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Reference N°	Creation Date	
SCK CEN/86265652	2024-09-18	
Alternative Reference N°	Revision	Version
N/A	1.0	1
ISC	Revision Status	
Public	Approved	

PREDIS Deliverable 4.13 Final report on dissemination in metallic waste.pdf

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Name	Outcome	Date
Bruno Kursten	Approved	2024-09-18

Change log*

Revision	Version	Status	Date	Description of change
1.0	1	Approved	2024-09-18	

**This automatically generated cover page shows references and document information as were available in the Alexandria document management system on 2024-09-18. Please refer to Alexandria for current and complete metadata, or to the document contents and/or author for additional information.*





PREDIS

Deliverable 4.13

Final report on dissemination in metallic waste

Date 31/07/2024

Version Final

Public

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Project acronym PREDIS	Project title PRE-DISposal management of radioactive waste	Grant agreement No. 945098
Deliverable No. D4.13	Deliverable title Final report on dissemination in metallics	Version Final
Type Report	Dissemination level Public	Due date M47
Lead beneficiary IMT		WP No. 4
Main authors Tomo Suzuki-Muresan (IMT)	Reviewed by Abdesselam Abdelouas (IMT) WP4 lead	Accepted by Maria Oksa (VTT) coordinator
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Abstract

Work Package 4 is dedicated to “Innovations in metallic material treatment and conditioning”. This deliverable concerns the dissemination activities of the main results obtained during the PREDIS project. It presents the list of published and upcoming articles as well as the proceedings. It indicates the participation of the WP4 partners in the different workshops organized within the project as well as in international conferences.

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Notification

The use of the name of any authors or organization in advertising or publication in part of this report is only permissible with written authorisation from the VTT Technical Research Centre of Finland Ltd.

Acknowledgement

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

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1 Deliverables and scientific publications

During the PREDIS project, significant progress was made in disseminating scientific results through various deliverables and publications within the three tasks:

- Task 4.4 Development and optimisation of decontamination processes
- Task 4.5 Optimisation of metallic waste characterisation and procedures for waste minimisation and recycling
- Task 4.6 Encapsulation of reactive metals in magnesium phosphate cement-based matrices

Seventeen articles were published across eleven peer-reviewed journals, addressing all tasks within the work package, with five more articles currently under review or in preparation. We can mention the production of two comprehensive review papers and twenty original research papers, appearing in journals edited by Elsevier, Springer Nature, Frontiers Media, MDPI, Cambridge University Press, Ukrainian Nuclear Society. The publication output of the project has increased significantly over the years, with 2 publications in 2022, 5 in 2023, and 10 in 2024.

1.1 Contributions in task 4.4

The task 4.4 treating the question on the “development and optimisation of decontamination processes” provided two complementary reviews dedicated on the radioactive surface contamination of metallic infrastructure and solid surfaces in nuclear facilities during both decommissioning and regular maintenance. The reviews enhanced the key point on the effectiveness of decontamination depending on the substrate (here the stainless steel materials) and the contamination type. Understanding the interactions between radionuclides and the metal surfaces is a key to developing targeted decontamination strategies, reducing waste, and facilitating material recycling or reuse. Various technologies, including mechanical, laser, and chemical methods, are discussed. Recent innovations focused on gels, strippable coatings, and foams, are also presented highlighting the importance of formulation for efficient decontamination.

Technological progresses on metal surface contamination have been made with the development of magnetic gels, enhanced with magnetite particles. They offer a solution for decontaminating surfaces that are difficult to access. These gels retain their decontamination properties while being remotely applicable using magnets. The presence of magnetite affects the gel's viscosity and spreading properties, requiring a balance for long-term storage and efficiency. Optimisation of chemical decontamination has also been made for complex geometry applications. Chemical Oxidation Reduction Decontamination (COREMIX) involves the dissolution of oxide layers from contaminated metallic surfaces, with respect to waste acceptance criteria and LCC/LCA assessments. These processes generate amounts of radioactive effluents, necessitating robust treatment methods. A two-step precipitation protocol has been optimized to reduce metallic concentration and radioactivity in the effluent. Oxalic acid, a byproduct in nuclear decontamination, poses environmental risks. Various degradation methods are explored, including the use of hydrogen peroxide and metallic ions (Mn^{2+} and Fe^{2+}), which accelerate the breakdown of oxalic acid. UV light and heating are also factors that influence the degradation rate.

