Summary of the International Workshop on the Implementation of Radon Dose Coefficients, 8 – 9 April, 2025 | Bonn, Germany

Following the publication of the new radon dose coefficients (RDCs) according to ICRP Publication 137 (short: ICRP 137) in 2017, numerous discussions took place in international bodies and committees, where questions and challenges of legislation and implementation repeatedly arose. The International Workshop on the Implementation of Radon Dose Coefficients organised by the German Federal Environment Ministry (BMUKN, formerly BMUV) and the Federal Office for Radiation Protection (BfS) on 8 - 9 April 2025 was motivated by the desire to facilitate an exchange of best practices, current challenges, and experiences in implementing the RDCs in various European countries. Among the approximately 70 participants from 15 European states were also several participants from state level organisations, like the EU Commission, IAEA, and ICRP.

This report briefly summarises the key findings of the workshop and provides an overview of the central discussion results and recommendations for action developed during the workshop.

"Interview with the ICRP"

Dr. François Paquet (ICRP), interviewed by Sebastian Feige (BfS)

In this interview Mr. Paquet, Vice-Chair of Committee 2 and Chair of Task Group 95 of the ICRP, discussed the development of the OIR-series, focusing on RDCs and the philosophy of the ICRP regarding RDC.

In 2009, the ICRP decided to develop dose coefficients for radon with the same methodology as for other radionuclides. Hence, the ICRP used the dosimetric approach including the biokinetic-dosimetric models for the development of the RDCs in succession of the until then applied epidemiological approach for radon described in ICRP 65. ICRP reports a remarkable consistency between radon dose coefficients obtained by dosimetric calculations and conversion coefficients based on lifetime excess risk derived from new epidemiological studies. As explained by Mr. Paquet, the ICRP did not provide dose coefficients for all situations for practical reasons, but instead for a set of representative reference situations. ICRP chose to calculate dose coefficients for several typical exposure locations due to their different characteristics of radon decay products in terms of equilibrium factor, unattached fraction and particle size for the attached fractions. In the specific case of office work environments, and because the dose coefficients for radon are given per exposure (and not per intake as for other radionuclides), the dose coefficient had to be adjusted to take into account a lower respiratory rate for sedentary workers. The sedentary worker concept with adjusted

activity pattern is introduced in ICRP 137 to represent typical office working environments.

The ICRP combined clusters of similar data from various situations and recommended two single rounded dose coefficients while considering the uncertainties in the data. For an accurate dose assessment, it is recommended by ICRP 137 to use a dose coefficient corresponding to the actual aerosol parameters and the workers‘ activity profiles in the workplace.

The intended usage of the dose coefficients was mainly to demonstrate the compliance with (occupational) dose limits. In order to establish effective radon protection, according to Mr. Paquet, the most important aspect is to limit the exposure by controlling and maintaining the radon activity concentration below the reference level.

Mr. Paquet emphasized the need for additional, high-quality data to perform more realistic and improved calculations, especially regarding the attached/unattached fraction and aerosol characteristics. He concluded that no immediate changes to the underlying assumptions and parameters of the dosimetric models and thus the radon dose coefficients are expected by ICRP, and the focus should now be on the implementation.

Presentation of EU COM on Basic Safety Standards Directive – Transposition and implementation of the requirements on radon

Dr. Stefan Mundigl (European Commission, DG ENER)

Mr. Mundigl reported on the Basic Safety Standards Directive (2013/59/Euratom, abbreviated as BSS), its contents, and its requirements regarding radon in workplaces. He emphasized that, for the first time, a legally binding framework for radon protection was established for EU member states. Mr. Mundigl provided an update on the implementation status of the BSS and the various national radon action plans. He outlined the European Commission's activities that led to its recommendation 2024/440 (of 2 February 2024) to implement the Dose Conversion Coefficients of the ICRP Publications on Occupational Intakes of Radionuclides: Part 1 – 5 (ICRP Publications 130, 134, 137, 141, and 151).

Current Status – Findings from a Questionnaire circulated within HERCA WG Nat

Dr. Felice Friedrich-Kees (BfS)

The most important results of a questionnaire developed by BMUKN and BfS and distributed within HERCA WG Nat were presented. The aim of the questionnaire was to gain insight into the current strategies and status of implementation of ICRP 137 in

different countries. Additionally, information on challenges encountered and best practices were to be acquired, in order to be discussed in different formats within the workshop. Of the 28 member states that received the questionnaire, 21 responded, and the majority of these states reported that the implementation of RDCs in accordance with ICRP 137 is either complete or planned. Most countries also indicated that they prefer site-specific coefficients over activity-specific coefficients.

