited experience available in the decommissioning of nuclear facilities. For this reason, the purpose of Radioactive Waste Tracking System developed by Nucleonova, is to implement tracking system based in Radio Frequency Identification (RFID) technology to guarantee the traceability and keep the information of waste in all its stages from generation, conditioning, characterization, transportation, and storage. Information like the radioactivity of the radioisotopes sealed in the container, the date when the container was sealed, the weight of the nuclear waste, etc. can be included in the data base by the employees or automatically. The system has different devices as parts of the hardware and a software that integrates all the inputs in an interactive digital program. The system is designed to be able to adapt to the requirements and needs of the decommissioning facility, since different facilities manage radioactive waste. In conclusion, this Radioactive Waste Tracking System combines the knowledge about nuclear physics and nuclear technologies, nuclear safety and radiological protection with a telecommunication system and software development to improve the quality in the radioactive waste management.

s01 R&D 140-call-eurad-s01-abs-rev00-MUNOZ-TIRADO_Juan-Antonio

ROBBE – Autonomous Robot-Operated Water Jet Blasting of Assemblies During Dismantling of Nuclear Power Plants

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For a successful decommissioning and dismantling of a nuclear power plant, a large part of the work relates to coated (mainly painted) steel components, which make up a significant portion of the inventory of the power plant to be processed. Contamination of these components is reduced by removing the surface coating using UHP (Ultra-High-Pressure) water jet blasting technology. Thus, the decontaminated material is released to be recycled conventionally. Almost all manual processes, especially UHP water jet technology, require the use of personal protective equipment. Not only is this type of work physically demanding for employees, they also risk radiation exposure during decontamination. An autonomous, automated solution is more economic, yields consistent high quality and helps avoiding the disadvantages of manual processing mentioned above. This project aims at implementing a robot-operated automated and autonomous decoating procedure of components using UHP water jet blasting technology. A prototype was built at the German Biblis NPP site and successfully made operational at an industrial scale. The acronym “ROBBE” (Robot-operated processing of assemblies during the dismantling of nuclear power plants) is derived from this project objective. An embedded, robot-operated 3D laser scanner autonomously captures the individual geometry of the assemblies and the clamping tools, as well as their spatial orientation on the clamping plate. Then a detailed and complete surface geometry model of the component including the clamps is calculated and, with knowledge of additional procedural parameters as well as the robot kinematics, the best trajectories for the decoating process are determined which completely cover the component’s visible surfaces minus those of the clamping tools and unreachable areas due to its geometric shape. The decoating process is carried out inside the decontamination cabinet by the robot operated UHP water jet blasting technology. Robbe is embedded in a sustainable, energy-saving, innovative filter and water circulation system further reducing radioactive waste and saving resources. The outstanding feature of our technology is the autonomous and complete real-time capture of the 3D geometry of arbitrary components of any shape and size inside its workspace as well as the adaptive trajectory planning for the robot-operated decoating process using UHP water jet blasting technology taking into account its efficacy parameters. The process of geometry recognition and the surface treatment are combined in one robotic arm end-effector tool. The basic process control is carried out via only four push buttons.

s01 R&D 141-call-eurad-s01-abs-rev00-SANTOS_Pedro (NIP ROBBE, Win-3)

THE NEW CONCEPT OF NEUTRON ABSORBERS PLACED DIRECTLY WITHIN SPENT NUCLEAR FUEL

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A unique solution presented in this research is based on special fixed neutron absorbers placed directly within the nuclear fuel assembly. A neutron absorber, permanently connected in specially designed tubes, decreases system reactivity more efficiently than absorber sheets between the assemblies. This solution is more efficient than absorber tubes, even with a neutron flux trap. Hence, it allows significant basket design changes, e.g., lowering boron content in steal or decreasing fuel assembly pitch in the basket resulting in lower cask wall diameter and lower total cask mass.

Legislative and criticality safety margins are commonly achieved by placing neutron absorbers in the cask basket design. Currently, boron content in steel is exclusively used in transport and storage absorber components as the absorber material. Mechanical and chemical properties of absorbing light boron nuclei allow adding boron directly to basket tubes material or in extra sheets between the tubes. Nevertheless, with higher fuel enrichment and limit on boron content in steel or alloys, criticality safety criteria are currently not easily met. This is a unique solution based on placing neutron absorbers in the most effective location.

This presented solution is more efficient than absorber tubes and allows to new view at storage, transport, and disposal of spent nuclear fuel. The prototype was prepared and tested in the research reactor LR-0. From an economic perspective, it is a suitable option (cheap but high-quality materials were used), including a simple mechanical connection to fuel assembly.

s01 PhD 143-call-eurad-s01-abs-rev01-ZAVORKA_Jiri (NIP ENSBEF)

Activities of the Laboratory of Expertise and destructive Characterization

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CHICADE is one of the nuclear facilities of Energy Division of French Alternative Energies and Atomic Energy Commission (CEA/DES).
The DES is responsible for structuring and piloting the research programmes on energy at CEA. It involves its own institutes of research and those of other divisions. CHICADE is part of the Directorate for Nuclear Dismantling, Services and Waste Management.
The Laboratory of Expertise and Destructive characterization is set up in the Basic Nuclear Facility - N°156 called “CHICADE” where heavy equipment is used. The laboratory brings together both competence and means of characterization, using destructive methods on waste packages. It also carries out measurements on the whole waste package (gas release measurements, leaching tests).
This presentation will review the characterizations carried out on nuclear wastes.

