Publishable Summary for 16ENV10 MetroRADON
Metrology for radon monitoring

Overview

The aim of this project is to develop reliable techniques and methodologies to enable SI traceable radon activity concentration measurements and calibrations at low radon concentrations. The results of the project will be targeted at the implementation of the European Council Directive 2013/59/EURATOM (EU-BSS), one aim of which is to reduce the risk of lung cancer for European citizens due to high radon concentrations in indoor air. The calibration methods and measurement techniques developed in the project will assist EU member states in the establishment of their national radon action plan, which is required under the EU-BSS.

Need

Radon is a radioactive, colourless, odourless and tasteless noble gas, which occurs naturally through geological-based processes. Despite its short half-life of 3.8 days, radon gas from natural sources can accumulate in buildings, particularly in confined or unventilated spaces. Radon is estimated to cause between 3 % and 14 % of all lung cancer cases, depending on the average radon level in the country. For Europe, this corresponds to around 15 000 to 20 000 people per year dying of lung cancer caused by radon exposure.

Before the commencement of the EU-BSS, the recommended maximum limit for the annual ^{222}Rn activity concentration at workplaces was 1 000 Bq/m^3. With the new EU-BSS, for the first time, an obligatory maximum limit for the national legal limits of the ^{222}Rn activity concentrations in indoor air of workplaces and dwellings is set for all member states, 300 Bq/m^3. Currently, the EU-BSS is in the process to implement this regulation into national legislation. The maximum limit set by the EU-BSS is 300 Bq/m^3. A significant improvement in the metrological infrastructure in Europe for radon calibrations, especially at low activity concentrations (< 300 Bq/m^3) is a prerequisite in order to be able to fulfil these requirements. Therefore, new procedures and traceable radon reference sources for the traceable calibration of radon measurement instruments at low activity concentrations with adequately low uncertainties need to be developed. Thoron and its progeny are known to bias the results of radon activity concentration measurements; however, information about this effect is limited. A better understanding of this effect is, therefore, needed together with techniques to reduce the influence of thoron and its progeny on radon measurements and calibrations. Traceability and quality assurance of calibrations of radon monitors and of radon calibration facilities, as well as the development of methods to conduct a large number of traceable and quality assured in-situ and laboratory measurements of radon are also required.

EU member states are bound to consider several aspects when preparing their national radon action plan, which is a strategy for conducting surveys of indoor radon concentrations. To ascertain that the required level of safety is met for all European citizens, the consistency of indoor radon measurements and soil radon exhalation rate measurements across Europe need to be optimised. Therefore, identification of radon priority areas is necessary in order to take appropriate actions for the protection of the public.

To reduce trade barriers and to ensure the mutual recognition of calibration certificates, general guidelines and recommendations on calibration and measurement procedures for the determination of radon concentration in air have to be established. This will be facilitated by the uptake of the project's results in the standards developing organisations and furthermore, by the end-users.

Objectives

The project focuses on the traceable measurement of low radon activity concentrations and contributes to the creation of a coordinated metrological infrastructure for radon monitoring in Europe.

The specific objectives of the project are:

1. To develop novel procedures for the traceable calibration of radon (^{222}Rn) measurement instruments at low activity concentrations (100 Bq/m^3 to 300 Bq/m^3) with relative uncertainties ≤ 5 % (k = 1). As

part of this, to develop new radioactive reference sources with stable and known radon emanation rates.

2. To investigate and to reduce the influence of thoron (^{220}Rn) and its progeny on radon end-user measurements and radon calibrations.
3. To compare existing radon measurement procedures in different European countries and from the results optimise the consistency of indoor radon measurements and soil radon exhalation rate measurements across Europe.
4. To analyse and develop methodologies for the identification of radon priority areas (i.e. areas with high radon concentrations in soil, as defined in the EU-BSS), including the development of the concept of a Radon Hazard Index (RHI), and to investigate the relationship between soil radon exhalation rates and indoor radon concentrations.
5. To validate traceability of European radon calibration facilities, and to publish guidelines and recommendations on calibration and measurement procedures for the determination of radon concentration in air.
6. To facilitate the take up of the technology and measurement infrastructure developed by the project by end users (regulators, radiological protection bodies and policy makers), standards developing organisations (ISO/TC45, CEN/TC351, ISO/TC85, CENELEC/TC 45, IAEA) and the measurement supply chain (accredited laboratories, instrumentation manufacturers).