Round Table Discussions

RT1: Impact of the ICRP 137 on national radiological protection frameworks

At Round Table 1, the following topics were discussed: modifications on the pre-existing graded approach, special workplaces and cross border activities. Regarding the first aspect, some participants mentioned that no changes to the global legal framework were needed to implement the RDC value of 3 mSv/ (mJ h m^{-3}). There were mixed experiences regarding objections from the employers against the implementation of the new RDC. Although clear communication was reported to be an effective solution. The number of dose assessments carried out per year varied among countries. Some countries reported that no dose calculations were made at all, since a large emphasis is put on remediation (and hence reducing indoor radon activity concentration in the air).

With regard to special national cases such as tourist caves or cable shaft workers, participants highlighted the need to investigate such cases and also consider special regulations for students or people under the age of majority (18 years in most countries).

The ensuing discussion on cross-border activities and the merging of doses from planned and existing exposure situations addressed i.e. the use of the European Radiation Passport and the combination of doses from different exposure situations. Participants stressed that radon doses determined in other countries should be considered as is, to guarantee confidence in a reliable assessment in those countries. This was found to be an already well-established practice for external dosimetry.

Experiences and challenges in implementing the new RDCs varied among countries. Participants representing regulatory authorities reported increased workloads, concerns about remediation and financial assistance, as well as communicatory challenges with the public or employers. Participants emphasized the importance of clear communication. Furthermore, the idea of linking radiation risks with chemical risks in warning signs to help employers understand the new regulations was presented.

RT2: National perspectives – different approaches to implement a recommendation

Most countries reported the use of a single RDC in practice while site-specific RDCs were reported to be appropriate in specific situations like tourist caves. The decision-making process for introducing new RDCs involves various stakeholders, such as workers' unions or in some cases other national authorities. The implementation process is influenced by various factors such as data uncertainty, detriment, and classification of radon as part of general occupational risks.

Categories of workplaces that may require an individual RDC might be offices, waterworks, tourist caves, tourist mines and schools. The application of tables provided in ICRP 137 for calculating (site-)specific RDCs is not commonly used in regulatory practice and oversight due to complex calculations and lack of site-specific data.

Considering workers' activity profiles in regulation is challenging. So, a one-value-fits-all approach seems more practical. Employers should focus on taking measurements to assess the radon concentration in the first place and on reducing radon exposure in general. Dose assessment procedures vary among countries, with options including calculations by employers themselves (e.g. via online tools) and by accredited measurement services.

Accreditation of measurement services across national borders is possible under some conditions such as comparable accreditation criteria, mutual recognition agreements, and requirements of local company sites.

Communication strategies for radon protection should target various groups, including employers, workers' unions, employees, measurement services, inspectors, and associations. Reactions by the respective target audience (e.g. the general public or employers) to communication strategies with equivalent messages can differ significantly based on the context, such as homes versus workplace situations. Impact assessments should be carried out before implementing new RDCs to consider the number of affected workplaces. For some countries a retrospective impact assessment might also be part of the evaluation of a national radon action plan.

RT3: Science and methodology

The thematic round table focused on the reliable metrology of radon gas and radon progeny. Participants identified minor challenges in radon gas metrology, particularly the high costs of calibration relative to device prices. Regarding the use of electronic and non-electronic devices in workplaces, participants agree on a combined use of both. Electronic devices could effectively engage the public by showcasing changes in radon levels promoting awareness and action regarding necessary mitigation measures. Non-electronic instruments are valued for their affordability. The metrological capacity for radon progeny remains limited, with few accredited European laboratories. Notable is

the need to measure the attached and unattached fractions, yet a lack of a closed traceability chain for the unattached fraction directs focus towards aerosol measurement capacities. Further challenges in the radon progeny measurements include a lack of innovation, expertise, and available instruments. A regulatory focus on radon progeny and consideration in research calls could boost market demand, that could then boost the investments on innovation.

Discrepancies in aerosol properties compared to reference parameters across workplaces necessitate site-specific calibrations, especially in environments with non-standard temperatures, like food or metal factories. Regulators may account for these differences by applying site specific dose coefficients but this requires potentially costly measurement of other parameters (i.e. characterisation of radon progeny and/or other aerosol properties).

