Executive Summary

MetroRADON is a Joint Research Project funded within the European Metrology Programme for Innovation and Research (EMPIR). Within the project, 17 European national metrology institutes and research institutes aim to provide metrology for radon monitoring. The purpose 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 need for this project has been largely motivated by the requirements of 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. Furthermore, it is a goal of the project to enable uptake and exploitation of its results and experiences by all stakeholders concerned with radon, from regulators and policy makers, professionals in designing, performing, evaluating and interpreting radon surveys, radon instrument manufacturers to the construction industry and scientific community.

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. 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.

Novel calibration methods and traceability validation at low radon activity concentrations will be devised, and new and stable radioactive reference sources developed to enable these traceable calibrations and achieve sufficiently low uncertainties.

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. Traceability to a primary thoron standard will be ensured and refined, enabling the thoron influence to be reliably investigated.

The newly developed reference sources and procedures will be 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 and the project partners will ensure that the results of this project will be taken up by end users, standards organisations, regulators and international bodies and associations. The project will help to establish a basic European metrological infrastructure for radon measurements, enabling sound monitoring of radon and radon protection in Europe.

For more information on the project, news, current developments and dates for workshops visit www.metroradon.eu.

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MetroRADON Partnership

BEV-PTP: Physikalisch-Technischer Prüfdienst des Bundesamts für Eich- und Vermessungswesen, Austria (coordinator)

BFKH: Budapest Főváros Kormányhivatala, Hungary

CEA: Commissariat à l'énergie atomique et aux énergies alternatives, France

CMI: Cesky Metrologicky Institut, Czech Republic

IFIN-HH: Institutul National de Cercetare-Dezvoltare pentru Fizica si Inginerie Nucleara "Horia Hulubei", Romania

PTB: Physikalisch-Technische Bundesanstalt, Germany

STUK: Sateilyturvakeskus, Finland

VINS: Institut Za Nuklearne Nauke Vinca, Serbia

AGES: Österreichische Agentur für Gesundheit und Ernährungssicherheit, Austria

BFS: Bundesamt für Strahlenschutz, Germany

CLOR: Centralne Laboratorium Ochrony Radiologicznej, Poland

IRSN: Institut de Radioprotection et de Surete Nucleaire, France

JRC: Joint Research Centre - European Commission, Europe

SUJCHBO: Státní ústav jaderné, chemické a biologické ochrany, v.v.i., Czech Republic

SUN: Sofiiski Universitet Sveti Kliment Ohridski, Bulgaria

UC: Universidad De Cantabria, Spain

METAS: Eidgenössisches Institut für Metrologie, Switzerland

The MetroRADON consortium at the kick-off meeting, June 2017, Vienna

Project structure and first activities

Development of novel procedures for the traceable calibration of radon measurement instruments at low activity concentrations (Work package (WP) 1)

The aim of this work package is to develop radon gas activity standards for the realization of reference atmospheres for radon activity concentration in air, to undertake two CCRI(II)[1] comparisons of existing radon gas primary standards at different European National Metrology Institutes and Designated Institutes for ^{222}Rn and ^{220}Rn in the range of a few kBq and to develop novel procedures in order to calibrate radon measurement instruments traceable to primary standards in a range of activity concentrations (100 Bq/m^3 to 300 Bq/m³) with relative uncertainties ≤ 5 % (k = 1). This activity range is relevant for regulations defined by the European Council Directive 2013/59/EURATOM (EU-BSS) for indoor radon concentrations at workplaces (article 54) and dwellings (article 74).

After a survey of the technical properties of the different calibration chambers in the partner institutes, the development of emanation sources with constant, stable emanations and activity measurements of the emanated radon traceable to primary standards has started. This includes the development of new methods for source production as well as the development of online-measurement systems for the continuous monitoring of the radon emanation from these sources.

Parallel to the source developments, the work has started at the calibration chambers to ensure that the new emanation sources can be included into radon tight gas circuits at the different calibration chambers. For the realization of stable activity concentrations in the calibration chambers two prerequisites must be fulfilled. The emanated radon activity of the sources must be traceable to primary activity standards and the volume of the chambers and of the whole gas circuits must be traceable to volume standards of national metrology institutes. These measurements are under way or have already been finished. In addition, the installation of instrumentation at the calibration chambers for the monitoring of temperature, air pressure and humidity is underway.

Influence of thoron and its progeny on radon end-user measurements and radon calibrations (WP 2)

The aim of this work package is to investigate and reduce the influence of thoron (^{220}Rn) and its progeny on radon (^{222}Rn) end-user measurements and ^{222}Rn calibrations. For that purpose the reference ^{220}Rn measurement instruments to be used by the WP2 partners will be calibrated using the primary ^{220}Rn system at IRSN. The influence of ^{220}Rn on the ^{222}Rn results of end-users' instruments will be investigated experimentally. The properties of different filters, foils and membranes that might serve as efficient barriers for ^{220}Rn, whilst not significantly reducing ^{222}Rn permeability, will be investigated in order to propose methods for reducing the influence of ^{220}Rn on the ^{222}Rn measurements.

A first meeting of WP2 partners was organised and took place in November 6th and 7th 2017 at Saclay. The establishment and the evaluation of a reference ^{220}Rn atmosphere in the IRSN radon reference chamber has started. Two set-ups have been tested with two flow-through ^{228}Th sources and dilution air to create the ^{220}Rn atmosphere and a primary ^{220}Rn measurement system to measure the ^{220}Rn activity concentration. Two steady ^{220}Rn activity concentrations of around 60 kBq m^{-3} and 480 Bq m^{-3} have been recorded with the primary ^{220}Rn system measurement but counting statistics need to be improved in order to calibrate instruments.

