
**Measurement of radioactivity in the
environment — Air — Radon 220:
Integrated measurement methods
for the determination of the average
activity concentration using passive
solid-state nuclear track detectors**

Mesurage de la radioactivité dans l'environnement — Air — Radon 220: Méthode de mesure intégrée pour la détermination de l'activité volumique moyenne avec des détecteurs passifs solides de traces nucléaires





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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 2, *Radiological protection*.

Introduction

Radon isotopes 222, 220, and 219 are radioactive gases produced by the disintegration of radium isotopes 226, 224, and 223, which are decay products of uranium-238, thorium-232, and uranium-235, respectively, are all found in the earth's crust. Solid elements, also radioactive, followed by stable lead are produced by radon disintegration.^[1]

Radon is considered to be the main source of human exposure to natural radiation. The UNSCEAR (2006) report^[2] suggests that, at the international level, radon accounts for around 52 % of the global average exposure to natural radiation. Isotope 222 (48 %) is far more significant than isotope 220 (4 %), while isotope 219 is considered negligible.

Recent studies on indoor radon-222 and lung cancer in Europe, North America, and Asia provide strong evidence that radon-222 causes a substantial number of lung cancers in the general population. Current estimates of the proportion of lung cancers attributable to radon-222 range from 3 % to 14 %, depending on the average radon-222 concentration in the country concerned and the calculation methods.^[3]

Indoor radon-222 concentration is mainly measured by passive detectors that can measure both radon-222 and radon-220 signals.^[4] If the readings are overestimated, the lung cancer risk is given as a biased estimate when epidemiological studies are carried out. Radon-222 and radon-220 parallel measurements have been carried out in several countries^{[4]-[11]} (See [Table A.1](#)). Experiences from field work indicate that there is no correlation among radon-222 and radon-220 and its decay products' concentrations. This implies that one parameter cannot be estimated from the other. Unless radon-220 activity concentration is measured, a correct radon-222 concentration cannot be given with a single use of radon-222 measuring device. Therefore, a specific measurement of radon-220 is justified.

Due to its short half-life, radon-220 disappears very rapidly in the atmosphere. An activity concentration gradient is observed from the walls or grounds to the inner space of the room. Depending on the objective of the measurement (building characteristics, construction material characterization, etc.), the sampling location is to be chosen after taking into account this gradient.

Due to a highest level of radon-222 in air, radon-220 is very difficult to measure alone. This International Standard proposes a measuring method of radon-220 activity concentration using a dual system considering radon-222 and radon-220.

There are many ways of measuring the activity concentration of radon-220 and its decay products. The measuring technique proposed is an integrated measurement method for radon-220 only.

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1 Scope

This International Standard covers integrated measurement techniques for radon-220 with passive sampling only. It provides information on measuring the average activity concentration of radon-220 in the air, based on easy-to-use and low-cost passive sampling, and the conditions of use for the measuring devices.

This International Standard covers samples taken without interruption over periods varying from a few months to one year.

This type of measurement is also applicable for determination of radon-222 activity concentration.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11665-1:2012, *Measurement of radioactivity in the environment — Air: radon-222 — Part 1: Origins of radon and its short-lived decay products and associated measurement methods*

ISO 11929, *Determination of the characteristic limits (decision threshold, detection limit and limits of the confidence interval) for measurements of ionizing radiation — Fundamentals and application*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

IEC 61577-1, *Radiation protection instrumentation — Radon and radon decay product measuring instruments — Part 1: General principles*

3 Terms, definitions, and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1

activity

number of spontaneous nuclear disintegrations occurring in a given quantity of material over a reasonably short time interval, divided by this time interval

[SOURCE: ISO 921:1997, 23]

Note 1 to entry: Activity is expressed by the relationship:

$$A = \lambda \times N$$

The decay constant is linked to the radioactive half-life (T) by the relationship:

$$\lambda = \frac{\ln 2}{T}$$

3.1.2

activity concentration

activity per unit volume

[SOURCE: IEC 61577-1]

3.1.3

average activity concentration

exposure to activity concentration divided by the sampling duration

3.1.4

radon exposure

integral with respect to time of radon activity concentration accumulated during the exposure time

Note 1 to entry: Exposure to radon is expressed by:

$$e = \int_0^t C dt$$

3.1.5

integrated measurement

measurement obtained by accumulating over time physical variables (number of nuclear tracks, number of electric charges, etc.) linked to the disintegration of radon and/or its decay products, followed by analysis at the end of the accumulation period

3.1.6

measurand

particular quantity subject to measurement

[SOURCE: ISO/IEC Guide 99]

3.1.7

passive sampling

sampling using no active device like pumps for sampling the atmosphere

[SOURCE: IEC 61577-1]

Note 1 to entry: In this case, the sampling is in most instruments mainly made by diffusion.

3.1.8

primary standard

standard designed or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity

[SOURCE: IEC 61577-1]

Note 1 to entry: The concept of primary standard is equally valid for base quantities and derived quantities.

3.1.9

reference atmosphere

radioactive atmosphere in which the influencing parameters (aerosols, radioactivity, climatic conditions, etc.) are sufficiently well-known or controlled to allow its use in a testing procedure for thoron or its decay products' measuring instruments

[SOURCE: IEC 61577-1]

Note 1 to entry: The parameter values concerned shall be traceable to recognized standards.