s01 R&D 152-call-eurad-s01-abs-rev00-DAVID_Olivier

SEPARATION OF TRITIUM IN RADIOACTIVE EFFLUENTS BY MEANS OF ADSORPTION WITH CELLULOSE FILAMENT STRUCTURES

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The basis for the experimental work based on effluents from an operational PWR reactor at focuses on the adsorption capacity of special cellulose filaments with respect to tritium. These cellulose fibbers, duly treated using a patented chemical procedure, give rise to cellulose microfibres with extensive amorphous regions. These amorphous (non-crystalline) regions permit the exchange of cellulose hydroxyl groups for OT groups of tritiated water. Technical excellence relapses in the capacity to modify the cellulose microfibres to be able to be tritium friendly applying the principles of the deuterium adsorption in their surface. The assumption has been proven with actual tritiated wastewater coming from RCS (Reactor Coolant System) on a Spanish NPP.

Due to the positive results with tritiated NPP wastewater, NUCLEAN requested on 27th May 2021 the patent number P202130480 to the OEPM Madrid for the "METHOD OF TREATMENT OF TRITIUM AS WASTE FROM NUCLEAR OPERATIONS" with the support of the Ascó NPP operator "ANAV". The patent has been accepted and is pending for official approval and EU first and then worldwide extension.

Nuclear operations with wastewater and flue gas involve working with isotopes generated by neutron activation, corrosion, or fission. Whatever parent solution is used, it always includes a certain amount of tritium that complicates effluent treatment. The ease with which tritium is incorporated into the water molecule makes it too hard to treat to reduce effluent activity. Different laboratory processes have been leveraged and a very few successfully employed at the industrial level (cryogenic distillation). NUCLEANTECH is developing a wastewater tritium-capture process that involves tapping a property widely studied by the literature and which presents certain cellulose filament structures exchanging protium isotopes for deuterium ones. The company has harnessed adsorption kinetics to bring diluted solutions (400 Bq/g) from a PWR nuclear reactor coolant into contact with cellulose filaments. The adsorption values oscillate between 11 and 14 %.

s01 R&D 163-call-eurad-s01-abs-rev00-ALBERT_Marc (NIP TRITUM REM SYS)

SPENT FUEL ALTERATION 1D MODEL INTEGRATING WATER RADIOLYSIS AND REACTIVE SOLUTE TRANSPORT

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A 1D reactive transport model has been implemented in iCP [1] (interface COMSOL Multiphysics - PHREEQC) to assess the corrosion of Spent Nuclear Fuel (SF) matrix of a failed container in a deep geological repository. The model solves the challenge of linking the complete water radiolysis system with chemical complexation and dissolution/precipitation reactions. It considers the SF as homogeneous UO_2(am,hyd) doped with Pd and couples transport by diffusion with the following processes: i) generation of water radiolysis species by alpha and beta radiation considering a complete radiolysis system with kinetic reactions involving: H^+, OH^-, O_2, H_2O_2, H_2, HO_2^-, $HO_2\cdot$, $O\cdot$, O^-, O_2^-,$H\cdot$, $\cdot OH$ and e^-, ii) kinetic oxidative dissolution of UO_2(am,hyd) and subsequent reduction of oxidized fuel, considering H_2 activation by Pd, occurring at the SF surface and iii) corrosion of Fe(s) in oxic and anoxic conditions. Processes i) were implemented in COMSOL (as well as transport by diffusion) and processes ii) and iii) were implemented in PHREEQC with their kinetic constants being calibrated with existing experimental data. Model development and its calibration is described in Riba et al. (2020) [2]. The described model simulates dissolution rates in the range of the values selected in various safety assessments and reproduces the UO_2 dissolution behavior of spent fuel leaching experiments existing in the literature and also generated in DisCo project. Therefore, the main processes controlling the uranium chemistry in these systems have been captured by the model. In the light of modelling and experimental results generated in DisCo project, the model described here can be applied not only to standard UOx spent fuel but also to Cr/Al doped-UOx spent fuel

References

[1] Nardi et al. (2014). Interface COMSOL-PHREEQC (iCP), an efficient numerical framework for the solution of coupled multiphysics and geochemistry. Computers & Geosciences 69:10-21
[2] Riba et al. (2020). Spent fuel alteration model integrating processes of different time-scales. MRS Advances,5(3),159-166

s01 R&D 167-call-eurad-s01-abs-rev00-RIBBA_Olga

IS IT FAIR TO NEGLECT A-THERMAL HELIUM RELEASE IN DRY STORAGE CONDITIONS?

