

**National and International Experiences in
Management of Radioactive Waste Arising
from Medical Applications**

**Report of the ENSREG WG2 Workshop, Luxembourg,
October, 7, 2025**

HLG-p(2026-58)_225 Report on the WG2 Workshop-Medical
Waste

ENSREG WG2 WORKSHOP

National and International Experiences in Management of Radioactive Waste Arising from Medical Applications

Luxembourg, October 7, 2025

Objectives and scope of the workshop

The aim of the workshop was to support the analysis and review of regulatory approaches and management practices for radioactive waste arising from non-energy uses of nuclear and radiation technologies, with particular emphasis on medical applications. Also, to provide a structured forum for the exchange of knowledge, experience, and current practices among Member States. Through this exchange, it could facilitate the identification of common challenges and opportunities for improvement in the regulation and management of radioactive waste from non-energy applications. The workshop was conceived as a collective learning exercise, intended to support continuous improvement.

In ENSREG's Programme of Work 2024-2026, a task to share experience regarding national approaches for specific operational issues highlighted by the 2021 WG2 survey on the non-nuclear radioactive waste management practices in EU was included and under this task the workshop was organised within the framework of the activities of ENSREG Working Group 2 (WG2).

Background and rationale

The organisation of the workshop built directly on earlier work carried out within ENSREG WG2, notably the ENSREG WG2 survey on the management of radioactive waste arising from medical applications of ionising radiation, conducted in 2021–2022.

The questionnaire enabled the collection of information on regulatory provisions and management practices across Member States and supports the identification of recurring challenges and waste streams requiring further specification of pre-disposal management.

That survey examined regulatory requirements and management practices across Member States, taking into account the SAMIRA Strategic Agenda for Medical Ionising Radiation Applications. The survey confirmed that radioactive waste arising from medical applications is generally integrated into national radioactive waste management frameworks, in accordance with national programmes established under Council Directive 2011/70/Euratom. At the same time, it highlighted that, while overarching legal and organisational frameworks are largely in place, certain waste streams and management steps require further clarification and experience-sharing, particularly with respect to pre-disposal management.

The analysis of survey responses confirmed that, even where no immediate safety concerns are reported, opportunities exist to further refine and optimise existing approaches. In particular, the results point to areas where improvements may be envisaged with regard to treatment methods, storage arrangements, and interfaces between licensees, regulatory authorities, and radioactive waste

management organisations. These insights informed both the selection of workshop themes and the design of the exchange format.

In this context, the workshop was conceived as a logical continuation of the survey, shifting the focus from data collection and comparative analysis towards a structured exchange of practical experience among Member States.

Preparatory work

The survey results indicated that, in most Member States, radioactive waste arising from medical applications is managed within the same general frameworks as other radioactive waste streams, and that pre-disposal management arrangements are in place. However, the survey also showed that disposal solutions are not always fully specified for certain waste streams and that specific challenges persist, notably in relation to waste arising from historical activities, the decommissioning of medical installations, and the use of new radioisotopes and emerging technologies.

Based on these findings, the workshop was designed to provide an opportunity to further explore waste streams identified as requiring additional attention, to facilitate peer-to-peer exchange on regulatory, organisational, and operational approaches, and to identify areas where experience-sharing contributes to optimisation and continuous improvement. The workshop did not seek to promote prescriptive harmonisation, but rather supports mutual learning within the diversity of national frameworks.

Thematic scope of the workshop

In line with the survey conclusions, the workshop discussions were structured around three thematic areas reflecting the origin of the waste streams identified by Member States as requiring further consideration. These include waste arising from historical activities, such as disused sealed sources and legacy medical equipment; waste arising from operational management and decommissioning activities, including installations such as cyclotrons, particle therapy facilities, and accelerators; and waste arising from the use of new radioisotopes, treatments, and emerging technologies, for which pre-disposal management solutions are still evolving.

These thematic areas provided a coherent framework for focused discussions and support the exchange of practical experience among participants.