Progress beyond the state of the art

In general, the technology and metrological infrastructure to assess the quality of radon measurements at low concentrations (< 300 Bq/m^3) with sufficiently low measurement uncertainties is not currently available. Within MetroRADON, novel calibration methods and traceability validation at low radon activity concentrations are currently being devised and new and stable radioactive reference sources are currently being developed to enable these calibrations. Such calibrations in a stable radon atmosphere will enable sufficiently low uncertainties to be achieved for low radon activity concentration measurements.

Although BIPM's Consultative Committee for Ionizing Radiation (CCRI(II)) comparisons of calibration for high radon activity concentrations (> 300 Bq/m^3) have been conducted in the past, comparisons of existing radon gas standards at different European NMIs/DIs for ^{222}Rn and ^{220}Rn at low activity concentrations will be undertaken.

For the first time, the distortion of the radon measurement results due to the presence of thoron will be considered and corrected at low radon activity concentrations within MetroRADON. For this purpose, reference thoron atmospheres will be established to calibrate secondary thoron reference instruments traceable to a primary thoron standard. Traceability to a primary thoron standard is ensured and refined enabling the thoron influence to be investigated. The influence of thoron on radon measurements will be studied using the traceably calibrated thoron reference instruments. Conclusions about the dependence of the radon monitor signal on the specific environmental conditions (radon to thoron ratio, temperature, time variations of radon/thoron concentrations and temperature) will be drawn together with the consequences for the design of radon surveys under real conditions.

The use of compact discs (CDs) and DVDs for retrospective radon measurements and their potential to define radon priority areas is being evaluated. For this purpose, a long-time exposure experiment of CDs and DVDs has been set up. New techniques for measurement of radon exhalation from soil based on liquid scintillation counting of polymers or track-etching of CDs will be developed and evaluated to analyse the results of the experiment.

The novel development of a European unified index of geogenic Rn hazards, which can be defined flexibly independent of the data available, will provide a consistent picture of susceptibility to geogenic Rn across Europe. The definition of this Radon Hazard Index (RHI) will be an important tool for the harmonised implementation and performance of national radon action plans of EU member states according to the EU-BSS requirements, which is not the case at present. For this purpose, concepts and definitions of radon priority areas (RPAs) which have been proposed or already implemented in the past and the role of stakeholders in the implementation process of RPA are being reviewed and evaluated together with approaches used to assess a "soil radon potential". Furthermore, existing mapping methods for RPAs used in various countries (e.g. indoor radon, gamma dose rate, geology, soil gas radon) are being tested.

The newly developed reference sources and procedures are being evaluated and compared to existing radon measurement procedures. Guidelines and recommendations on the new calibration and measurement procedures will be published based on the evaluation. Traceability of European radon calibration facilities using the new procedures and novel reference sources will be evaluated.
The project partners will ensure that the results beyond the state of the art of this project will be taken up by end users and standards organisations.

Results

Objective 1: Procedures for traceable calibration of radon (^{222}Rn) instruments at low activity concentrations

In order to develop novel procedures for the traceable calibration of radon (^{222}Rn) measurement instruments at low activity concentrations (100 Bq/m^3 to 300 Bq/m^3) with sufficiently low relative uncertainties (≤ 5 %, k = 1), it is necessary to develop new radioactive reference sources with stable and known emanation rates. Existing ^{222}Rn emanation sources were re-evaluated concerning their present emanation power. Problems and alternative manufacturing techniques were investigated. Based on these investigations, prototypes of ^{222}Rn emanation sources, which rely on electrodeposition, drop-implantation and chemisorption of radium (^{226}Ra) were developed and produced. Additionally, a procedure for preparing ^{220}Rn emanation sources was developed and tested successfully and thoron emanation sources were produced. Furthermore, a new low-level radon chamber has been designed and built to create long-time and time stable low-level radon atmospheres and has been used to test the feasibility of the new sources.