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No, it is not. In recent works, a conservative estimation of helium release from nuclear fuel irradiated in light water reactors in dry storage conditions has been set at 5%. This assumption is well founded as for the diffusional release of helium is considered. In addition to the diffusional thermally activated release process one should consider that a (slightly) conservative estimation of the range of an alpha particle in the fuel is ≈ 18 μm, and that ≈ 64% of the helium production is concentrated in an 18 μm rim of the fuel pellet, one should expect an a-thermal contribution to helium release in the order of ≈ 16% (assuming one out of four of the alpha particles produced are directly emitted from the fuel pellet). The consequence of such release has been considered in recent sensitivity studies and could result in an increase of the cladding hoop stress during dry storage.

s01 R&D 168-call-eurad-s01-abs-rev00-PIZZOCRI_Davide

CURRENT STATUS OF THE GENERAL RADIOACTIVE WASTE PLAN IN SPAIN

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Spain currently has a fleet of 7 operating nuclear reactors as well as 3 plants in different phases of their decommissioning process. Regarding medium and low-level radioactive waste the *El Cabril* facility has been established as an international reference, however, a centralized facility to manage high-level radioactive waste does not exist yet as of today. In this regard, plans for such facility were advanced in the past, having selected a site and developed a Project for the facility, including associated research installations, but when it was close to obtain its construction license, the Project was halted. Recently, the Ministry for Ecological Transition has released the draft of the Seventh General Plan of Radioactive Wastes for public consultation, open to comments until June 16th, 2022. This draft includes as a key point the "start-up of a Centralized Temporary Storage Facility for the spent fuel and high-level radioactive waste, or alternatively, [what has been named as] seven Decentralized Temporary Storage Facilities". This poster shall present the recent history and the current status of the radioactive waste plan in Spain, with emphasis on the possible management options for irradiated fuel and high-level waste.

s01 PhD 172-call-eurad-s01-abs-rev00-SUAREZ_Francisco (ENS YGN)

OPTIMIZATION OF THE MORTARS MECHANICAL CHARACTERISTICS OBTAINED WITH METAKAOLIN ADDITIVE

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The objective of this work is to determine the amount of metakaolin as a replacement of cement in the recipe of mortars made with recycled concrete in order to obtain good mechanical characteristics. Currently, low-level radioactive waste (LLW) resulted from the decommissioning of nuclear facilities is pre-placed in cylindrical steel containers and solidified with cement mortar prepared with natural aggregates. The mortar matrices that fix the radioactive waste in the container must have optimal properties (good flow ability and no bleeding for fresh mortar and compressive and flexural strength as high as possible for hardened mortar) for the waste package to keep its properties as long as possible. In this study, a type of kaolin from Bulgaria (Senovo, Vetovo and Ruse regions) was heat treated at 700^0 C for 2 hours to be transformed into metakaolin. The resulted metakaolin was ground in a ball mill for 24 hours and used in the radioactive waste solidification mortar recipe. The experiments were done with mortars in the recipe of which the cement was partially replaced with metakaolin 5 - 30% wt. and fine natural aggregates, respectively. The bleeding of the fresh mortar and the values of compressive and flexural strength of the hardened mortar were measured. The additions in this study, as substitutes for cement in mortars prepared with recycled concrete, have the following effects: the presence of metakaolin eliminates the phenomenon of bleeding from fresh mortars, in the hardened mortar with metakaolin addition the flexural strength of the samples with the addition of 15% wt. metakaolin is close to the compressive strength of the reference mortar samples (8.6 MPa versus to 9.3 MPa), the compressive strength is higher for the sample with the addition of 5% wt. metakaolin versus reference mortar samples (51.9 MPa versus 50.3 MPa), the flexural and compressive strengths for samples with the addition of fine natural aggregates are below the values displayed by the OPC.
Mortars with the addition of 5% wt. metakaolin and recycled concrete meet the requirements for compressive strength and can be used to solidify radioactive waste resulted from the decommissioning of RN VVR-S Magurele.

s01 R&D 173-call-eurad-s01-abs-rev00-MINCU_Monica

Trial Run of Final Disposal verifies the readiness to operate the DGR for spent nuclear fuel

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Posiva Oy submitted the operating license application for the encapsulation plant and for the final disposal facility for spent nuclear fuel, located in Olkiluoto, Finland, in the end of 2021. As part of the preparations to start the final disposal, all systems, structures and equipment in these nuclear facilities need to be proven to function in an industrial manner, which is verified in the Trial Run of Final Disposal.
Currently the commissioning of the encapsulation plant and the final disposal facility is ongoing. When all the systems in these facilities are qualified or other means accepted for use, follows the Trial Run of Final Disposal.
The Trial Run of Final Disposal verifies the whole chain of encapsulation plant and final disposal facility operations using systems and vehicles qualified or by other means accepted for nuclear operations. The Trial Run is not only technology and process test, but the operating organization and procedures are in place and tested as well. Qualified personnel operates the process using the QA/QC procedures and documentation required for a nuclear facility and taking into account safeguards and monitoring aspects.
The trial run provides a demonstration to multiple stakeholders that Posiva can manage the entire final disposal process and is able to start the industrial operation of ONKALO®.

s01 R&D 174-call-eurad-s01-abs-rev00-HANSEN_Joanna

INTERNATIONAL COOPERATION ON PREDISPOSAL WASTE MANAGEMENT – PREDIS PROJECT

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2 Nuclear Laboratory Limited, (NNL), UK
3 Belgian Nuclear Research Centre (SCK CEN), Belgium

The project "*PREDIS: Pre-Disposal Management of Radioactive Waste"* develops and improves safer treatment and conditioning methodologies and processes for wastes, for which no adequate or industrially mature solutions are currently available. The project addresses innovation and break-through technologies for better handling of low-level and intermediate level radioactive wastes, with a focus on treatment of metallic materials, liquid organic waste and solid organic waste which can result from nuclear power plant operation, decommissioning and other industrial processes. The project also addresses digitalization solutions for improved safety and efficiency in handling and assessing cemented-waste packages in extended interim surface storage. An example of this is digital twins and the use of artificial intelligence for big data mining from non-destructive evaluation methods. Through all of these pre-disposal treatment activities, waste acceptance criteria are a critical parameter for optimizing the safe and efficient handling and minimisation of wastes over the whole life cycle, from cradle to grave.