Quality assurance requirements for measurements pose challenges for cross-border activities, requiring a bilateral common understanding to address differences in quality assurance expectations and methods. Participants emphasized the need for measurement protocols for specific workplaces.

Measuring thoron in mixed atmospheres presents challenges, primarily due to difficulties in obtaining accurate readings even with costly instruments. As a result, there is currently no discussion about the existing dose coefficients for thoron exposure.

Open interactive reflection on the Results of Round Tables ("Poster Session")

All participants

The poster session enabled open discussions, especially about those topics, which were identified during the round tables. In the following summary, the titles of the posters are listed, as well as selected statements/questions:

From the revision of dose coefficients in ICRP 137 to real-life workplaces: Communication strategies? Stakeholder involvement? Impact and Insights?

- *"Even if radon science is complex: We need simple regulations to carry [it] out!"*
- *"What will be the impact in economic terms, if the number of workers/ workplaces > ref. Level / >6mSv increases?"*
- "*Employers need clearly communicated messages!*"

Science, Methodology, Metrology: What is the biggest gap in research? What are the next steps?

- "*How about to initiate an EU-funded study to increase/ complement the data on Radon to increase the confidence of the RDC*"

- "*Personal dosimetry is necessary for special cases (e.g. water works)* ➔ *Easier and less complicated*"
- "*Electronic (cheap) devices for engagement of the public*"
- *"We need small, cheap, easy-to-use, reliable Radon-DP-monitors (personal dose meters)*"

Upcoming RDC for the general public? (possible regulatory consequences? Lessons learned from RDC for workers?)

- "*Do not communicate in doses, but in other quantities e.g.:"*
  - *Number of lung cancers per year*
  - *"DALY"* [ed.: disease-adjusted life years] ➔ *"Most people don't understand DALY/QALY" [ed.: quality-adjusted life-years]*
  - *Reference value [Bq/m³]*
  - *"Exposure"*
- *"What to do with RDC?": "No limit of dose"; "Excess of risk more relevant*"

Space to discuss… (any open questions from the Round Tables and from your side)

- *"Where are the results of epidemiological studies included in the new dose coefficient?"*
- *"We should minimize risk, not dose. We can perfectly do this by using exposure"*
- *"It is not possible and not necessary to transpose science 1:1 in regulations"*
- *"Why should we – without need – include the detriment with all its problems into Rn risk assessment?"*
- *"Why 'wasting' time on touristic caves? There are workplaces that are more relevant"*

Plenary discussion and take-home message | Podium and Plenum

Dr. François Paquet (ICRP), Dr. Stefan Mundigl (EU COM), Heloisa Fonseca (IAEA), Marcela Berčíková (SÚJB)

In the panel discussion, Mr. Mundigl (EC) elaborated on the background that led to the setting of the reference value to 300 Bq/m³ for radon, and urged participants to focus on effective radon protection rather than the precision of radon dose estimations. Ms. Fonseca (IAEA) highlighted the importance of radon and thoron issues worldwide, and emphasised the need for more information on special workplaces like caves. Mr. Paquet (ICRP) discussed the new scientific findings that led to the revised RDC-values, and the importance of reducing radon concentrations. The importance of remediation measures is supported by Ms. Berčíková (SÚJB), who emphasises that the Czech Republic provides financial support for the renovation of houses. In the case of workplaces, subsidies are

only provided to schools and school facilities as well as social and health services with long-term residence, if they meet the requirements of the decree. Other workplaces must finance the renovation themselves.
During the plenary discussion, the differences between UNSCEAR and ICRP RDCs were explained, with UNSCEAR using a different approach and not utilizing RDCs for radiation protection purposes. In conclusion of the workshop, it was emphasized that successful implementation of new RDCs relies on stakeholder involvement and target group specific communication. At the same time there has to be an understanding that only a few workplaces require dose control and the focus should be on remediation and reduction of radon concentration.

Overall Take-Away Messages

The workshop highlighted the importance of good communication strategies and focusing on reducing radon concentrations rather than exact dose calculations. The benefit of experiences from countries that have already implemented the new RDCs was considered very valuable for countries who have not implemented the new RDCs yet.
It can be concluded that continued efforts to inform the public about the health risks connected with exposures to radon and to further improve protection strategies will also be of high relevance for further research, practical approaches, and exchange on the national and international level.