RadoNorm
Managing risks from radon and NORM

Deliverable 2.19

Dose-assessment procedure for NORM involving situations. Recommendations

Work Package 2

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This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 900009.

Document information

Project Acronym	**RadoNorm**
Project Title	**Towards effective radiation protection based on improved scientific evidence and social considerations - focus on radon and NORM**
Project Type	**RIA**
EC grant agreement No.	**900009**
Project starting / end date	**1st September 2020 – 31 August 2025**
Work Package No.	**2**
Work Package Title	**Exposure**
Deliverable No.	**2.19**
Deliverable Title	**Dose-assessment procedure for NORM involving situations. Recommendations**
Lead Beneficiary	**ISS**
Contractual Delivery Date	**31.05.2025**
Actual Delivery Date	**28.08.2025**
Original document title	**Dose-assessment procedure for NORM involving sites from the selection of Task 2.5. Recommendations**
New document title	**Dose-assessment procedure for NORM involving situations. Recommendations**
Type	**Report**
Dissemination level	**PU**
Authors	**Gennaro Venoso (ISS), Cristina Nuccetelli (ISS), Christian Di Carlo (ISS), Rosabianca Trevisi (INAIL), Federica Leonardi (INAIL), Raffaella Ugolini (ARPAV), Flavio Trotti (ARPAV), Danyl Pérez-Sánchez (CIEMAT), Almudena Real (CIEMAT), Jelena Mrdakovic Popic (DSA), Justin Brown (DSA), Amandine Katz (ASNR), Paul Wigniolle (ASNR), Edouard Veilly (ASNR), Helene Caplin (ASNR), Laureline Février (ASNR), Thuro Arnold (HZDR), F. Bok (HZDR), G. Montavon (SUBATECH), C. Bertin (BRGM), Laura Urso (BfS)**

To be cited as:

Venoso G., Nuccetelli C., Di Carlo C., Trevisi R., Leonardi F., Ugolini R., Trotti, F., Pérez-Sánchez D., Real A., Mrdakovic Popic J., Brown J., Katz A., Wigniolle P., Veilly E., Caplin H., Février L., Arnold T., Bok F., Montavon G., Bertin C., Urso L. (2025): Dose-assessment procedure for NORM involving situations. Recommendations. Final version as of 28.08.2025 of deliverable D2.19 of project RadoNorm.

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Acknowledgement

This document is a deliverable of the RadoNorm project. This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 900009.

Status of deliverable		
	By	Date
Delivered (Lead Beneficiary)	Gennaro Venoso (ISS)	27/08/2025
Verified (WP Leader)	Laureline Février (ASNR)	28/08/2025
Reviewed (Reviewers)	WPL, PC	28/08/2025
Approved (PC)	PC	28/08/2025
Submitted to EC (PC)	PC	28/08/2025

Executive Summary

This document provides a set of strategic recommendations for dose-assessment procedures in situations involving Naturally Occurring Radioactive Materials (NORM). These recommendations are derived from the scientific evaluations and methodological developments detailed in RadoNorm Deliverable 2.18, which critically reviewed dose assessment frameworks for four key NORM-relevant topics: the disposal of NORM residues in conventional landfills, the agricultural application of NORM-containing sludge, the use of complex hydrological models for legacy sites, and the radiological impact on non-human biota.

The findings from Deliverable 2.18 provide the basis for the following key recommendations, which aim to make NORM management more harmonised and scientifically sound:

- *Dose assessment for humans*: It is recommended to adopt Operational Levels (OLs) as a primary, conservative screening tool for managing exposure due to NORM residues. These assessments should systematically incorporate the most recent ICRP dose coefficients and focus on identified dose-limiting scenarios, pathways, and population groups to ensure a protective and efficient graded approach. For specific scenarios, a mass-based annual criterion should be applied for disposal in conventional landfill. Moreover, for situations involving continuous environmental application long-term radionuclide accumulation have to be modelled. A critical aspect of all assessments is the explicit evaluation of decay chain disequilibrium, since assuming secular equilibrium in NORM residues is often incorrect.