Technological progress of contaminated liquid effluents has also been provided. New methods for strontium extraction from acidic solutions are explored using crown ethers in ionic liquids. These methods aim to improve the efficiency of strontium separation, a key fission product in nuclear waste. Finally, in the effort of reducing low-level radioactive wastes generated during chemical decontamination, regeneration and reuse of spent decontamination solutions were dedicated to the use of ionic liquids.

1.2 Contributions in task 4.6

The task 4.6 was dedicated to the “encapsulation of reactive metals (Al, Be) in magnesium phosphate cement-based matrices (MPC)”. MPC matrices are studied as alternatives to ordinary Portland cement (OPC) for encapsulating low and intermediate-level radioactive waste, especially for reactive metals like aluminium and beryllium. The primary motivation for exploring MPC lies in its ability to reduce corrosion rates and mitigate hydrogen evolution, which are significant concerns in waste management and risk assessment.

One study investigated the use of fillers such as coal fly ash, wollastonite, pumice, and metakaolin. These studies found that the fillers did not form new mineral phases, indicating minimal chemical interaction with the cement. Formulations with water-to-cement ratios below 0.65 achieved compressive strengths greater than 30 MPa after 90 days, and the pH values remained below 8.5, helping to prevent aluminium corrosion. The MPC formulations showed good workability and mechanical stability, particularly at higher magnesium-to-phosphate molar ratios (2, 3, and 4).

The long-term durability of MPC was also examined through leaching tests, revealing good stability with a nearly neutral pore solution pH. The leaching process created distinct zones within the paste, with the outermost zone showing depletion of K-struvite ($\text{MgKPO}_4 \cdot 6\text{H}_2\text{O}$, main hydrate of the paste samples) and the formation of alternative phases like calcium-deficient hydroxyapatite and magnesium silicate hydrates. Numerical simulations using reactive transport models supported these experimental findings, confirming the predictable phase evolution and degradation extent in MPC. Leaching was mainly governed by diffusion of dissolved species through the pore network of the paste.

Further studies compared the corrosion behaviour of pure aluminium (A1050) and Al-Mg alloy (AA5754) embedded in MPC and OPC mortars. Key findings indicate that MPC significantly reduces corrosion rates and hydrogen production compared to OPC, attributed to its near-neutral pH which aids in aluminium passivation. Studies examined various $\text{MgO}/\text{KH}_2\text{PO}_4$ (M/P) molar ratios (1, 2, and 3) and curing conditions, including 100% relative humidity and endogenous curing in plastic containers. The corrosion potential (E_{corr}) and corrosion kinetics (i_{corr} and V_{corr}) of aluminium were evaluated over 90 days. Results showed that higher M/P ratios led to increased corrosion resistance and mechanical strength due to improved pore structure and higher physicochemical stability. The presence of phosphate ions in the pore solution inhibited the corrosion process in both pure aluminium and Al-Mg alloys.

In addition to aluminium, the encapsulation and stabilization of metallic beryllium waste in cementitious matrices have been evaluated. Activated beryllium wastes pose significant challenges due to aqueous corrosion, leading to hydrogen production and potential crack formation. Studies on the corrosion behaviour of beryllium metal in various pH conditions revealed that highly alkaline solutions, representative of OPC pore fluids, significantly increase corrosion rates. Scanning electron microscopy indicated that pitting corrosion is the primary mechanism under these conditions.