[1] Consultative Committee for Ionising Radiation, Section II: Measurement of radionuclides, BIPM, Sèvres, France

Research on experimental evaluation of ^{220}Rn homogeneity in ^{222}Rn/^{220}Rn exposure facilities has started. Two experimental approaches are proposed for testing the ^{220}Rn homogeneity. The first approach is based on ^{220}Rn absorption in Makrofol N polycarbonate foils packed between appropriate filters and measurement of the foils by Liquid Scintillation Counting (LSC). The second approach is based on the application of Nuclear Track Etch detectors for evaluation of ^{222}Rn inhomogeneity. Experimental research is ongoing in order to evaluate the suitable method for ^{220}Rn homogeneity evaluation in the exposure facilities.

A ^{220}Rn exposure facility is under construction at STUK. A chamber has been validated for exposures and a ^{220}Rn source (100 kBq) was purchased. A literature survey on ^{220}Rn cross-interference on radon measurements is underway.

Preliminary soil gas measurements in a region in Austria with proportionally high occurrence of thorium due to the underlying geological conditions were accomplished. The activity concentration of both ^{222}Rn and ^{220}Rn in the soil gas was measured using traceably calibrated ^{222}Rn and ^{220}Rn measurement instruments (Saphymo AlphaGUARD). The preliminary measurements suggest a significant influence of the presence of ^{220}Rn on the measurement results of the ^{222}Rn measurement devices.

Comparison and harmonization of radon measurement methodologies in Europe (WP 3)

The aims of this work package are to collect and analyse meta-information from radon surveys and existing radon databases in European countries, to evaluate if the data and methodologies are comparable and to identify how they could be harmonised in the event of methodical inconsistency. Moreover, in this WP it will be evaluated what kind of data are useful for different purposes such as the evaluation of workplaces, preventive measures and estimation of population dose caused by radon.

The first steps taken were focused on the overview and analysis of indoor and geogenic radon surveys in Europe. A literature review of existing indoor Rn surveys in Europe has been performed using information available in journals, reports and conference contributions. The relevant data has been collected and reported for each European country.

In order to collect the missing information from the literature, and to obtain information about how the countries intend to implement the EU-BSS into national law two questionnaires have been designed: one on indoor radon surveys and the other on geogenic radon surveys. The two questionnaires will be distributed together to competent institutions, research institutes and universities of European countries by December 2017. The results of the questionnaires will be compared with the information of literature sources to identify and describe differences and possible inconsistencies. The impact and relevance of inconsistencies on stakeholders (the public, regulatory authorities, etc.) will be assessed.

A literature review of more than 50 relevant publications was conducted to study the applicability of using CDs and DVDs as a method for retrospective radon measurement.

Furthermore, reviews of ISO standards 11665-7 and 11665-11 were carried out.

Radon priority areas and the development of the concept of a geogenic radon hazard index (WP 4)

This work package deals with the methodology of definition and estimation of radon priority areas (RPA), relationships between geogenic radon and indoor radon, retrospective radon measurement aiming to RPA estimation, developing a multivariate geogenic radon hazard index (RHI) and with questions of harmonisation of RPAs across borders.

The project partners started collecting information about the status and necessary methodology of RPA definitions that are required for EU Member States by the EU-BSS. A questionnaire addressing matters of RPA definition will be sent to competent institutions within WP3.

To understand and quantify relations between geogenic radiation and indoor radon is important to enable or improve estimation of indoor radon levels and RPAs when indoor radon data are scarce or missing. Data collection and literature reviews are under way. The mentioned questionnaire also addresses questions related to this topic.

Work on the geogenic radon hazard index (RHI) as measure of the geogenic radon potential constructed of different quantities related to geogenic radiation, as regionally available, has started and two presentations were given at International Workshop on the European Atlas of Natural Radiation (IWEANR), Verbania, Italy in November 2017.

To explore the potential of retrospective methods to defining RPAs currently exposure experiments in the Spanish field laboratory at Saelices el Chico (Salamanca) are being performed as part of the QA programme. This laboratory is located on the grounds of a former uranium mine with high natural variability of indoor Rn concentrations and provides realistic exposure conditions.

For the subject of harmonisation of RPA concepts an exercise will be performed to try mapping methods on available datasets from different European regions. The aim is to compare methodologies and their impact on the resulting RPA estimates.

Validation of traceability of European radon calibration facilities (WP 5)

The aim of this work package is to validate the traceability of existing European radon calibration facilities over the activity concentration ranges from 100 Bq/m^3 to 300 Bq/m^3 and 300 Bq/m^3 to 10 000 Bq/m^3. Many existing laboratories request uniform traceability to a validated radon standard. In this WP, international comparisons will be performed. These comparisons will fulfil the need to provide confidence in the capability of European radon calibration facilities in the field of radon activity concentration measurements in air.

The first step in WP5 is to identify existing European radon calibration facilities and primary radon gas standards, to obtain information about their capabilities, to evaluate their suitability for inclusion in the validation exercises and to select those radon calibration facilities that will be included in the validation exercise. For this purpose a questionnaire was drafted to survey European radon calibration facilities and institutes with primary and secondary radon calibration standards. The questionnaire was designed to obtain information about the national standards, used reference atmospheres, radon chambers, instruments measuring radon activity concentrations, calibration procedures and traceability chains in order to determine the suitability for inclusion in the traceability validation exercises. The questionnaire in English was distributed to all MetroRADON project partners, to accredited radon calibration laboratories and to the most relevant radon calibration laboratories in Europe. The completed questionnaires will be evaluated and based on this information the laboratories to be included in the traceability validation exercises will be selected. The participating calibration facilities, which should preferably be situated in different Member States, should represent the respective national reference for the quantity radon activity concentration in air.

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