Organisation and methodology

The workshop was organised as a one-day, hybrid (in-person and online participation) event, structured into sequential thematic sessions (see Annex 1). This format ensures that all participating Member States were able to engage with each thematic area, irrespective of whether they contribute a presentation.

The workshop methodology was based on voluntary contributions by Member States, with presentations focusing on practical experience rather than formal policy positions. Each thematic session was followed by moderated discussions, including question-and-answer exchanges and online discussions. The agenda was designed with sufficient flexibility to allow the depth and duration of discussions to adapt to the level of participation and interest.

The topics and challenges to be addressed were communicated to participants in advance, enabling targeted preparation and supporting meaningful dialogue. Consistent with the approach adopted in the survey, the workshop followed a non-evaluative and non-comparative methodology.

Principles guiding participation and exchange

Participation in the workshop was based on a voluntary and collective approach, reflecting the shared objective of improving practices through mutual learning. Contributions were not attributed to individual Member States, and the workshop deliberately avoided singling out specific practices or regulatory approaches.

The workshop recognised that the absence of reported difficulties does not necessarily indicate optimality of existing arrangements and that the improvement of radioactive waste management practices is a continuous process requiring sustained dialogue and experience-sharing among Member States.

Positioning within ongoing WG2 work and follow-up

The workshop represents an intermediate step between the analytical conclusions of the WG2 survey and potential future WG2 activities. It contributes to deepening the understanding of practical challenges identified in the survey, identifying good practices and areas for further exploration, and informing possible future thematic work, without pre-empting regulatory or policy conclusions.

The outcomes of the workshop support WG2 in its ongoing work and inform future discussions on the optimisation of regulatory and management approaches for radioactive waste arising from non-energy uses.

Overview of the Workshop Presentations

Session 1: Waste from Historical Activities

- **Decommissioning of a Historically Contaminated Hospital: Overview of Legacy Radiological Pollution and Operations Undertaken Since 2020.** This case illustrates that historical medical practices can result in legacy contamination comparable to non-medical legacy sites and highlights the importance of preserving institutional memory, ensuring clear allocation of responsibilities, and maintaining adaptable regulatory and financing frameworks.
- **Safe management of biohazardous radioactive waste from medical applications. Lessons Learnt.** This case highlights the critical role of robust characterisation and clearance verification for biohazardous radioactive waste from medical applications. Waste initially considered short-lived may contain hidden long-lived radionuclides due to impurities, activation products, or cross-contamination. A stepwise approach combining decay storage, statistically justified sampling, and complementary non-destructive and destructive analyses is therefore essential. Experience shows that a significant share of waste batches requires reclassification as radioactive waste. The case also underlines the need for site-specific clearance scenarios, strong traceability, dedicated budget allocation, strict regulatory oversight, and the use of radionuclides free of impurities to ensure safe and compliant waste management.
- **Characterisation of the Reconditioning Projects / Reconditioning of Historic Waste in Austria.** This case shows that systematic reconditioning of historic waste packages is essential to ensure long-term safety where original conditioning, documentation, or container integrity is inadequate. Robust waste characterisation is a prerequisite for sound decision-making, clearance, and waste minimisation. The use of simple, proven technologies enables reliable implementation and cost control. Reconditioning significantly reduces the volume of waste (minimisation strategy) requiring long-term management and mitigates risks linked to extended interim storage.
- **Management of radium-contaminated waste from medical applications.** This case shows that radium-containing waste from medical applications requires long-term, adaptive management strategies. Historical legacies continue to emerge despite past collection campaigns, while new medical technologies generate future radium-bearing waste streams. Robust conditioning, control of gas generation, and radon management are essential. The case highlights the need for flexible treatment routes, sustained inventories, recycling options and dedicated disposal solutions for radium waste.
- **Treatment and conditioning of radium sources and institutional waste.** This case demonstrates that safe long-term management of radium sources relies on robust conditioning, shielding, and traceability. Integrated treatment facilities and digital life-cycle documentation support waste minimisation and regulatory confidence. Even small waste inventories require stable institutional arrangements and long-term planning to ensure compatibility with future disposal.