PREDIS will produce tools guiding decision-making on the added-value of the developed technologies and their impact on the design, safety, environmental impact and economics of pre-disposal waste management and future disposal. It is anticipated that the project results are close to implementation by the end user community, which is ensured through their active involvement with the partners and the co-funding structure of this EC project. The project's Strategic Research Agenda will highlight needs for future technology development, investments and needs also from the perspectives of competence development and preservation of knowledge.

With 47 partners from 17 countries across Europe, the 4-year, 23 million euro project, which started in September 2020, should make great strides in the best practices and new technologies ready for global markets. The project has already hosted twelve online free public webinars and the first in-person workshop in April 2022. The first year produced over ten public deliverables, including the Gap Analysis, Baseline Strategic Research Agenda, technical documents and training and mobility guidelines to facilitate competence development. The project includes over 25 industrial parties as end user group members and stives to cooperate with international bodies such as IAEA and OECD-NEA. Synergies with the EURAD project are also developed, especially with respect to contributing to the prediposal aspects of the EJP's Roadmap.

s01 R&D 175-call-eurad-s01-abs-rev00-OKSA_Maria (PREDIS INCO)

CONCRETE COMPOSITE MATERIAL REINFORCED BY MODIFIED BASALT FIBRE FOR NUCLEAR ENERGY AND NUCLEAR WASTE MANAGEMENT APPLICATIONS

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The basalt fibre is relatively new product that has investigated actively in recent years for a wide range of applications in various industries. The basalt fibre is environmentally safe and non-toxic product. The reinforced concrete with basalt fibre has the following advantages: high chemical and corrosion resistance, longevity, high abrasion and shock resistance, high frost resistance. As the basalt fibre has approximately the same specific gravity as the basic components of concrete it is uniformly distributed over the concrete volume, unlike steel fibre and different types of polymer fibres. Our research presents the possibility of using modified basalt fibre as a neutron absorbing additive in concrete for Spent Nuclear Fuel containers, for biological shield of conventional fission reactor and for constructive elements of fusion reactors (for example, DEMO). Three types of modified basalt fibre were proposed and considered: 1) basalt-boron fibre, produced by adding 20% boron oxide to the basalt melt; 2) basalt-gadolinium fibre, produced by adding 20% gadolinium oxide to the basalt melt; 3) basalt-boron-gadolinium fibre, produced by adding 10% boron oxide and 10% gadolinium oxide to the basalt melt. For assessment of neutron flux decreasing, when using modified BF, a simplified model of the HI STORM 190 UA container was developed with 31 VVER-1000 Spent Nuclear Fuel assemblies loaded with the help of Monte Carlo Serpent code. The neutron transport from Spent Nuclear Fuel was modelled through ordinary and heavy concrete reinforced with basalt-boron, basalt-gadolinium and basalt-boron-gadolinium fibre at a dosage of 20, 40 and 60 kg/m^3 of concrete. Modelling results showed that all three types of modified basalt fibre successfully increase the neutron radiation shielding properties of HI STORM 190 UA containers, especially for thermal and epithermal neutrons. The most promising neutron-absorbing results were shown by the use of basalt-boron-gadolinium fibre. Therefore, it can be concluded that the combined basalt-boron-gadolinium fibre may be the optimal solution in terms of reducing thermal and epithelial neutrons. The research results presented in this research show that modified basalt fibre can be an inexpensive effective neutron-absorbing additive in concrete, which also can improve the mechanical and strength characteristics of concrete.

s01 R&D 178-call-eurad-s01-abs-rev00-GULIK-Volodymyr (R&D)


FISA 2022
EURADWASTE'22

INVITED INVITED SPEAKERS

EURADWASTE ’22 SESSION 1 - Collaborative Research, Development and Demonstration in Radioactive Waste Management

176-inv-eurad-s01-abs-rev00-JALONEN_Tiina (IGDTP)
096-inv-eurad-s01-abs-rev00-MORICHI_Massimo
011-inv-eurad-s01-abs-rev00-HOLT_Erika
030-inv-eurad-s01-abs-rev00-ALTMAIER_Marcus
024-inv-eurad-s01-abs-rev00-CLARET_Francis
042-inv-eurad-s01-abs-rev00-LEVASSEUR_Severine
135-inv-eurad-s01-abs-rev00-SJOLAND_Anders

EURADWASTE ’22 SESSION 2 – Strategic Research Studies in Radioactive Waste Management