- *Advanced site-specific modelling*: For legacy sites where bounding assessments are insufficient, the application of complex, site-specific hydrological models is recommended to achieve more realistic dose assessments, improve long-term predictions, and support risk-informed decision-making. However, the use of such models implies availability of site-specific data and specific hydrological know-how for their use.

- *Assessment of impacts on non-human biota and ecosystems*: The radiological assessment of NORM impacts on non-human biota, if wished for by stakeholders, should follow a graded, tiered approach. Crucially, assessments must be contextualised by characterising the incremental dose above the natural radiation background. Furthermore, a holistic approach requires the integration of both radiological and non-radiological hazards, as chemical toxicity may represent an equal or greater risk in many NORM-contaminated environments.

Overall, these recommendations are intended to facilitate the transition from scientific evaluation to practical implementation, with the goal of supporting greater consistency and confidence in radiation protection assessments across Europe.

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1. Introduction

This document presents a series of structured recommendations for the enhancement of dose-assessment procedures in situations involving Naturally Occurring Radioactive Materials (NORM). Based on the research detailed in *RadoNorm Deliverable 2.18, "Evaluation of updated dose-assessment at NORM involving situations*," these recommendations transpose the principal findings, scientific analyses, and conclusions from that report into practical, evidence-based guidance.

To ensure clarity, applicability, and stakeholder relevance, each recommendation is structured following the framework utilised in the *TERRITORIES* project's D9.72 guidance document (Territories partners, 2020). This approach addresses three fundamental questions:

Why?

Articulates the scientific rationale and necessity of the recommendation, directly linking them to the findings established in *RadoNorm Deliverable 2.18*.

How?

Outlines the specific procedures and methodological approaches required for the recommendation's application

By Whom?

Identifies the primary actors and stakeholders to whom the recommendation is addressed.

This structured format provides a logical pathway from scientific evaluation to practical implementation, translating complex research into accessible guidance.

2. Recommendations (R)

R1: Adopt Operational Levels (OLs) as a primary screening tool for managing NORM residues

Why?

Operational Levels (OLs) are designed as conservative screening tools that allow operators and regulators, who may not be radiation protection experts, to make initial decisions about NORM management in a straightforward manner. They ensure that dose criteria (e.g., 1 mSv/y or 0.3 mSv/y) are not exceeded under defined, representative scenarios. As pointed out by the RadoNorm Deliverable 2.18, the development and application of Operational Levels (OLs) provide a robust, scientifically based methodology for the preliminary dose assessment of NORM residues intended for disposal in conventional landfills or for use in agriculture (Venoso et al., 2025; Venoso et al., 2024a; Venoso et al., 2024b).

The use of Operational Levels (OLs) provides a practical implementation of the graded approach to NORM residues management, as encouraged by international recommendations (e.g., ICRP Publication 142 (ICRP, 2019)) and required by European Directive 2013/59/Euratom (European Commission, 2014). The graded approach aim is to focus resources on situations of potential concern while also streamlining the management of materials with negligible radiological impact.

Without standardised screening levels, decisions on NORM residues management can become overly complex and resource-intensive, leading to inconsistent decisions and creating potential barriers to the sustainable management of NORM residues.

How?

Implement a tiered assessment strategy in which the derived OLs in terms of activity concentration are used for an initial screening. If activity concentrations exceed the OLs, a more detailed, site-specific dose assessment should be conducted to evaluate compliance with dose criteria. The methodology for deriving such OLs, as detailed in the RadoNorm Deliverable 2.18, should be followed. This involves using recognised software (e.g., RESRAD), updated dosimetric data, and well-defined, conservative exposure scenarios.

By whom?

This recommendation addresses national and European regulatory bodies in the implementation of Directive 2013/59/Euratom (European Commission, 2014), environmental protection agencies, industry operators in NORM-involving sectors, waste management facilities, and radiation protection experts.