Session 2: Operational Radioactive Waste Management

- **Non-nuclear radioactive waste management within a national framework.** This case shows that clear allocation of waste-management responsibility to the waste producer, combined with early planning, financial securities, and clearance-based strategies, is essential for non-

nuclear radioactive waste. Existing disposal facilities can support institutional waste if regulatory flexibility is ensured. Clear guidance on waste characterisation and acceptance criteria remains critical to address waste streams outside standard disposal routes.

- **Management of radioactive waste from a university hospital nuclear medicine clinic.** This case highlights that large volumes of low-activity medical waste require structured procedures, adequate measurement capability, and trained staff. Clearance decisions are strongly influenced by radioactive impurities. Waste-management systems must be proportionate to the scale and complexity of medical activities, and cost recovery mechanisms should support sustainable practice.
- **Radioactive waste arising from nuclear medicine wastewater treatment systems.** This case shows that wastewater treatment shifts radioactive discharges into solid waste streams requiring robust characterisation and decay management. Accumulation of long-lived impurities can limit clearance options and increase disposal costs. Waste generation from treatment systems should be considered early in facility design and regulatory decision-making.

Session 3: Waste from Operational and Decommissioning Activities

- **Management of activated accessories from proton therapy facilities.** Activated accessories may generate small but complex waste streams requiring detailed characterisation. Early planning for decay storage, reuse, or disposal avoids unnecessary waste generation. Material choice and component design strongly influence long-term waste management outcomes.
- **Dismantling of cyclotrons and linear accelerators.** Early and systematic characterisation during dismantling is essential to minimise radioactive waste volumes. Material segregation and decay storage enable optimisation. Pre-agreed dismantling strategies prevent unnecessary disposal of low-risk materials.
- **Decommissioning of cyclotrons – lessons learned from Project MIRDEC.** Cyclotron decommissioning confirms that design and operational choices determine future waste volumes. Early planning, stakeholder coordination, and lifecycle thinking are key to safe and cost-effective waste management.
- **Design options for cyclotrons to minimise radioactive waste during dismantling.** Design choices strongly influence activation and dismantling waste volumes. Low-activation materials, sacrificial shielding, and modular designs enable effective waste minimisation. Waste prevention begins at facility design.

Session 4: Regulatory and Operational Challenges in the Management of Emerging Therapies

- **Specialised toilet systems for radionuclide therapy patients.** Filtered toilet systems shift radioactivity from liquid effluents to solid waste. While discharge is reduced, filters require shielding, decay storage, and long-term management. Secondary waste must be fully integrated into the waste strategy.
- **Management of Waste produced by Radionuclide Therapy Patients.** Patient-related waste can disrupt conventional waste systems despite low activity levels. Clear procedures, patient instructions, and coordination with waste operators are essential to reduce alarms and ensure effective waste management.

Conclusions, overarching issues and way forward

Across Member States, radioactive waste arising from medical applications is not always systematically identified, characterised, and integrated into national radioactive waste management programmes. This can lead to gaps in completeness, inconsistencies between sectoral practices and national strategies, and challenges in demonstrating regulatory compliance. In several cases, waste from medical applications is only partially reflected in national radioactive waste inventories. Where such waste streams are insufficiently represented in inventories, their impact on national programme provisions, such as waste treatment routes, storage capacity, clearance strategies, and financial planning, tends to be underestimated. In addition, the principle of minimisation of radioactive waste generation is not always systematically embedded throughout the lifecycle of medical facilities, from design and construction to operation and decommissioning. This points to a broader need for improved coordination between healthcare operators, waste producers, and competent authorities, as well as for harmonised approaches to inventory development, programme integration, and waste minimisation practices across Member States.