A long-term stable low-level ^{222}Rn flow through source was designed, manufactured and installed in two radon chambers. After checking that a stable ^{222}Rn atmosphere could be achieved, the source was tested at different air pressure, temperature and humidity values. A combined standard uncertainty of about 1 % of the activity measurement could be achieved for the flow through source in both reference chambers, which is well below the target uncertainties (≤ 5 %, k = 1).

Additionally, a method for the determination of activity concentration in a steady air flow has been developed and implemented. The feasibility of the method was tested with the developed long-term stable, low-level flow, through ^{222}Rn for activity concentrations between 45 Bq/m^3 and 100 000 Bq/m^3.

A comparison protocol and schedule for the comparison of existing ^{222}Rn gas primary standards at European Metrology Institutes and Designated Laboratories in the low kBq range were developed. ^{222}Rn gas standards were produced and distributed to the participating laboratories. The results of this registered EURAMET supplementary comparison were analysed and will be published in Metrologia.

A comparison protocol and a schedule for the developed ^{220}Rn emanation sources, which were designed within the project, are currently being developed.

Objective 2: Reducing the influence of thoron on radon measurements and calibrations

In order to investigate and to reduce the influence of thoron (^{220}Rn) and its progeny on radon end-user measurements and radon calibrations, three reference thoron atmospheres (low, intermediate and high activity concentration) have been established at the reference chamber for calibration of measurement devices with the primary thoron standard system. Before conducting the calibration of the instruments, the homogeneity of the reference atmospheres in the chambers were tested using newly developed methods based on liquid scintillation counting of aerogels and solid-state nuclear track detectors (SSNTD), as well as numerical calculations.

The calibrated measuring instruments are being used to study the influence of thoron on the radon measurement in two new exposure facilities to measure pure and mixed ^{220}Rn and ^{222}Rn atmospheres. Dynamic temperature conditions were also built where static and dynamic temperature conditions within -15 °C to + 60 °C can be created as well as predefined variable concentration profiles. Additionally, measurements have been conducted to quantify the influence of thoron on the radon measurement under field conditions. A literature review of potential techniques and materials to reduce the influence of thoron on radon measurements and calibrations has provided the necessary data to start an experimental study on diffusion barriers against thoron, radon-thoron cross-interference, radon permeability data and radon transport properties at different temperatures. The findings of this study will provide crucial and much needed information on how to limit the influence of thoron on radon measurements. A model for the evaluation of the performance of these polymers as thoron barriers was developed. Additionally, a method for evaluation and correction of the temperature bias when polymer foils are used as thoron barriers was proposed. The

method is based on differential measurements with two detectors and is currently being tested experimentally.

Direct experimental determination of the radon transmission through polymer foils in the volume of passive detectors for different temperatures was performed. At the same time a study of the temperature dependence of the response of widely used detectors was made. It was observed that both the radon transmission through polymer foils and the detector response showed significant temperature dependence. However, the trends in both cases are reciprocal. Radon transmission increases with temperature increase, while the detectors' response decreases. At this point a novel concept, beyond state-of-the-art was proposed. Compensating modules were designed in which detectors are placed, so that the thoron interference on the results is eliminated and both temperature bias and influence of humidity are greatly reduced. A patent for this technique was registered (SUBG: Bulg. Patent Application 112897/19.03.2019). A theoretical model for radon/thoron transmission that is usable for module design was developed. The pilot experimental results obtained with various passive detectors demonstrated the feasibility of this approach. This approach is capable to reduce the thoron interference and the temperature dependency of radon measurements.

IEC standard 61577 was reviewed and tested. It was found to be vague and not suitable for field measurements, as well as not covering some of the most used detectors (e.g. SSNTDs). When the activities are completed, the findings will be presented to the standard committee and merged and published as a "Report on the influence of thoron on radon monitors used in Europe".