1.3 List of publications (published)

- Gossard, A., Lilin, A., and Faure, S. (2022). Gels, coatings and foams for radioactive surface decontamination: State of the art and challenges for the nuclear industry. *Prog. Nucl. Energy* 149, 104255. doi: 10.1016/j.pnucene.2022.104255
- Rivonkar, A., Katona, R., Robin, M., Suzuki-Muresan, T., Abdelouas, A., Mokili, M., et al. (2022). Optimisation of the chemical oxidation reduction process (CORD) on surrogate stainless steel in regards to its efficiency and secondary wastes. *Front. Nucl. Eng.* 1. doi: 10.3389/fnuen.2022.1080954

- Barton, D. N. T., Johnson, T., Callow, A., Carey, T., Bibby, S. E., Watson, S., et al. (2023). A review of contamination of metallic surfaces within aqueous nuclear waste streams. *Prog. Nucl. Energy* 159, 104637. doi.org/10.1016/j.pnucene.2023.104637
- Dieguez, M., Ruiz, A. I., Cuevas, J., Alonso, M. C., García-Lodeiro, I., and Fernández, R. (2023). Evaluation of Fillers for Magnesium Potassium Phosphate Cement (MKPC) for the Encapsulation of Low and Intermediate Level Metallic Radioactive Wastes. *Materials (Basel)*. 16, 679. doi: 10.3390/ma16020679
- Perona, R., Fernández-García, C., García-Lodeiro, I., Criado, M., Bastidas, J. M., and Alonso, M. C. (2023). Corrosion behaviour and immobilization of pure aluminum and Al–Mg alloy LLRW in magnesium potassium phosphate cements. *J. Nucl. Mater.* 582, 154501. doi: 10.1016/j.jnucmat.2023.154501
- Sayenko, S., Shkuropatenko, V., Pylypenko, O., Kholomieiev, H., Karsim, S., and Zykova, A. (2023). Production and Properties of Magnesium Potassium Phosphate Cements Containing Ash and Metallurgical Slag Additives for Radioactive Waste Immobilization. *Nucl. Radiat. Saf.*, 30–43. doi: 10.32918/nrs.2023.2(98).03
- Fernández-García, C., Alonso, M. C., Bastidas, J. M., García-Lodeiro, I., and Fernández, R. (2024). MgO/KH₂PO₄ and Curing Moisture Content in MKPC Matrices to Optimize the Immobilization of Pure Al and Al-Mg Alloys. *Materials*. 17, 1263. doi: 10.3390/ma17061263
- Padilla-Encinas, P., Dieguez, M., Cuevas, J., Ruiz, A. I., and Fernández, R. (2024). The Influence of the Magnesium-to-Phosphate Molar Ratio on Magnesium Potassium Phosphate Cement Properties Using Either Wollastonite or Volcanic Ash as Fillers. *Minerals* 14, 103. doi: 10.3390/min14010103
- David, A., Lăutaru, V., and Samarineanu, C. (2024). Corrosion behaviour of aluminium alloys immobilized in MKPC mortar. *J. Nucl. Res. Dev.* 27, 49–50.
- Diaz Caselles, L., Cau Dit Coumes, C., Antonucci, P., Rousselet, A., Mesbah, A., and Montouillout, V. (2024a). Chemical degradation of magnesium potassium phosphate cement pastes during leaching by demineralized water: Experimental investigation and modeling. *Cem. Concr. Res.* 178, 107456. doi: 10.1016/j.cemconres.2024.107456
- Diaz Caselles, L., Cau Dit Coumes, C., Antonucci, P., Rousselet, A., Mesbah, A., and Montouillout, V. (2024b). Leaching of magnesium potassium phosphate cement pastes under alkaline conditions. *Appl. Geochemistry* 170, 106067. doi: 10.1016/j.apgeochem.2024.106067
- Pochat-Cottilloux, H., Frances, F., Girard, L., Rivonkar, A., and Gossard, A. (2024). Colloidal magnetic gels for the decontamination of limited access metallic surfaces. *Environ. Technol. Innov.* 35, 103688. doi: 10.1016/j.eti.2024.103688
- Houzar, J., Čubová, K., Semelová, M., and Němec, M. (2023). Solvent extraction of radiostrontium into ionic liquids using crown ethers. *J. Radioanal. Nucl. Chem.* 332, 1515–1519. doi: 10.1007/s10967-022-08617-2
- Robin, M., Rivonkar, A., Suzuki-Muresan, T., Abdelouas, A., and Mokili, M. (2024). Optimized precipitation process for the treatment of radioactive effluents from Ni-alloy decontamination using a chemical oxidation reduction process. *Front. Nucl. Eng.* 3. doi: 10.3389/fnuen.2024.1396821
- Blenkinsop, J., Rivonkar, A., Robin, M., Carey, T., Dunnett, B., Suzuki-Muresan, T., et al. (2024). Methods for the destruction of oxalic acid decontamination effluents. *Front. Nucl. Eng.* 3. doi: 10.3389/fnuen.2024.1347322
- Bukaemskiy, A., Caes, S., Modolo, G., Deissmann, G., and Bosbach, D. (2024). Investigation of kinetics and mechanisms of metallic beryllium corrosion for the management of radioactive wastes. *MRS Adv.* 9, 391–396. doi: 10.1557/s43580-024-00835-y