R2: Systematically use the most recent ICRP dosimetric data into NORM dose assessments

Why?

The use of up-to-date and internationally harmonised dose coefficients is a basis for a scientifically robust radiological assessment. This is not only a scientific requirement but is now formally endorsed by EU Commission Recommendation (EU) 2024/440, which aims to ensure a consistent application of dose estimation for the purposes of the EU BSS (European Commission, 2024). A study reported in the RadoNorm Deliverable 2.18 demonstrates the impact of this update; the use of updated ICRP external dose coefficients resulted in higher (i.e., less restrictive) Operational Levels (OLs) compared to previous assessments that used older data (Venoso et al., 2025).

Adopting these updated coefficients ensures that NORM management decisions are consistent throughout the European Union and based on the best available scientific evidence. This prevents the use of outdated, overly conservative data which could impose unnecessary economic burdens and unjustifiably restrict viable residue management options without justification.

How?

Ensure that software and models used for dose calculations (e.g., RESRAD) are updated with the most recent libraries of dose coefficients for external, inhalation, and ingestion exposures, as published by the ICRP. Specifically, the external dose coefficients from ICRP Publication 144 (Petoussi-Henß et al., 2020; Satoh and Petoussi-Henss, 2024) and the intake coefficients from the ICRP OIR series (Paquet et al., 2017) should be adopted as standard practice. All radiological assessments should transparently report the source and version of the dose coefficients used.

By whom?

This recommendation addresses radiation protection experts, scientific bodies, and regulators.

R3: Focus assessments on dose-limiting scenarios and exposure pathways

Why?

Focusing on dose-limiting scenarios, pathways, and population groups is a foundational step for correctly and efficiently implementing the graded approach (European Commission, 2014; ICRP, 2019). This focus is critical at every tier of the assessment.

For Tier 1 *(Screening)*, Operational Level (OLs) estimation has to be based on the most restrictive plausible case to be reliably protective. As an example, the landfill worker was identified by RadoNorm Deliverable 2.18 as the dose-limiting scenario for deriving OLs for NORM disposal in conventional landfill. Using this limiting scenario to determine the OLs ensures that any situation passing this initial check will not pose an undue risk under other less restrictive scenarios.

For Tier 2 *(Refined Assessment)*, if the OLs are exceeded, the graded approach requires a more focused, detailed analysis. Knowledge of the dominant pathways (e.g., external radiation and food ingestion) allows the site-specific assessment to be targeted, making efficient use of resources by concentrating on the factors that drive the risk.

Without a clear focus on limiting scenarios (as well as on exposure pathways and relevant population groups), a graded approach cannot be implemented effectively. Identifying and prioritizing these critical elements allows for a more efficient and effective assessment process. This ensures that protective measures are targeted where they are most needed, while preventing significant resources from being allocated to analysing pathways that have a negligible contribution to the overall dose (e.g., the ingestion of dust-contaminated crops near a landfill).

How?

Assessments intended to derive generic screening levels must first identify and model the most restrictive exposure scenarios, as exemplified in RadoNorm Deliverable 2.18 for landfills (worker scenario) and agricultural sludge (resident farmer).

When conducting a site-specific assessment as part of a higher tier, prioritise collecting local data on the dose-limiting pathways and population groups that were identified in the initial analysis.

Clearly document and justify in the assessment report which scenarios and pathways are considered dose-limiting and why, ensuring the rationale for the assessment's focus is transparent.

By whom?

This recommendation addresses radiation protection experts, scientific bodies, and regulators.

R4: Apply a mass-based graded approach for the disposal of NORM residues in conventional landfills

Why?

RadoNorm Deliverable 2.18 along with other published studies (Anderson and Mobbs, 2010; Venoso et al., 2024b) provides a clear methodology to relate the Operational Level (OL) to the annual admissible mass of NORM waste that can be disposed of in conventional landfill fulfilling a given dose criterion. This allows for a flexible, graded approach where landfill capacity can be managed according to the average activity concentration of all NORM waste disposed of over a year.