Objective 3: Comparison of existing radon measurement procedures in different European countries and optimisation of the consistency of indoor radon measurements and soil radon exhalation rate measurements

In order to compare existing radon measurement procedures in different European countries and the results on consistency of indoor radon measurements and soil radon exhalation rate measurements across Europe, a review and comparison of existing radon measurement procedures in different European countries has been conducted. The goal was to use the results of the study to optimise the consistency of indoor radon measurements and soil radon exhalation rate measurements across Europe. An extensive literature review on existing indoor radon survey and geogenic radon surveys in Europe has been conducted. Two questionnaires, one on indoor radon surveys, and one on geogenic radon surveys conducted in Europe were prepared and sent to stakeholders. The questionnaires collected missing information from the literature and obtained information on how the countries intend to transpose the EU-BSS directive into national law. Although solid state nuclear track detectors were used in 82 % of the studies, the analysis of the results of the questionnaire on indoor radon surveys showed that the designs of surveys in Europe are not comparable. According to the questionnaire, 44 % of surveys were not performed during the whole year, and seasonal corrections were not applied in all of them. Therefore, another important aspect highlighted by the questionnaires was in the harmonisation to apply seasonal corrections. This is important because seasonal variation of radon could differ within a country from region to region due to different factors, such as climate, living habits, building construction, etc. Also, the non-negligible effect of reported indoor radon concentrations could be due to thoron influence. Although a large percentage of participants knew about the interference of thoron, they did not correct or check for thoron presence. A study of the representativeness of indoor radon measurement over different measurement periods (durations and seasons) was started. A discussion on seasonal correction factors for estimating radon exposure in dwellings is ongoing. The further evaluation of the results of both questionnaires and the literature reviews will be part of a report on indoor and geogenic radon surveys in Europe, including their strategies, the methodologies employed, inconsistencies in the results, and potential methodologies to harmonise data and reduce inconsistencies.

Another literature review on the applicability of the CD/DVD method for indoor radon surveys was conducted, concluding that CDs and DVDs can be used as ^{222}Rn detectors in radon surveys. Existing ISO standards EN ISO 11665-7 and ISO 11665-11, on the methodology of the radon exhalation measurement and of radon concentration in soil gas measurement, were reviewed in order to assess whether and how appropriate methodologies are for use in the MetroRADON project. The evaluation of the questionnaires and the literature reviews will become the "report on indoor and geogenic radon surveys in Europe, including their strategies, the methodologies employed, inconsistencies in the results, and potential methodologies to harmonise data and reduce inconsistencies".

In addition, an intercomparison based on variable indoor radon conditions along with ambient parameters that are subjected to change has been organised. The intercomparison site was the Laboratory of Natural Radiation located at the facilities of a former uranium mine near Salamanca, Spain. Measurements were

conducted together with 20 participants. The goal of this activity was to compare the response of instruments traceably calibrated in reference radon chambers to changing conditions of radon gas concentrations. Indoor radon gas measurements for passive and continuous monitoring devices were conducted at around 200-300 kBq/m³h and 2000 kBq/m³h or higher. Radon exhalation from soil and radon concentration in soil gas measurements were conducted in the outdoor area of the laboratory. More than 80 % of the results for radon activity concentration in air were within the interval defined by the reference value and the standard deviation. The results were analysed and documented in a report. The findings will be part of the "Report on the results from the on-site comparison of indoor radon measurements and geogenic radon measurements under field conditions".

Objective 4: Methodologies for the identification of radon priority areas and investigation of the relationship between soil radon exhalation rates and indoor radon concentrations

For the development of harmonised and comparable methodologies for the identification of radon priority areas (RPA) it is necessary to investigate the relationship between soil radon exhalation rates and indoor radon concentrations. An extensive literature review was conducted, reviewing and evaluating the concepts and definitions of radon priority areas proposed or already implemented. Methods developed in Europe to assess the "soil radon potential" which can be used for radon mapping and priority area definition were reviewed. Different approaches were selected to be tested and compared based on a case study from a region in France.