- Houzar, J., Cubova, K., Semelova, M., and Nemeč, M. (2024). Liquid–liquid extraction of strontium from acidic solutions into ionic liquids using crown ethers. *J. Radioanal. Nucl. Chem.* doi: 10.1007/s10967-023-09293-6

1.4 List of publications - Peer reviewed (Under preparation / Submitted)

- Fernández-García, C., Padilla-Encinas, P., Fernández, R., & Alonso, M. C. (2024). Interaction of aluminium alloys with MKPC and OPC blended cements on the metal – matrix interface. *Applied Geochemistry Journal* (under review).
- A. Callow, D. Connor, T. Carey, K. Summers, C. Hofer, K. Jurkschat, J. Street, S. Bibby, Understanding the hazard from contamination on nuclear reprocessing plant: A study of caesium and strontium uptake onto NAG18/10L stainless steel, *J. Haz. Mater.* (under review).
- F. Fattori, G. Magugliani et al., “Radiation Stability and Durability of Magnesium Phosphate Cement for Radioactive Reactive Metals Encapsulation”, *Cement and Concrete Research* (under review).
- Leskinen, A; Kekki T.: Analysis of ⁵⁹Ni in high activity steel. To be submitted in *Journal of radioanalytical and nuclear chemistry*.
- Meriläinen, V; Leskinen, A: Analysis of ⁹³Mo in high activity steel. To be submitted in *Journal of radioanalytical and nuclear chemistry*.
- A. Markopoulos, D. Mavrikis, A. Savidou, D. Germanas, M. Konstantinova, L. Juodis, E. Lagzdina, K. Mikalauskiene, R. Plukienė, A. Plukis, “Non-destructive analysis possibilities for low level waste surface contamination and volume activation determination” (Under preparation not submitted yet).
- K. Mikalauskiene, R. Plukienė, D. Germanas, M. Konstantinova, E. Lagzdina, L. Juodis, A. Plukis, Method for surface and volume activity determination in metallic radioactive waste samples (Under preparation not submitted yet).

1.5 List of journals

- Applied Geochemistry
- Cement and Concrete Research
- Environmental Technology & Innovation
- Frontiers in Nuclear Engineering
- Journal of Nuclear Materials
- Journal of Radioanalytical and Nuclear Chemistry
- Materials
- Minerals
- MRS Advances
- Nuclear and Radiation Safety
- Progress in Nuclear Energy

2 Organisation of technical workshops

PREDIS project started during the COVID time, disabling any organization of technical workshops in person. Thus, remote meetings were organized the first two years (2020-2021). Thereafter, two technical meetings were organized per year (with a total of 7 meetings) among which half was done in junction with the general annual assembly event.

These meetings were dedicated to present the major progresses and to discuss difficulties encountered if any, as well as the future actions. Each partner and sub-tasks had allocated time for the presentations.

- 2020 : 19-20 October (on-line)
- 2021
 - 4 May: workshop (on-line)
 - 23 November: workshop (on-line)
- 2022
 - 26 April: workshop held at VTT (Espoo, Finland)
 - 21 October: workshop held at IMT Atlantique (Nantes, France)
- 2023
 - 24 May: workshop held at Conference Centre Lamot (Mechelen, Belgium)
 - 24 November: workshop held at IJC Lab (Orsay, France)
- 2024: 4 June: workshop held at Novotel Avignon Center (Avignon, France)

3 Organisation and participation of webinars

The work package 4 was involved in the preparation and organisation of three webinars (2021, 2024) and in the participation of one webinar in 2021.