This approach provides landfill operators and waste producers with a practical framework for managing various NORM waste streams. It allows for the co-disposal of materials with different activity concentrations while ensuring that the overall annual dose criteria are met. This aligns with the optimisation principle in radiation protection and supports sustainable waste management pathways for NORM industries.

Without such a framework, landfills may refuse all NORM waste, exempted or cleared, due to a misperception of risk or non-flexible regulations, even if it poses a negligible risk. This can result in limited disposal options which can have a negative impact on industrial operations.

How?

The methodology establishes an Annual Operational Level (AOL), which is defined as the total activity (in MBq) per year that the landfill can be accepted. This is used as the ultimate compliance criterion rather than the concentration of any single disposal load. For multiple or mixed NORM loads, an ad hoc summation formula should be applied, as outlined in RadoNorm Deliverable 2.18.

By whom?

This recommendation addresses landfill operators, NORM waste producers, regulators, and national authorities responsible for waste management policies.

R5: Model long-term radionuclide accumulation for continuous exposure scenarios

Why?

For activities involving the repeated application of NORM residues to the environment, such as the annual use of sludge as fertiliser, the radiological impact is driven by the long-term accumulation of radionuclides in the soil. An assessment based on a single, isolated application will significantly underestimate the dose over the lifetime of the practice and is therefore not sufficiently protective. Modelling accumulation over a realistic timeframe provides a more accurate and scientifically sound basis for decision-making.

How?

For scenarios involving continuous application of NORM, use an iterative methodology to model the build-up of radionuclides in the relevant environmental compartment (EPA (USA), 2004; NRPB, 2002; Venoso et al., 2024a).

The assessment should sum the dose contributions from each year of application over a given operational lifetime, such as the 50-year period used in the RadoNorm Deliverable 2.18 study for agricultural sludge.

This can be achieved using assessment tools such as RESRAD-ONSITE ,which can track the temporal evolution of contamination and dose over extended periods (Yu et al., 2001).

By whom?

This recommendation addresses radiation protection experts and regulators, particularly those involved in authorising the use of recycled materials (e.g., sludge) in agriculture.

R6: Explicitly assess radionuclide decay chain disequilibrium in NORM residues

Why?

NORM residues frequently exhibit significant disequilibrium in the U-238 and Th-232 decay series. This occurs because radionuclides in the same chain have different chemical and physical properties (e.g., solubility), causing them to be separated during processing. Assuming secular equilibrium in these common situations is scientifically incorrect and can lead to major errors in the dose assessment (European Commission, 2002).

A proper assessment of disequilibrium leads to more accurate and reliable dose calculations, ensuring that the radiological risk is correctly characterised.

Indeed, erroneous assumptions regarding secular equilibrium can invalidate a dose assessment, resulting in overly restrictive residue management in the case of lower levels of more radiotoxic daughters. Conversely, such assumptions may result in inadequate controls on a residue with an increased concentration of these daughters, thus failing to provide adequate protection.

How?

The radiological characterisation of NORM residues must include measurements of individual key radionuclides along the decay chain, rather than relying solely on a measurement of the parent nuclide.

Dose assessments must be performed for individual radionuclides or for relevant segments of the decay chains (e.g., Ra-226+, Pb-210+, Th-228+) as reported in the European guidelines Radiation Protection 122 Part II (European Commission, 2002)

Configure assessment tools to model these radionuclides and segments individually, using their measured concentrations and allowing the model to calculate subsequent decay and ingrowth, rather than assuming secular equilibrium.

By whom?

This recommendation addresses laboratories performing the radiochemical analysis of NORM, radiation protection experts, and regulators.

R7: Develop complex hydrological model to assess the dose impact at NORM site

Why?

The initial step in dose estimation typically involves bounding dose assessments. While this approach is straightforward to implement, it often results in overly conservative estimates. As a result, safety margins may become not clear, limiting the usefulness of the findings for effective decision-making.