The concepts of classification uncertainty of RPAs were reviewed. Given its economic and political impact, QA for RPA estimation is crucial. In particular, this concerns the uncertainty of RPA estimates. Sources of RPA classification uncertainty were identified and ways to estimate and to quantify RPA uncertainty were proposed. The results will be published as a "report and guideline on the definition, estimation and uncertainty of radon priority areas (RPA)".

To study the various approaches for radon mapping, a mapping exercise was conducted. Exercise data for testing existing mapping methods used in various countries has been compiled and edited and is under assessment by project partners. It consists of two data sets that comprise the region of Cantabria (Spain) and six municipalities in Austria. They include indoor radon measurements, building characteristics of measured dwellings, soil air radon activity concentrations, permeability estimations, activity concentrations of soil samples, ambient dose rates and maps of geogenic parameters. The partners have applied their typically used mapping method to characterise radon risk. The findings were presented at the 14th International Workshop on the Geological Aspects of Radon Risk Mapping. Finally, there was a special focus on differences between radon mapping and definition of RPAs across boundaries. To study this aspect, the borders between Portugal and Spain, Spain and France, Switzerland and France, and Belgium and France were examined.

To develop a complementary approach for mapping RPAs, data on geology, geochemistry, gamma radiation, indoor radon measurements and associated buildings characteristics at a national and local scale in regions with very high radon levels in Spain, Portugal and France were collected. Statistical tools were applied at both scales to identify sectors with the highest indoor radon concentrations. The identified areas are currently being examined.

In addition, and knowing that CD/DVDs can be used as ^{222}Rn detectors, a long-term exposure experiment of CDs and DVDs was conducted. The results will be used to assess the precision, applicability and uncertainties involved when using CDs/DVDs for retrospective radon measurements and for the identification of RPAs.

The first CDs/DVDs that were exposed to a radon atmosphere in the long-term exposure experiment have been analysed. Radon concentrations in a range of < 10 to 147 300 Bq/m³ were found. Measurement of ^{222}Rn activity concentrations of 100 Bq/m³ to 300 Bq/m³ and even lower concentrations posed no problem. While aimed at radon exhalation and radon mitigation measurements, the scope of potential application for the CD/DVD-method appears to be much wider. It was found that the overall good correspondence between CDs/DVDs and the reference measurements can be further improved if the correlation between radon concentrations and temperature during exposure is taken into account. A modified method, based on CDs/DVDs, with improved sensitivity, was studied. This modified method can be used for measurement of low ^{222}Rn concentrations, as well as for measurements in soil gas and for measurements determining the radon exhalation from soil surface. Results of the experiment and mapping exercise will be published in the "report and guideline on the definition, estimation and uncertainty of radon priority areas (RPA)".

Objective 5: Validation of the traceability of European radon calibration facilities, and guidelines on calibration and measurement procedures for the determination of radon concentration in air

In order to validate the traceability of European radon calibration facilities, a survey of European calibration facilities, institutes with primary and secondary radon calibration standards, and selected end-users has been conducted. The results were evaluated, and 15 facilities were selected for validation and traceability exercises using an AlphaGUARD radon monitor as a reference instrument. The comparison exercise will validate the traceability, performance and precision of European radon calibration facilities in the range of 300 Bq/m³ to 10 000 Bq/m³ at three calibration points (400 Bq/m³, 1 000 Bq/m³ and 6 000 Bq/m³). Following the development of constant radon activity concentrations in reference chambers and calibration procedures at low activity concentrations, an intercomparison exercise to validate the traceability of the secondary standards used by the European radon calibration facilities was conducted. A reference instrument was circulated through the participants who calibrated this using their usual calibration procedures. This exercise is still ongoing.

Furthermore, the schedule and comparison protocol for the exercise to validate the traceability of European radon calibration facilities at stable radon atmospheres in the range from 100 Bq/m³ to 300 Bq/m³ was developed. The results and findings from the intercomparison exercises will be a published in a “guideline and recommendations on calibration and measurement procedures for the determination of radon concentration in air”.