Webinar February 16th 2021	Webinar October 5th 2021	Webinar October 26th 2021	Webinar February 14th 2024
Innovations in Metallic Waste Treatment and Conditioning	PREDIS metallic and organic waste characterization	Geopolymers in Radioactive Waste Management	Difficult To Measure (DTM) Radionuclides: progress and new challenges
WP4	WP2, WP4 – WP7	WP2, WP4 - WP6	WP4

3.1 Organisation of the webinar of 16th February 2021

This webinar was dedicated on the “Innovations in metallic material treatment and conditioning: Getting the most from optimised characterisation, efficient decontamination and advanced conditioning of both ferrous and more reactive metallic wastes”. It was chaired by B. Grambow and A. Abdelouas (IMT Atlantique, France). Waste management agencies, technical support organisation, research entities, as well as the end-users and stakeholders have participated by sharing their point of view. General presentations were given on metallic waste management & characterization and specific topics were dedicated on uncertainties in neutron activation calculation, decontamination activities in NPP, and magnesium phosphate cement as host matrix for metallic waste. Finally the different technologies (from treatment to conditioning) to be developed within the WP4 have been also presented. The access to the presentations can be found [here](#).

3.2 Participation to the webinar of 5th October 2021

This webinar was dedicated to “metallic and organic waste characterization” joining the WP2 (Strategic Implementation) and the technical workpackages (WP4 to 7) issues, and chaired by E. Holt (VTT, Finland). Work Package 4 presented the variety of materials used in the studies, including metallic materials (stainless steel, Ni-Alloy, etc.) and conditioning materials (cement) and the

characterization techniques (simulation, gamma, beta, alpha spectrometry, XRD, FTIR, NMR, etc.). It was conducted together with other European projects that are in close field, were also invited to participate, such as CHANCE, MICADO, TOMI, etc. The access to the presentations can be found [here](#).

3.3 Participation to the webinar of 26th October 2021

This webinar was devoted to “Geopolymers in Radioactive Waste Management”, chaired by E. Holt (VTT, Finland). A general introduction explains the benefits and advantages of this innovative material for conditioning nuclear wastes stemming from waste treatments and decommissioning. Technical presentations from WP4 to WP6 with the contribution of WP2 were given. WP4 presented its contributions within PREDIS project by assessing the chemical durability of different formulations of geopolymers with the effect of gamma irradiation. The access to the presentations can be found [here](#).

3.4 Organisation of the webinar of 14th February 2024

This webinar was devoted to the analysis and the measurements of hard-to-detect radionuclides for various applications, such as metal and concrete, and chaired by T. Suzuki-Muresan (IMT Atlantique, France). It covered measurement innovations and future prospects. Radioactivity levels of these radionuclides can be determined through non-destructive methods, such as scaling factors or modelling, or through destructive methods involving selective extraction of the radionuclides. These approaches are complementary and offer a range of options for accurately assessing radioactivity levels. Almost 130 persons from European countries participate including waste management agencies, technical support organisation, research entities, as well as the end-users and stakeholders. The access to the presentations can be found [here](#).

4 Participation to events/conferences

4.1 Internal events – general assembly/public

The PREDIS General Assemblies are events that share scientific progresses and collaborative efforts with the end-users group and stakeholders. Each presentation of the work package 4 begins with a comprehensive overview presented by the WP leader, A. Abdelouas (IMT Atlantique, France). His presentations provided a general overview of the progress of the work package and set the stage for the more detailed presentations that followed.

In 2022, the General Assembly was held in Espoo, Finland. A highlight on “WP4 Tasks on Metallic Decontamination” was delivered by A. Rivonkar and al. (IMT Atlantique, France).

The 2023 General Assembly took place in Mechelem, Belgium, featuring several presentations:

- R. Plukiene (FTMC, Lithuania, task 4.5) discussed the ongoing work to optimize metallic waste characterization.
- T. Suzuki (IMT Atlantique, France, task 4.5) presented the new radiochemical procedures for difficult-to-measure (DTM) radionuclides.

Additionally, there were two engaging student presentations:

- Carla Fernández (CSIC, Spain, task 4.6) explored the corrosion of aluminum in magnesium phosphate cements.
- Jessica Hopkin (NNL, UK, task 4.4) focused on the decontamination of oxidized metallic waste.