In light of the issues identified, it is proposed to continue the work of WG2 with a specific focus on the integration of radioactive waste arising from medical applications into comprehensive national radioactive waste management programmes. This continued work could provide a structured framework for further analysis, exchange of experience, and development of shared understanding among Member States.

The possible topics to follow up are:

- Approaches to identify and incorporate radioactive waste streams from medical applications systematically into Member States' national programmes to ensure completeness, coherence, and regulatory compliance. This would allow an assessment of existing practices, identification of common challenges, and consideration of possible elements for guidance to support completeness, coherence, and regulatory compliance.
- To what extent is the inventory of radioactive waste from medical applications reflected in national waste inventories. Such an assessment may highlight differences in scope, level of detail, and data quality, and help identify opportunities for improved alignment or harmonisation of inventory practices across Member States.
- To what extent does the inventory of radioactive waste from medical applications impact provisions of national programmes. This work could help clarify whether and how inventory data are effectively used to support strategic and long-term decision-making.
- How is the principle of minimisation of generation of radioactive waste taken into account during the design, construction, operation and decommissioning of medical facilities. This may include examining technical, organisational, and procurement-related measures that contribute to reducing waste generation at source.

Overall, this proposed continuation of WG2 activities could lead to the identification of good practices, lessons learned, and possible recommendations, supporting Member States in strengthening the integration of radioactive waste from medical applications into their national programmes in a coherent, transparent, and sustainable manner.

ANNEX 1 – Workshop programme

National and International Experiences in Management of Radioactive Waste Arising from Medical Applications

Date	October 7, 2025
Time	9:00–17:30
Venue	Luxembourg, DG ENER ; 10 Rue Robert Stumper, 2557 Gasperich Luxembourg, Luxembourg

09:00–09:15 — Welcome and Opening Remarks

- Introduction
- Objectives of the workshop

Session 1: Waste from Historical Activities, 09:15–10:30

Moderator: Maryna SURKOVA (FANC, Belgium)

Time	Topic	Speaker
09:15–09:35	Decommissioning of a Historically Contaminated Hospital: Overview of Legacy Radiological Pollution and Operations Undertaken Since 2020.	Corine SALMON (ASNR, France)
	<i>Questions/Comments</i>	ALL
09:40–10:00	Safe Management Strategies for Biohazardous Radioactive Waste. Lessons Learnt.	Egidio MAURO (NUCLECO, Italy)
	<i>Questions/Comments</i>	ALL
10:05–10:25	Characterisation of the Reconditioning Projects.	Wolfgang NECKEL (NES, Austria)
	<i>Questions/Comments</i>	ALL
10:30–10:50	Management of Radium-Contaminated Waste from Medical Applications.	Ester STEVENS (ONDRAF/NIRAS, Belgium) <i>online</i>
	<i>Questions/Comments</i>	ALL
10:55–11:15	Treatment and Conditioning of Ra-226 Sources.	Wolfgang NECKEL (NES, Austria)
	<i>Questions/Comments</i>	ALL
11:20–11:25	Summary Session 1	Moderator/Reporter

11:25–11:45 — Coffee Break

Session 2: Operational Radioactive Waste Management, 11:45–13:00**Moderator:** David Garf ULFBECK (SIS, Denmark)

Time	Topic	Speaker
11:45-12:05	Non-Nuclear Radioactive Waste Management	Kai Hämäläinen (STUK, Finland)
	<i>Questions/Comments</i>	ALL
12:10-12:30	Management of radioactive waste from the clinic for nuclear medicine and other departments of a university hospital in Germany	Dr. Carsten WANKE (MHH, Germany) <i>online</i>
	<i>Questions/Comments</i>	ALL
12:35-12:55	Radioactive waste arising from operation of a nuclear medicine wastewater treatment system	Dr. Bastian SZERMERSKI (MHH, Germany) <i>online</i>
	<i>Questions/Comments</i>	ALL
12:55-13:00	Summary Session 2	Moderator/Reporter