For legacy sites involving NORM, use of complex water flow models is essential for realistic dose assessments, and it is mainly the combination of these models with the selection of realistic exposure scenarios that will determine the accuracy of dose estimates. Such models provide the basis for accurate understanding of the evolution of exposure over time, allowing for more nuanced safety evaluations and improved risk management. Additionally, these sophisticated models offer valuable insights into how sensitive dose estimates are to various parameters and clarify the relative significance of different exposure pathways, supporting accurate long-term predictions.

This approach enables precise risk-informed decisions and clearer communication of risks to the public, therefore leading to significant societal benefits.

How?

The primary challenges associated with “best-estimate” dose evaluations lie in their substantial data requirements, which necessitate accurate and comprehensive measurements and monitoring tools. Also, achieving reliable results depends heavily on a thorough understanding of the site-specific input parameters, such as environmental conditions, source characteristics, and exposure scenarios. Furthermore, these assessments often require the use of advanced, state-of-the-art computational tools capable of handling complex systems.

Given these complexities, it is critical to carefully select and develop the dose assessment model to reflect the conditions of the site. Validation of the model through comparison with measured data is essential to build confidence in the results and ensure that predictions are both accurate and reliable. This iterative process of refinement and validation helps to reduce uncertainties and supports informed decision-making in risk assessment and management.

By whom?

This recommendation addresses institutional actors including TSOs (Technical Support Organizations), authorities and academics.

R8: Adopt a graded approach for the environmental assessment (if needed) of NORM sites

Why?

NORM-contaminated sites are complex exposure situations, often involving large areas, diffuse contamination, and the co-presence of non-radiological stressors (e.g., heavy metals). A graded approach ensures that the level of detail and resources required for an environmental impact assessment is proportional to the radiological risk associated with the NORM situation. As pointed out in the RadoNorm Deliverable 2.18, this methodology is broadly supported in scientific literature and implemented in tools like ERICA (Brown et al., 2008; Larsson, 2008) and USDOE standard (USDOE, 2002, 2019). It begins with a conservative screening to quickly identify situations of negligible concern, reserving more complex, resource-intensive analyses for cases where a potential risk cannot be excluded.

This provides a structured, transparent, and resource-efficient framework for assessing environmental risk, focusing efforts where they are most needed.

Without a graded approach, all assessments may require a maximum level of effort, leading to the inefficient use of resources for low-risk sites. Alternatively, a single, overly simplified approach might not be sufficiently protective for more complex situations.

How?

Implement a tiered assessment process, such as the one in the ERICA Integrated Approach.

Tier 1 (*screening*): Begin with a simple, conservative assessment using generic parameters and default reference organisms to calculate a preliminary risk quotient. If the risk is shown to be trivial (e.g., well below established benchmarks like the 10 µGy/h ERICA screening value), the assessment may conclude at this stage.

Higher Tiers (*detailed assessment*): If the initial screening indicates a potential for risk, proceed to a more detailed assessment. This involves using more site-specific data, such as measured radionuclide concentrations in local environmental media and biota, and selecting reference organisms that are more representative of the local ecosystem to provide a more realistic estimate of the radiological impact.

By whom?

This recommendation addresses regulatory bodies defining environmental assessment frameworks, environmental consultants and scientific institutions performing the assessments, and industry operators responsible for demonstrating the environmental safety of their activities.

R9: Integrate the assessment of radiological and non-radiological hazards at NORM sites

Why?

NORM-contaminated sites are frequently co-contaminated with other hazardous substances, such as heavy metals or chemicals from industrial processes. In many of these situations, the radiological hazard is not necessarily the dominant risk, and chemical toxicity may pose an equal or greater threat to the ecosystem. A holistic assessment is required because different stressors can have interactive effects on biota. Addressing only the radiological component provides an incomplete and potentially misleading picture of the overall environmental risk. Indeed, ICRP (ICRP, 2019) explicitly recommends that both radioactive and non-radioactive risks be considered in the management of NORM industries.