In 2024, the General Assembly was held in Avignon, France, including highlights and main achievements reached by each task during the PREDIS project:

- Tomo Suzuki (IMT Atlantique, task 4.4) discussed the development and optimization of decontamination processes.
- Savidou (NCSR, Greece, task 4.5) presented the optimization of characterization and waste minimization techniques.
- Cannes (IJCLab, France, task 4.6) covered advances in encapsulating materials in magnesium phosphate cement-based matrices.

In addition to these, there were two engaging student presentations:

- D. Mavrikis (NCSR, Greece, task 4.5) described a non-destructive gamma spectrometry setup for the characterization of metallic waste.
- M. Robin (IMT Atlantique, France, task 4.4) discussed the decontamination of radioactive effluents.

The proceedings of the PREDIS annual workshops including the contributions from WP4 partners can be found here:

- Deliverable 1.5 – [Proceedings of PREDIS May Workshop 2021](#),
- Deliverable 1.5 – [Proceedings of PREDIS April Workshop 2022](#),
- Deliverable 1.5 – [Proceedings of PREDIS May Workshop 2023](#),
- The last proceedings of June workshop 2024 will be available [here](#).

4.2 External conferences

Scientific results and significant advancements in metal radioactive waste management were disseminated through presentations (oral, posters) at international conferences and workshops.

List of contributions with proceedings

- 2021
 - Rivonkar, A., Suzuki, T.-M., Abdelouas, A., Mokili, M., and Katona, R. (2021). Study of Existing Chemical Decontamination Methods of Radioactive Metals with a View on their Optimization. International Conference on Radioactive Waste Management: Solutions for a Sustainable Future – Programme (IAEA), Nov. 1-5 (Vienna, Austria)
 - M. Konstantinova, E. Lagzdina, D. Germanas, D. Lingis, J. Garankin, R. Plukienė, A. Plukis, V. Remeikis, Modeling of gamma spectra in samples of various geometries of metal waste from nuclear power plants, LNFK-44// 44th Lithuanian National Physics Conference, 2021 October 6 - 8, Program and abstracts. Vilnius, 2021, P85. ISBN 9786099551180
 - R. Plukienė, A. Plukis, E. Lagzdina, M. Konstantinova, A. Savidou, S. Coninx, J. Feinhals, Characterization and classification of the metallic radioactive waste of the nuclear reactors in PREDIS LNFK-44// 44th Lithuanian National Physics Conference, 2021 October 6 - 8, Program and abstracts. Vilnius, 2021, O49. ISBN 9786099551180. p. 1
 - E. Lagzdina, D. Germanas, D. Lingis, J. Garankin, M. Konstantinova, R. Plukienė, A. Plukis and V. Remeikis, Modeling of γ -spectra for characterization of surface and volume activity in different geometry metallic waste samples, The European Nuclear Young Generation Forum (ENYGF), Tarragona, Spain, September 27-30, 2021