13:00–14:00 — Lunch Break**Session 3: Waste from Operational and Decommissioning Activities, 14:05–15:45****Moderator:** David Garf ULFBECK (SIS, Denmark)

Time	Topic	Speaker
14:05-14:20	Specific Management of Activated Collimators from Proton therapy. Lessons learned	Corine SALMON (ASNR, France)
	<i>Questions/Comments</i>	ALL
14:25-14:45	Decommissioning of cyclotrons and accelerators in the Spanish regulatory framework	Ramón SENDON (CSN, Spain)
	<i>Questions/Comments</i>	ALL
14:50-15:10	Decommissioning of Cyclotrons. Project MIRDEC. Lessons Learnt.	David Garf ULFBECK (SIS, Denmark)
	<i>Questions/Comments</i>	ALL
15:15-15:35	Design Options for Cyclotrons to Minimize Radioactive Waste During Dismantling.	Frédéric SCHMITZ (Bel V, Belgium)
	<i>Questions/Comments</i>	ALL

Time	Topic	Speaker
15:40-15:45	Summary Session 3	Moderator/Reporter

15:50–16:00 — Coffee Break

Session 4: Regulatory and Operational Challenges in the Management of Emerging Therapies, 16:00–17:00

Moderator: Maryna SURKOVA (FANC, Belgium)

Time	Topic	Speaker
16:05–16:25	Specialized Toilet Systems for Radiotherapy patients. Lessons Learnt.	Lorenzo CIMINO (FANC, Belgium) <i>online</i>
	<i>Questions/Comments</i>	ALL
16:30-16:50	Management of Waste produced by Radionuclide Therapy Patients.	Marleen VANDECAPELLE (FANC, Belgium) <i>online</i>
	<i>Questions/Comments</i>	ALL
16:55-17:00	Summary Session 4	Moderator/Reporter

17:00–17:20 — Panel Discussion and Wrap-Up

- Key reflections from all session moderators
- Questions from participants
- Proposals for future cooperation and next steps

17:20-17:30 — Closing Remarks

- Summary by organizers
- Thank-you to participants

ANNEX 2 – Feedback of the Participants

The evaluation results show that the workshop was highly appreciated and considered successful by participants. The content was viewed as relevant, informative, and well delivered, providing concrete insights and practical value.

While the overall format worked well, the feedback highlights interaction—particularly for online participants—as the main area for potential improvement. Participants expressed strong interest in continued exchanges and more in-depth discussions on specific technical and regulatory challenges in future editions.

In conclusion, the workshop met its objectives effectively and provides a solid foundation for future events, with opportunities to further strengthen interaction and deepen thematic focus.

The following questions have been asked to the participants:

Area	Question
1. Relevance of the content:	What aspects of the workshop content did you find most relevant or useful for your work, and why?
2. Clarity and Presentation:	How did you experience the presentations in terms of clarity, style, and engagement, and how could they be improved?
3. Practical Usefulness:	Which insights, examples, or tools from the workshop do you think you can apply in your own work, and how?
4. Interaction and Participation:	How did you feel about the opportunities to discuss, exchange ideas, and connect with other participants, and what could make these interactions even more valuable?
5. Suggestions for Improvement and Future Work:	What changes or additions would you suggest for future workshops to make them more effective or engaging? What topics/challenges to discuss would you like to see in the next edition?

Below, a more narrative overview of the feedback from the participants per evaluation question is given. The anonymity of the participants is kept.

1. Relevance of the content: aspects of the workshop content that were most appreciated

Participants expressed a very positive overall appreciation of the workshop content. The feedback indicates that all aspects of the workshop were considered relevant and useful, with particular emphasis on the quality and usefulness of the presentations. Several respondents highlighted that the talks provided valuable insights and concrete examples, and that the diversity of topics contributed to a well-balanced programme.

2. Clarity and Presentation: experience of the presentations (content, clarity, format)

The presentations were generally described as clear, well-structured, and informative. Participants appreciated the high technical quality and the relevance of the topics addressed.