Impact

The project will help to establish a basic European metrological infrastructure for radon measurements enabling sound monitoring of radon and radon protection in Europe. Over the course of the project a list of approx. 150 European stakeholders has been generated through the MetroRADON webpage, the newsletter, participation and organisation of workshops, presentations at scientific conferences and publications of peer-reviewed articles in scientific journals. The list of stakeholders consists of manufacturers of radon monitoring equipment, companies offering radon measurements, calibration facilities, national authorities charged with the implementation of the EU Basic Safety Standards into national law, international bodies, etc. The list is regularly updated and used to disseminate project results to the relevant groups.

The topicality of radon and the dissemination of the project’s result created a strong interest in collaboration, resulting in nine academic and public organisations approaching the project to become involved as collaborators.

The project’s results have been presented at international and national conferences, published in seven peer reviewed scientific articles, used in two technical workshops and disseminated in four scientific committee meetings in Europe. The findings will be published in guidelines and best practice guides.

Impact on industrial and other user communities

This project will help to establish a basic infrastructure for low radon activity concentration measurements and thus assist with the generation of RHI maps so that metrologically sound measurements can be made to support the implementation of the EU-BSS and sound decision making for radiological protection and ensuring public health.

The impact of the project is firstly targeted to the process of the transposition of the EU-BSS, but beyond this, the project will enable uptake and exploitation of its results and experience by all stakeholders concerned with radon, including the scientific community. As a consequence, field measurements in Europe will have a higher precision, allowing more appropriate precautions and counter measures against public exposure to radon. In addition, harmonisation and standardisation will allow the comparison and merging of different existing radon data sets on a European scale. The credibility of reported radon data will improve due to harmonised measurement procedures and lead to more consistent results. The relevant authorities and end users in EU member states will have the possibility to perform accurate radon monitoring due to improved calibration methods, summarised in best practice guides and recommendations on metrologically sound calibration and measurement procedures for the determination of radon concentration in air.

A large number of recommendations and guidelines, such as recommendations on the construction of radon monitors that are not sensitive to thoron will be developed and technical concepts/solutions aimed at reducing thoron-related bias to the radon signal in existing monitors will be published, thus leading to

improved radon measurements and the opportunity for improved instrumentation. An industry interest group, established in the project, will provide a specialized platform to disseminate the project's results to stakeholders and pursue discussion and uptake. In June 2019, a first Industry Interest Group (IIG) Meeting was achieved, and 20 representatives of highly relevant industry sectors attended. At this meeting, the demand of industry on radon monitoring has been discussed based on the presented aims and interim results of the present project.

Impact on the metrology and scientific communities

Stakeholders, regulators and end-users of radon measurement methods will profit from the dissemination of the results of this project. For this purpose, an industry interest group, group of national authorities and a group of European and international bodies and associations dealing with radon issues has been formed and are being used as channels to disseminate relevant information to different stakeholders. To inform all stakeholders of the on-going research conducted in MetroRADON, a project newsletter has been sent to approx. 150 stakeholders. The newsletter is facilitating the uptake of the procedures developed in the project by the end-users. To obtain input from stakeholders, questionnaires have been sent to competent institutions in Europe to obtain information about the primary and secondary standards used, the reference atmospheres, procedures and traceability chains, as well as on indoor radon surveys and geogenic radon surveys. The results of the surveys will be used for recommendations and guidelines that will be discussed in the scientific and metrological communities and published for end-users.

Ensuring traceability for the most commonly used European radon calibration facilities, especially at low radon activity concentrations, will significantly reduce calibration uncertainties. Impact is expected in the short term as various stakeholders have requested calibration services for instruments measuring the radon concentration in air.

The consideration of thoron in the newly developed calibration and measurement procedures will trigger the development of new and improved methods in the scientific community and, therefore, the end-user community.

