

Measurement of radioactivity in the environment — Air: radon 222

Part 13: Determination of the diffusion coefficient in waterproof materials: membrane two-side activity concentration test method

Mesurage de la radioactivité dans l'environnement — Air : radon 222 —

Partie 13: Détermination du coefficient de diffusion des matériaux imperméables : méthode de mesurage de l'activité volumique des deux côtés de la membrane

ISO/DTS 11665-13

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Contents

Foreword.....	iv
Introduction.....	vi
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Symbols.....	5
5 Principle of the test method.....	5
6 Measuring system.....	6
6.1 Components of the measuring system.....	6
6.2 Configuration of the measuring system.....	6
7 Test methods.....	9
7.1 General information.....	9
7.2 Method A — Determining the radon diffusion coefficient during the phase of non-stationary radon diffusion.....	10
7.3 Method B — Determining the radon diffusion coefficient during the phase of stationary radon diffusion.....	10
7.4 Method C — Determining the radon diffusion coefficient during the phase of stationary radon diffusion established during ventilation of the receiver container.....	11
7.5 Method D — Determining the radon diffusion coefficient during stationary radon activity concentrations in the source and receiver containers.....	12
8 General application procedures.....	13
8.1 Preparation of samples.....	13
8.2 Fixing the samples in the measuring device.....	13
8.3 Test of radon-tightness, assessment of the radon leakage rate of the receiver container.....	14
8.4 Determining the radon diffusion coefficient according to method A.....	14
8.5 Determining the radon diffusion coefficient according to method B.....	15
8.6 Determining the radon diffusion coefficient according to method C.....	16
8.7 Determining the radon diffusion coefficient according to method D.....	18
8.8 General requirements for performing the tests.....	18
9 Influence quantities.....	20
10 Expression of results.....	21
10.1 Relative uncertainty.....	21
10.2 Decision threshold and detection limit.....	21
10.3 Limits of the confidence interval.....	21
11 Quality management and calibration of the test device.....	22
12 Test report.....	22
Annex A (informative) Determining the radon diffusion coefficient during the phase of stationary radon diffusion according to method C.....	24
Annex B (informative) Determining the radon diffusion coefficient during the phase of non-stationary radon diffusion.....	30
Bibliography.....	38

Foreword

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This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies and radiological protection*, Subcommittee SC 2, *Radiological protection*.

This second edition cancels and replaces the first edition (ISO/TS 11665-13:2017), which has been technically revised.

The main changes are as follows:

- ~~6.2~~ ~~6.2~~ configuration of the measuring system has been revised and supplemented with new figures to show different configuration options with different types of radon sources and radon detectors;
- new ~~7.5~~ ~~7.5~~ Method D (determining the radon diffusion coefficient from the stationary radon activity concentrations in receiver and source containers) has been introduced;
- ~~8.4~~ ~~8.4~~ a new procedure for determining the minimum duration of decisive measurement has been established for method A;
- ~~8.5~~ ~~8.5~~ a revised procedure for determining the minimum duration of decisive measurement has been established for method B;
- new ~~8.7~~ ~~8.7~~ has been inserted describing the measurement procedure according to method D;
- ~~8.8~~ ~~8.8~~ the procedures for determining the minimum radon activity concentration in the source container and for situations when the growth curve is not clearly determined, or when no radon penetrates the receiver container were specified.

A list of all parts in the ISO 11665 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Radon isotopes 222, 219 and 220 are radioactive gases produced by the disintegration of radium isotopes 226, 223 and 224, which are decay products of uranium-238, uranium-235 and thorium-232, respectively, and are all found in the earth's crust. Solid elements, also radioactive, followed by stable lead are produced by radon disintegration [0][1].

When disintegrating, radon emits alpha particles and generates solid decay products, which are also radioactive (polonium, bismuth, lead, etc.). The potential effects on human health of radon lie in its solid decay products rather than the gas itself. Whether or not they are attached to atmospheric aerosols, radon decay products can be inhaled and deposited in the bronchopulmonary tree to varying depths according to their size.

Radon is today considered to be the main source of human exposure to natural radiation. UNSCEAR [0][2] suggests that, at the worldwide level, radon accounts for around 52 % of global average exposure to natural radiation. The radiological impact of isotope 222 (48 %) is far more significant than isotope 220 (4 %), while isotope 219 is considered negligible. For this reason, references to radon in this document refer only to radon-222.

Radon activity concentration can vary from one to more orders of magnitude over time and space. Exposure to radon and its decay products varies tremendously from one area to another, as it depends on the amount of radon emitted by the soil, weather conditions, and on the degree of containment in the areas where individuals are exposed.

As radon tends to concentrate in enclosed spaces like houses, the main part of the population exposure is due to indoor radon. Soil gas is recognized as the most important source of residential radon through infiltration pathways. Other sources are described in other parts of ISO 11665 series and ISO 13164 series [0] for water [3].

Radon enters into buildings via diffusion mechanism caused by the all-time existing difference between radon activity concentrations in the underlying soil and inside the building, and via convection mechanism inconstantly generated by a difference in pressure between the air in the building and the air contained in the underlying soil. Indoor radon activity concentration depends on radon activity concentration in the underlying soil, the building structure, the equipment (chimney, ventilation systems, among others), the environmental parameters of the building (temperature, pressure, etc.) and the occupants' lifestyle.

To limit the risk to individuals, a national reference level of 100 Bq·m⁻³ is recommended by the World Health Organization [0][4]. Wherever this is not possible, this reference level should not exceed 300 Bq·m⁻³. This recommendation was endorsed by the European Community Member States that shall establish national reference levels for indoor radon activity concentrations. The reference levels for the annual average activity concentration in air shall not be higher than 300 Bq·m⁻³ [0][4].

To reduce the risk to the overall population, building codes should be implemented that require radon prevention measures in buildings under construction and radon mitigating measures in existing buildings. Radon measurements are needed because building codes alone cannot guarantee that radon concentrations are below the reference level.

When a building requires protection against radon from the soil, radon-proof insulation (based on membranes, coatings or paints) placed between the soil and the indoors may be used as a stand-alone radon prevention/remediation strategy or in combination with other techniques such as passive or active soil depressurization. Radon-proof insulation functions at the same time as the waterproof insulation.

Radon diffusion coefficient is a parameter that determines the barrier properties of waterproof materials against the diffusive transport of radon. Applicability of the radon diffusion coefficient for radon-proof insulation can be prescribed by national building standards and codes. Requirements for radon-proof