162-inv-eurad-s02-abs-rev00-DETILLEUX_Valéry (SITEX Network)
083-inv-eurad-s02-abs-rev00-DIACONU_Daniela

055-proj-eurad-s02-abs-rev01-MARSAL_François(032-inv)

EURADWASTE ’22 SESSION 3 - Knowledge Management in Radioactive Waste Management

013-inv-eurad-s03-abs-rev00-THEODON_Louise
041-inv-eurad-s03-abs-rev00-TATOMIR_Alexandru
045-inv-eurad-s03-abs-rev00-FALTEJSEK_Jiri
028-inv-eurad-s03-abs-rev00-BELMANS_Niels
086-inv-eurad-s03-abs-rev00-VUORIO_Marja

144-inv-eurad-s03-abs-rev00-MAYER_Stefan

EURATOM PROJECTS

EURADWASTE ’22 SESSION 1 - Collaborative Research, Development and Demonstration in Radioactive Waste Management	
ROUTES	032-inv-eurad-s02-abs-rev00-LEONI_Elisa
EURAD ROADMAP	147-proj-eurad-s02-abs-rev00-BEATTIE_Tara
EURAD ETKM UPDATE	151-proj-eurad-s02-abs-rev00-DETILLEUX_Valéry
PREDIS WP5	037-proj-eurad-s02-abs-rev00-HAMADACHE_Kahina
EURAD & PREDIS (WAC)	029-proj-eurad-s02-abs-rev00-DEBOCK_Chris
EURADSCIENCE	121-proj-eurad-s02-abs-rev00-BRUGGEMAN_Christophe
HARPERS	170-proj-eurad-s02-abs-rev00-SZOKE_Reka

EURADWASTE ’22 SESSION 2 – Strategic Research Studies in Radioactive Waste Management	
ROUTES	032-inv-eurad-s02-abs-rev00-LEONI_Elisa
EURAD ROADMAP	147-proj-eurad-s02-abs-rev00-BEATTIE_Tara
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PREDIS WP5	037-proj-eurad-s02-abs-rev00-HAMADACHE_Kahina
EURAD & PREDIS (WAC)	029-proj-eurad-s02-abs-rev00-DEBOCK_Chris

EURADWASTE ’22 SESSION 3 - Knowledge Management in Radioactive Waste Management	
SoK	074-proj-eurad-s03-abs-rev00-BEATTIE_Tara
PREDIS WP6	051-proj-eurad-s01-abs-rev00-PANCOTTI_Federica

Open Call FISA 2022 MSc/PhD/R&D and Prizes

Open Call EURADWASTE ’22 MSc/PhD/R&D and Prizes FOR Session 1-2-3	
s01 PhD	012-call-eurad-s01-abs-rev00-IBRAHIM_layla
s01 PhD	014-call-eurad-s01-abs-rev00-YUAN_Tao
s01 PhD	016-call-eurad-s01-abs-rev00_STIETZ_Janina
s01 PhD	017-call-eurad-s01-abs-rev00-PITZ_Michael
s01 PhD	018-call-eurad-s01-abs-rev00-TOLNAI_Istvan (idem 019)
s01 R&D	019-call-eurad-s01-abs-rev00-FABIAN_Margit (idem 018)
s01 PhD	020-call-eurad-s01-abs-rev00-DEWITTE_Charlotte
s01 R&D	025-call-eurad-s01-abs-rev00-SCHINTGEN_Tom
s01 R&D	026-call-eurad-s01-abs-rev00-LOPEZ-GARCIA_Marta
s01 PhD	027-call-eurad-s01-abs-rev00-RIVONKAR_Aditya
s01 R&D	035-call-eurad-s01-abs-rev00-KATONA_Richard
s01 PhD	038-call-eurad-s01-abs-rev00-GUPTA_Abhishek
s01 R&D	047-call-eurad-s01-abs-rev00-RUDYCHEV_Yegor
s01 PhD	048-call-eurad-s01-abs-rev00-LLABJANI_Qazim
s01 PhD	049-call-eurad-s01-abs-rev00-ZERVA_Dimitra
s01 R&D	054-call-eurad-s01-abs-rev00-FRASCA_Benjamin
s01 R&D	056-call-eurad-s01-abs-rev00-VERNAY_Alienor
s01 R&D	058-call-euradwaste-s01-abs-rev00-SHULHA_Oleksii (idem 059)
s01 R&D	059-call-euradwaste-s01-abs-rev00-KUBA_Ihor (idem 058)
s01 PhD	060-call-eurad-s01-abs-rev00-YANIKOMER_Neslihan (ENEN PhD Applicant)
s01 R&D	062-call-euradwaste-s01-abs-rev00-NARKUNIENE_Asta
s01 PhD	066-call-eurad-s01-abs-rev00-SAMMALJARVI_Juuso
s01 R&D	069-call-eurad-s01-abs-rev00-DIDIER-LAURENT_Regis
s01 PhD	070-call-eurad-s01-abs-rev00-BRABANTS_Lowie
s02 R&D	071-call-eurad-s02-abs-rev00-PROSKURA_Ganna
s01 PhD	072-call-eurad-s01-abs--rev00-NOLDEN_Markus
s01 R&D	075-call-eurad-s01-abs-rev00-LAGZDINA_Elena
s01 PhD	077-call-eurad-s01-abs-rev00-ZENG_Hao
s01 PhD	078-call-eurad-s01-abs-rev00-GONZALEZ-BLANCO_Laura
s01 PhD	082-call-eurad-s01-abs-rev00-BONDARIEVA_Antonina
s02 R&D	087-call-eurad-s01-abs-rev01-NIEDERLEITHINGE_Ernst (UPDATED)
s01 R&D	088-call-eurad-s01-abs-rev00-RENTSCHLER_Eric
s01 R&D	090-call-eurad-s01-abs-rev00-LE_Trung
s02 R&D	091-call-eurad-s01-abs-rev00-PLUKIENE_Rita
s01 PhD	092-call-eurad-s01-abs-rev00-BRUNEEL_Yaana