Some respondents who attended online noted minor technical issues, such as occasional sound quality problems, but these did not significantly affect the overall positive experience. The hybrid format was seen as functional, though slightly less conducive to interaction for online participants.

3. Practical Usefulness: Key insights, examples, or tools gained from the workshop

Participants reported gaining practical and applicable insights, particularly related to:

- Concrete operational examples
- Treatment and management of specific waste streams, including aqueous discharges
- Regulatory and technical approaches that can be transferred to their own contexts

The workshop was perceived as contributing meaningfully to knowledge exchange and professional learning.

4. Interaction and Participation: Opportunities for discussion and interaction

In-person participants generally felt that the opportunities for discussion were good and constructive.

However, several respondents indicated that interaction was more limited for online participants, who found it more difficult to engage actively in discussions. Some feedback suggested that additional or more structured discussion moments could further enhance interaction, especially in hybrid settings.

5. Suggestions for Improvement and Future Work:

Suggestions for improvement or future editions

Suggestions for improvement focused mainly on enhancing interaction, rather than on content changes. Proposed ideas included:

- Introducing break-out groups or informal discussion sessions
- Creating more dedicated time slots for exchange between participants
- Further improving engagement opportunities for online attendees

Overall, the suggestions were incremental and constructive, reflecting a generally high level of satisfaction.

Topics and challenges for future discussion

Participants expressed interest in addressing more specific and advanced technical topics in future workshops. Suggested themes included:

- Cyclotron-related challenges
 - What are the main challenges and good practices related to gaseous abatement and monitoring at cyclotron facilities, and how can regulatory oversight be improved?
- Management of emerging radionuclides in nuclear medicine

- What specific waste management challenges arise from the increasing use of Actinium and other emerging radionuclides in nuclear medicine therapies, and how can they be addressed proactively?
- Preventive design and operation of new facilities
 - Which preventive measures should be integrated into the design, licensing, and operation of new facilities to avoid recurring radioactive waste management and contamination issues observed in existing installations?
- Assessment criteria for radioactive waste management procedures
 - What criteria and methodologies are used by regulatory authorities to assess the adequacy of facility procedures for radioactive waste management and material clearance, and how consistent are these approaches across countries?
- Exemption, clearance, and discharge criteria across EU Member States
 - How do national approaches to exemption, clearance, disposal, reuse, and discharges differ across EU Member States, particularly regarding:
 - clearance values and assessment methods,
 - distinctions between NORM and artificial radionuclides, and
 - short-lived versus long-lived radionuclides?
- Graded approach and ALARA implementation
 - To what extent is the graded approach and ALARA principle implemented in a harmonised way across EU Member States, and where do significant national differences persist in regulatory practice?
- Harmonisation versus flexibility in EU radiation protection regulation
 - Which areas of radiation protection regulation would benefit most from further EU harmonisation, and where is national flexibility justified (e.g. existing exposure situations or emergency exposure situations)?
- Radioactive consumer products and cross-border inconsistencies
 - How are radioactive consumer products (such as smoke detectors) regulated and managed as radioactive waste across different Member States, and what challenges arise from cross-border differences?
- High-risk practices beyond radioactive waste management
 - Should future workshops also address high-risk practices beyond radioactive waste management, such as:
 - industrial radiography (including the application of ISO 3999:2004),
 - authorisation and inspection of radiotherapy practices,
 - and NORM-related activities?
- Interdisciplinary collaboration in nuclear medicine
 - How can interaction between regulators, operators, and pharmacists responsible for radiopharmacies be strengthened to improve radioactive waste management and radiation protection outcomes?
- Contaminated land and legacy issues
 - What strategies and regulatory approaches are being applied for the remediation of contaminated land, and how can experience-sharing support more consistent and effective decision-making?

A desire to build on the current workshop and move towards more focused, in-depth discussions is underlined by the participants.