- R. Plukienė, A. Plukis, E. Lagzdina, M. Konstantinova, A. Savidou, S. Coninx, J. Feinhals, Classification of the metallic radioactive waste streams of the different types of reactors in PREDIS, International Conference on Radioactive Waste Management: Solutions for a Sustainable Future, IAEA Headquarters Vienna, Austria, 1–5 November 2021.
- 2022
 - Anne Callow, Thomas Carey, Daniel Barton, Thomas Johnson, Junliang Liu, Clint Sharrad, and Sarah Bibby, Preparation of Artificially Contaminated Stainless-Steel Samples for Decontamination Technology Development, WM2022 Conference, Phoenix Arizona, USA
 - R. Plukienė, A. Plukis, E. Lagzdina, M. Konstantinova, A. Savidou, S. Coninx, J. Feinhals, Metallic radioactive waste classification for the different types of reactors considered in PREDIS, International Conference FISA 2022 / EURADWASTE '22, 30 May–3 June 2022, Lyon, France.
 - E. Lagzdina, D. Germanas, D. Lingis, J. Garankin, M. Konstantinova, R. Plukienė, A. Plukis, and V. Remeikis, Discrimination of surface and volume activity in metallic waste samples by using HPGe and CeBr₃ detectors and MCNP modelling of γ -spectra, International Conference FISA 2022 / EURADWASTE '22, 30 May–3 June 2022, Lyon, France.
 - Rivonkar, A., Katona R., Robin M., Suzuki-Muresan, T, Abdelouas, A., Mokili, M., Study of existing chemical decontamination methods of radioactive metals with a view on their optimization, International Conference FISA 2022 / EURADWASTE '22, 30 May–3 June 2022, Lyon, France.
 - Katona R., Rivonakar A., Robin M., Bator G., Abdelouas A., Somlai J., Kovacs T., Effects of AP-CITROX decontamination technology to Ni-alloys, International Conference FISA 2022 / EURADWASTE '22, 30 May–3 June 2022, Lyon, France.
 - Robin M., Suzuki-Muresan T., Abdelouas A., Mokili M., Development of decontamination processes for metallic radioactive effluents, International Conference FISA 2022 / EURADWASTE '22, 30 May–3 June 2022, Lyon, France.
- 2023
 - I. Moschetti, L. Sarrasin, G. Blain, E. Mossini, M. Mariani, and A. Abdelouas, “Effect of Curing Time and Water to Binder Ratio on Magnesium Potassium Phosphate Cement Exposed to Gamma Irradiation” in ASME 2023 International Conference on Environmental Remediation and Radioactive Waste Management, Stuttgart, Germany: American Society of Mechanical Engineers, Oct. 2023, p. V001T05A001. doi: 10.1115/ICEM2023-109457
 - Fattori, E. Mossini et al. Radiation Stability and Durability of Magnesium Phosphate Cement for the Encapsulation of Radioactive Reactive Metals, ICEM2023, Stuttgart (Germany), October 2023
 - K. Mikalauskiene, M. Konstantinova, D. Germanas, R. Plukienė, E. Lagzdina, A. Plukis, Assessment of Compton/photopeak ratio for various thickness metal shielding, Proc. of Int. Conf. “Medical Physics in the Baltic States 2023”, Kaunas, Lithuania, 09-11 November (2023), ISSN 1822-5721
 - E. Lagzdina, R. Plukienė, D. Germanas, K. Mikalauskiene, M. Konstantinova, A. Plukis, V. Remeikis, Modelling and experimental determination of surface and volume activity in different geometry metallic waste samples, ENYGF, Kraków, Poland, 8 - 12 May 2023.

- M.-Ch. Bornhoeft, G. Colavolpe, S. Coninx, H. D. Espejo, J. Feinhals, F. Gagliardi, F. Gentile, E. Lagzdina, N.J. L. Leganés, A. Leskinen, A. Markopoulos, D. Mavrikis, M. Němec, R. Plukiene, A. Savidou, T. Suzuki-Muresan, Optimization of metallic waste characterization and procedures for waste minimization and recycling in PREDIS project, International Conference on Radioactive Waste Management: Solutions for a Sustainable Future, IAEA Headquarters Vienna, Austria, 15-19 May 2023.
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5 Social networks

The visibility and engagement of partners involved in Work Package 4 were shared and disseminated across professional platforms like LinkedIn using the hashtag [#PREDIS](#). This platform was utilized to publish the latest scientific papers and to share highlights from workshops and conferences.

6 Press release and Institutional Annual reports

The PREDIS project has received considerable attention, with press releases and annual reports from partners' institutions appearing on multiple sites. This coverage highlights the innovative aspects and potential impact of the PREDIS project and the contributions of the partners in WP4. Here are some examples:

- <https://www.ftmc.lt/department-of-nuclear-research/projects>
- <https://imtech.imt.fr/en/2020/09/10/innovating-to-improve-radioactive-waste-management-predis/>

- <https://www.imt-atlantique.fr/fr/recherche-innovation/collaborer/projet/predis>
- <https://www.enresa.es/documentos/annual-report-2020.pdf>
- https://nuclear.ro/wp-content/uploads/2022/10/Raport-Anual_2021_final_31-mai-2022st-m_postat-V.-ENG.-IUN.2022.pdf

7 Acknowledgements

This work has received funding from the Euratom research and training programme 2019-2020 under agreement No 945098 (PREDIS project).