s01 PhD	094-call-eurad-s01-abs-rev00-QIAN_Yanting
s01 PhD	097-call-eurad-s01-abs-rev00-GAJST_Tamara
s01 PhD	101-call-eurad-s01-abs-rev00-KOZLOWSKI_Andrea
s01 PhD	104-call-eurad-s01-abs-rev00-SHANG_Chengming (ENEN PhD Invited)
s01 R&D	105-call-eurad-s01-abs-rev00-MARGIT_Fabian (NIP HLW-MATRIX, see 018-19)
s01 PhD	106-call-eurad-s01-abs-rev00-DE-HITA-FERNANDEZ_Maria-Jimena (idem 155)
s01 PhD	111-call-eurad-s01-abs-rev00-GALLUCCIO_Francesco (ENEN PhD Applicant)
s01 R&D	113-call-eurad-s01-abs-rev00-COQUARD_Laurent (NIP QUANTOM, Win-2)
s01 R&D	114-call-eurad-s01-abs-rev00-FOURNIER_Maxime (NIP DEM MELT)
s02 PhD	116-call-eurad-s01-abs-rev00-BOURDON_Jeremy
s01 R&D	128-call-eurad-s01-abs-rev00-KHERADMAND_Mohsen (NIP KH2021)
s01 R&D	131-call-eurad-s01-abs-rev00-CEDERWALL_Bo (NIP ARCTERIX, Win-1)
s01 R&D	136-call-eurad-s01-abs-rev00-LOPEZ-GARCIA_Marta
s01 R&D	137-call-eurad-s01-abs-rev00-THORNBER_Stephanie
s01 PhD	138-call-eurad-s01-abs-rev00-ROBIN_Mathurin
s01 R&D	140-call-eurad-s01-abs-rev00-MUNOZ-TIRADO_Juan-Antonio
s01 R&D	141-call-eurad-s01-abs-rev00-SANTOS_Pedro (NIP ROBBE, Win-3)
s01 PhD	143-call-eurad-s01-abs-rev00-ZAVORKA_Jiri (NIP ENSBEF)
s01 R&D	150-call-eurad-s01-abs-rev00-SHULHA_Oleksii (idem 058 and 059)
s01 R&D	152-call-eurad-s01-abs-rev00-DAVID_Olivier
s01 PhD	155-call-eurad-s01-abs-rev00-FERNANDEZ_Maria-Jimena (idem 106)
s01 R&D	163-call-eurad-s01-abs-rev00-ALBERT_Marc (NIP TRITUM REM SYS)
s01 R&D	167-call-eurad-s01-abs-rev00-RIBBA_Olga
s01 R&D	168-call-eurad-s01-abs-rev00-PIZZOCRI_Davide
s01 PhD	172-call-eurad-s01-abs-rev00-SUAREZ_Francisco (ENS YGN)
s01 R&D	173-call-eurad-s01-abs-rev00-MINCU_Monica
s01 R&D	174-call-eurad-s01-abs-rev00-HANSEN_Joanna
s01 R&D	175-call-eurad-s01-abs-rev00-OKSA_Maria (PREDIS INCO)
s01 R&D	178-call-eurad-s01-abs-rev00-GULIK-Volodymyr (R&D)