The project is facilitating the opportunity to conduct supplementary comparisons (EURAMET, CCRI(II)) for low radon activity concentrations. Through this, national metrology institutes (NMIs) and designated institutes (DIs) will have the ability to submit or expand their CMC entries for radon measurements. This will enhance the application of the mutual recognition arrangement (MRA) in that specific field of radionuclide metrology.

Impact on relevant standards

The project's outputs and data will benefit European and international standards on radon monitoring and guidelines on radiological protection, construction products, radiation instrumentation and nuclear data. In particular, input has been given to:

- IEC TR 61577-5 "Radiation protection measurement instrumentation – Radon and radon decay product measuring instruments – Part 5: General properties of radon and radon decay products and their measurement methods" (IEC TC 45/SC 45B Radiation protection instrumentation – WG 10: Radon and radon daughter measuring instruments),
- "Measurement of radioactivity in the environment – Air: radon-222 – QA/QC for calibration facilities" (ISO/TC 85/SC 2 Radiological protection – WG 17 Radioactivity measurements), and
- Transformation of the CEN Technical Report TR 17113:2017 "Construction products: Assessment of release of dangerous substances — Radiation from construction products — Dose assessment of emitted gamma radiation" into a CEN Technical Standard (EC Action on CEN TC 351 WG 3 Construction products: Assessment of release of dangerous substances, Radiation from construction products).
- Input to a EURAMET standard comparison report: EURAMET comparisons for ^{222}Rn, not involving any Radon chambers, had been carried out about 15 years ago. The JRP comparison for ^{222}Rn and ^{220}Rn, done in WP1, has been successfully established as EURAMET TC IR comparison.
- Input to CENELEC/TC 45 Technical Report CLC/FprTR 62461 Radiation protection instrumentation - Determination of uncertainty in measurement - CLC/FprTR 62461:2019.

- Input to the revised IAEA Specific Safety Guide No. SSG-32 ‘Protection of the Public against Exposure Indoors due to Radon and Other Natural Sources of Radiation’, jointly sponsored by the IAEA, WHO. BEV and other JRP partners support the IAEA radon section.
- Input to ICRM guideline on radon metrology. BEV and other JRP partners presented the progress and the interim results of the JRP in the ICRM Low Level Radionuclide Metrology Techniques Working Group at the 22nd International Conference on Radionuclide Metrology and its Applications, at the University of Salamanca (May 2019).

This input should improve the traceability requirements of radon and radon daughter measuring instruments in European and international standards. The aims of which are the reduction of uncertainties at instrument calibrations and harmonization of calibration methods at low radon activity concentrations (< 300 Bq/m³ ^{222}Rn). Input will also be given to IEC standard 61577 at the end of the project.

Longer-term economic, social and environmental impacts

In Europe thousands of lung cancer cases annually are attributed to indoor radon progeny exposure. This project will contribute to improving public health through more reliable radon measurements as a basis for effective radon mitigation and prevention of radon progeny induced lung cancer in Europe, leading to improved public health and reduced healthcare costs.

List of publications

1. Bossew, P., Radon Priority Areas – Definition, Estimation and Uncertainty, Nuclear Technology and Radiation Protection 33, 3 (2018) p. 286-292, https://doi.org/10.2298/NTRP180515011B
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6. Maringer F.J., Wiedner, H., Cardellini, F. An innovative quick method for traceable measurement of radon 222 in drinking water. Applied Radiation and Isotopes 155 (2020) 108907. https://doi.org/10.1016/j.apradiso.2019.108907
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Internal Funded Partners: 1 BEV-PTP, Austria 2 BFKH, Hungary 3 CEA, France 4 CMI, Czech Republic 5 IFIN-HH, Romania 6 PTB, Germany 7 STUK, Finland 8 VINS, Serbia	External Funded Partners: 9 AGES, Austria 10 BfS, Germany 11 CLOR, Poland 12 IRSN, France 13 JRC, European Commission 14 SUBG, Bulgaria 15 SUJCHBO, Czech Republic 16 UC, Spain	Unfunded Partners: 17 METAS, Switzerland
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