Taking a standalone approach to assessing radiological risk without considering other contaminants present in the same area may result to ineffective or inefficient remediation strategies, wasted resources and inadequate protection of the environment from the most significant hazards.

How?

During the site characterisation phase, the assessment scope should be broadened to include the identification and quantification of both key radionuclides and relevant non-radiological contaminants.

The environmental risk assessment should follow a multi-stressor framework. While quantitative models for combined effects are still in development, the assessment should, at a minimum, evaluate the combined impact by comparing concentrations of each contaminant against its respective environmental protection benchmark.

Foster collaboration between radiological and ecotoxicological experts, as well as between various regulatory agencies responsible for chemical and radiological protection, to ensure a comprehensive and scientifically sound assessment that considers the overall hazard profile of the site.

By whom?

This recommendation addresses regulatory authorities (often from different agencies for radiological and chemical hazards), site operators, environmental consultants, and scientific researchers working in ecotoxicology and radioecology.

R10: Contextualise assessments by characterising the natural radiation background

Why?

NORM industries enhance radiation levels that are already naturally present in the environment. A key objective of a NORM impact assessment is therefore to determine the incremental dose contribution from the industrial activity above the local or regional natural background radiation levels. This distinction is fundamental to understanding the actual impact of the industrial process.

Contextualising the calculated doses against the natural background allows regulators and stakeholders to make informed decisions. It helps to distinguish the impact of the industry from natural geological variability and to evaluate the acceptability of the excess risk.

Failing to account for the natural background can lead to a significant misinterpretation of the radiological situation. It could result in attributing all measured radiation at a high-background site to the industrial activity, potentially leading to disproportionate and scientifically unjustified remediation requirements.

How?

During the site characterisation phase, collate information on regional background levels of natural radionuclides. This can be achieved through dedicated monitoring campaigns at reference sites unaffected by the industrial activity or by consulting relevant scientific literature and geological surveys.

In the final assessment report, the calculated dose rates to biota from the NORM site should be explicitly compared with the dose rates attributable to the natural background. This clearly presents the incremental dose, providing crucial context for comparison with protective benchmarks (e.g., DCRLs) and for communicating the results to stakeholders.

By whom?

This recommendation addresses environmental consultants, regulatory bodies, and site operators responsible for conducting and interpreting environmental impact assessments for NORM facilities.

3. Conclusions

Based on research detailed in the RadoNorm Deliverable 2.18, this work presents strategic recommendations to enhance the radiation protection framework for NORM through more harmonised and scientifically based management approaches.

The key conclusions are as follows:

- For dose assessment for human, a structured, graded approach is essential. This requires using screening tools like Operational Levels (OLs) with updated ICRP dose coefficients for ingestion, inhalation and external exposure, while focusing on dose-limiting scenarios.
- For complex legacy sites, advanced, site-specific hydrological models are advantageous for accurate risk characterisation and effective management with downside of requiring abundant data, parameters and technical expertise in the field of hydrology to be used.
- Quantitative impact of NORM to the environment, if to be proven explicitly, demands a holistic perspective, including a graded assessment for non-human biota and an integrated assessment of both radiological and chemical hazards.

4. References

Anderson, T., Mobbs, S., 2010. Conditional Exemption Limits for NORM Wastes, HPA-CRCE-001.

Brown, J.E., Alfonso, B., Avila, R., Beresford, N.A., Copplestone, D., Pröhl, G., Ulanovsky, A., 2008. The ERICA Tool. J Environ Radioact 99, 1371-1383.

EPA (USA), 2004. Assessment of Radioactivity in Sewage Sludges: Modeling to Assess Radiation Doses.

European Commission, 2002. Radiation Protection 122 Practical use of the concepts of clearance and exemption. Part II. Application of the concepts of exemption and clearance to natural radiation sources.