FISA 2022
EURADWASTE'22

Exhibition POSTERS – EURADWASTE ’22 Session 1-2-3

Day1 / Day2	REFERENCE EURADWASTE ’22
D1EUR01	DEVELOPMENT OF FORMULATIONS FOR DIRECT CONDITIONING OF RADIOACTIVE LIQUID ORGANIC WASTES – PREDIS WP5 051-proj-eurad-s01-pptA0-rev00-PANCOTTI_Federica (PREDIS WP5)
D1EUR02	ESTABLISHING EURADSCIENCE AS A SUSTAINABLE NETWORK FOR RESEARCH ORGANISATIONS IN RADIOACTIVE WASTE MANAGEMENT 121-proj-eurad-s02-pptA0-rev00-BRUGGEMAN_Christophe (EURADSCIENCE)
D1EUR03	CHEMO-MECHANICAL COUPLING FOR MODELLING OF REINFORCED CONCRETE DISPOSAL UNDERGROUND STRUCTURES 012-call-eurad-s01-pptA0-rev00-IBRAHIM_layla
D1EUR04	INFLUENCE OF GLUCONATE ON THE SORPTION OF TH(IV) / PU(IV) ON HARDENED CEMENT PASTE 016-call-eurad-s01-pptA0-rev00_STIETZ_Janina
D1EUR05	CHARACTERIZATION OF URANIUM DOPED BOROSILICATE GLASS MATRICES FOR CONDITIONING OF HIGH LEVEL RADIOACTIVE WASTES 018-call-eurad-s01-pptA0-rev00-TOLNAI_Istvan (idem 019)
D1EUR06	CHEMO-MECHANICAL CHARACTERIZATION OF CEMENT PASTES IMMERSED IN MAGNESIAN SOLUTION 020-call-eurad-s01-pptA0-rev00-DEWITTE_Charlotte
D1EUR07	STUDY OF EXISTING CHEMICAL DECONTAMINATION METHODS OF RADIOACTIVE METALS WITH A VIEW ON THEIR OPTIMIZATION 027-call-eurad-s01-pptA0-rev00-RIVONKAR_Aditya
D1EUR08	Gas mixture flow modelling in a nuclear waste repository 038-call-eurad-s01-pptA0-rev00-GUPTA_Abhishek
D1EUR09	Insights into the hydro-mechanical behaviour of undisturbed and remoulded Opalinus Clay subjected to gas transport processes 048-call-eurad-s01-pptA0-rev00-LLABJANI_Qazim
D1EUR10	DIFFUSION AND RETENTION OF SURFACE COMPLEXING RADIONUCLIDES IN DIFFERENT IONIC FORMS OF COMPACTED ILLITE 049-call-eurad-s01-pptA0-rev00-ZERVA_Dimitra
D1EUR11	Multiscale Modelling of Radiation Induced Microstructure Evolution: Assessment of Spent Fuel Element Integrity for Prolonged Interim Storage 060-call-eurad-s01-pptA0-rev00-YANIKOMER_Neslihan (ENEN PhD Applicant)
D1EUR12	DEPTH PROFILING OF 137CS CONTAMINATED CONCRETE: ASSESSING ERRORS THROUGH COMPUTED TOMOGRAPHY IMAGES OF CONCRETE 070-call-eurad-s01-pptA0-rev00-BRABANTS_Lowie
D1EUR13	GAS TRANSPORT IN MX-80 TYPE GRANULAR BENTONITE AND MICROSTRUCTURAL OBSERVATION 077-call-eurad-s01-pptA0-rev00-ZENG_Hao
D1EUR14	A MULTI-SCALE INSIGHT INTO BOOM CLAY SELF-SEALING ABILITY AFTER GAS EXPERIMENTS 078-call-eurad-s01-pptA0-rev00-GONZALEZ-BLANCO_Laura
D1EUR15	SORPTION PURIFICATION OF THE AQUATIC MEDIUM FROM RADIONUCLIDES AND HEAVY METALS 082-call-eurad-s01-pptA0-rev00-BONDARIEVA_Antonina

D1EUR16	RETENTION OF REDOX-SENSITIVE TC(VII) ON FE(II)/FE(III) BEARING CLAY MINERALS 094-call-eurad-s01-pptA0-rev00-QIAN_Yanting
D1EUR17	Replacing Pulversized Fly Ash in cement with natural and anthropogenic geomaterials identifying the corresponding physico-chemical properties used for the encapsulation of Low-Level Waste 101-call-eurad-s01-pptA0-rev00-KOZLOWSKI_Andrea
D1EUR18	IMMOBILIZATION OF SPENT NUCLEAR GRADE RESINS IN LOW CARBON CEMENT: STUDY OF THE REACTION KINETICS. 106-call-eurad-s01-pptA0-rev00-DE-HITA-FERNANDEZ_Maria-Jimena
D1EUR19	INNOVATIVE OXIDATIVE TREATMENT AND GEOPOLYMER. ENCAPSULATION OF SPENT MIXED BED ION EXCHANGE RESINS 111-call-eurad-s01-pptA0-rev00-GALLUCCIO_Francesco (ENEN PhD Applicant)
D1EUR20	THE NEW CONCEPT OF NEUTRON ABSORBERS PLACED DIRECTLY WITHIN SPENT NUCLEAR FUEL 143-call-eurad-s01-pptA0-rev00-ZAVORKA_Jiri (NIP ENSBEF)
D1EUR21	IMMOBILIZATION OF SPENT NUCLEAR GRADE RESINS IN LOW CARBON CEMENT: STUDY OF THE REACTION KINETICS. 155-call-eurad-s01-pptA0-rev00-FERNANDEZ_Maria-Jimena (idem 106)
D1EUR22	THE INFLUENCE OF MICROBIAL ACTIVITY ON SUBSURFACE TRANSPORT PROCESSES IN CEMENT AT THE PORE SCALE 014-call-eurad-s01-pptA0-rev00-YUAN_Tao
D1EUR23	MODELLING OF GAS PRESSURE EVOLUTION IN HLW REPOSITORIES OVER LARGE SPACE AND TIME SCALES 025-call-eurad-s01-pptA0-rev00-SCHINTGEN_Tom
D1EUR24	INTERACTIONS OF RADIONUCLIDES, ORGANICS AND CALCIUM SILICATE HYDRATES 026-call-eurad-s01-pptA0-rev00-LOPEZ-GARCIA_Marta
D1EUR25	EFFECTS OF AP-CITROX DECONTAMINATION TECHNOLOGY TO NI-ALLOYS 035-call-eurad-s01-pptA0-rev00-KATONA_Richard
D1EUR26	REDUCTION OF RADIATION DOSE WHEN STORING A LARGE AMOUNT OF RADIOACTIVE WASTE IN SURFACE STORAGE FACILITIES 047-call-eurad-s01-pptA0-rev00-RUDYCHEV_Yegor
D1EUR27	INNOVATIVE PROGRAM FOR RADIOACTIVE WASTE DECOMMISSIONING MANAGEMENT OPTIMIZATION IN FRANCE 054-call-eurad-s01-pptA0-rev00-FRASCA_Benjamin
D1EUR28	In-Can Vitrification of ALPS Slurries from Fukushima Daiichi Effluent Treatment Waste using DEM&MELT Technology 056-call-eurad-s01-pptA0-rev00-VERNAY_Alienor
D1EUR29	Preliminary water purification from surfactants and organic compounds through ozone oxidation, intensified by electrical impulses 058-call-euradwaste-s01-pptA0-rev00-SHULHA_Oleksii (idem 059)
D1EUR30	Analysis of impact of elevated temperature on hydro-mechanical regime in the vicinity of High-level waste disposal tunnel 062-call-eurad-s01-pptA0-rev00-NARKUNIENE_Asta
D1EUR31	CHARACTERISATION OF THE POROSITY EVOLUTION OF CEMENTITIOUS MATERIALS IN CONTACT WITH CALCAREOUS AND MAGNESIUM-ENRICHED WATERS BY C-14-PMMA AUTORADIOGRAPHY (EURAD MAGIC) 066-call-eurad-s01-pptA0-rev00-SAMMALJARVI_Juuso
D1EUR32	In-Can Vitrification of SPENT MINERAL SORBENTS Using DEM&MELT Technology 069-call-eurad-s01-pptA0-rev00-DIDIER-LAURENT_Regis