European Commission, 2014. Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation. Official Journal of the European Union 57.

European Commission, 2024. Commission Recommendation (EU) 2024/440 of 2 February 2024 on the use of dose coefficients for the estimation of the effective dose and equivalent dose for the purposes of Council Directive 2013/59/Euratom. Official Journal of the European Union L series, 1-2.

ICRP, 2019. ICRP Publication 142: Radiological Protection from Naturally Occurring Radioactive Material (NORM) in Industrial Processes. Annals of the ICRP 48.

Larsson, C.M., 2008. An overview of the ERICA Integrated Approach to the assessment and management of environmental risks from ionising contaminants. J Environ Radioact 99, 1364-1370.

NRPB, 2002. Generalised Derived Constraints for Radioisotopes of Polonium, Lead, Radium and Uranium, Documents of the NRPB.

Paquet, F., Bailey, M.R., Leggett, R.W., Lipsztein, J., Marsh, J., Fell, T.P., Smith, T., Nosske, D., Eckerman, K.F., Berkovski, V., Blanchardon, E., Gregoratto, D., Harrison, J.D., Authors on Behalf of ICRP. 2017. ICRP Publication 137: Occupational Intakes of Radionuclides: Part 3. Ann ICRP 46, 1-486. https://doi.org/10.1177/0146645317734963

Petoussi-Henß, N., Satoh, D., Endo, A., Eckerman, K.F., Bolch, W.E., Hunt, J., Jansen, J.T.M., Kim, C.H., Lee, C., Saito, K., 2020. ICRP Publication 144: Dose Coefficients for External Exposures to Environmental Sources. Annals of the ICRP 49, 11-145.

Satoh, D., Petoussi-Henss, N., 2024. Dose-rate coefficients for external exposure to radionuclides uniformly distributed in soil to an infinite depth. PLoS One 19, e0310552. https://doi.org/10.1371/journal.pone.0310552

Territories partners, 2020. D9.72 – Guidance for management/NORM. Recommendations based on output of the TERRITORIES project.

USDOE, 2002. Graded approach for evaluating radiation doses to aquatic and terrestrial biota, technical standard DOE-STD-1153-2002. USDOE, Washington, DC.

USDOE, 2019. Standard. A graded approach for evaluating radiation doses to aquatic and terrestrial biota. DOE-STD-1153-2019.

Venoso, G., Nuccetelli, C., Di Carlo, C., Trevisi, R., Leonardi, F., Ugolini, R., Trotti, F., Pérez-Sánchez, D., Real, A., Mrdakovic Popic J., Brown, J., Katz, A., Wigniolle, P., Veilly, E., Caplin, H., Février, L., Arnold, T., Bok, F., Montavon, G., Bertin, C., Urso, L., 2025. Evaluation of up-dated dose-assessment at NORM involving situations. Deliverable D2.18 of project RadoNorm.

Venoso, G., Nuccetelli, C., Di Carlo, C., Trotti, F., Ugolini, R., Trevisi, R., Leonardi, F., Urso, L., 2024a. Development of a methodology for assessing radiological dose due to use of NORM sludge as fertilizer. Science of The Total Environment 912, 168934. https://www.sciencedirect.com/science/article/pii/S0048969723075630

Venoso, G., Nuccetelli, C., Leonardi, F., Di Carlo, C., Trotti, F., Ugolini, R., Mrdakovic Popic, J., Trevisi, R., Caplin, H., Perez-Sanchez, D., Fevrier, L., Urso, L., 2024b. Development of a methodology for dose assessment and estimate of amount of NORM residues disposable in a conventional landfill. J Environ Radioact 280, 107564. https://doi.org/10.1016/j.jenvrad.2024.107564

Yu, C., Zielen, A.J., Cheng, J.J., LePoire, D.J., Gnanapragasam, E., Wallo Iii, A., Williams, W.A., Peterson, H., 2001. User's manual for RESRAD version 6. Argonne National Lab., IL (US).