D1EUR33	DISCRIMINATION OF SURFACE AND VOLUME ACTIVITY IN METALLIC WASTE SAMPLES BY USING EXPERIMENTAL MEASUREMENTS AND MCNP MODELLING OF γ-SPECTRA 075-call-eurad-s01-pptA0-rev00-LAGZDINA_Elena
D1EUR34	Microbial composition of the 3-years-old low-pH SURAO concrete used as an input material for the EURAD WP MAGIC 090-call-eurad-s01-pptA0-rev00-LE_Trung
D2EUR35	EURAD-PREDIS KNOWLEDGE MANAGEMENT INTERACTIONS 013-inv-eurad-s03-pptA0-rev00-THEODON_Louise
D2EUR36	Cooperation between the EC projects EURAD and PREDIS on the subject of waste acceptance criteria 029-proj-eurad-s02-pptA0-rev00-DEBOCK_Chris (EURAD & PREDIS)
D2EUR37	Innovations in liquid organic waste treatment and conditioning within the PRE-DISposal management of radioactive waste (PREDIS) European collaboration project 037-proj-eurad-s02-pptA0-rev00-HAMADACHE_Kahina (PREDIS WP5)
D2EUR38	EURAD Key achievements at mid-term 074-proj-eurad-s03-pptA0-rev00-BEATTIE_Tara
D2EUR39	THE EURAD ROADMAP – A ROADMAP FOR IMPLEMENTING RADIOACTIVE WASTE MANAGEMENT, LEADING TO GEOLOGICAL DISPOSAL 147-proj-eurad-s02-pptA0-rev00-BEATTIE_Tara (EURAD ROADMAP)
D2EUR40	EURAD Strategic research and knowledge management agenda: an update process preparing future joint actions 151-proj-eurad-s02-pptA0-rev00-DETILLEUX_Valéry (EURAD ETKM UPDATE)
D2EUR41	HARPERS: HARMONISED BEST PRACTICES, REGULATIONS AND STANDARS IN WASTE MANAGEMENT AND DECOMMISSIONING 170-proj-eurad-s02-pptA0-rev00-SZOKE_Reka (HARPERS)
D2EUR42	MODEL-BASED APPROACH FOR THE STUDY OF NUCLEAR WASTE TREATMENT SCENARIOS 116-call-eurad-s01-pptA0-rev00-BOURDON_Jeremy
D2EUR43	DEVELOPMENT OF WAC METHODOLOGY FOR GEOPOLYMER MATRICES 071-call-eurad-s02-pptA0-rev00-PROSKURA_Ganna
D2EUR44	Management of cemented LL/IL waste: new tools developed and improved in PREDIS 087-call-eurad-s01-pptA0-rev01-NIEDERLEITHINGE_Ernst (UPDATED)
D2EUR45	METALLIC RADIOACTIVE WASTE CLASSIFICATION FOR THE DIFFERENT TYPES OF REACTORS CONSIDERED IN PREDIS 091-call-eurad-s01-pptA0-rev00-PLUKIENE_Rita
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List of PROJECTS [Grant Agreement number] covered

Acknowledgments
The research PROJECTS leading to these results have received funding from the H2020 Euratom Research and Training Framework Programmes under grant agreements n° [number].

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