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BSI Standards Publication

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 11665-1:2019)

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National foreword

This British Standard is the UK implementation of EN ISO 11665-1:2019. It supersedes BS EN ISO 11665-1:2015, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NCE/2, Radiation protection and measurement.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Mesurage de la radioactivité dans l'environnement - Air: radon 222 - Partie 1: Origine du radon et de ses descendants à vie courte, et méthodes de mesure associées (ISO 11665-1:2019)

Ermittlung der RadioaktivitÃ¤t in der Umwelt - Luft: Radon-222 - Teil 1: Radon und seine kurzlebigen Folgeprodukte: Quellen und Messverfahren (ISO 11665-1:2019)

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Contents

Page

European foreword **3**

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European foreword

This document (EN ISO 11665-1:2019) has been prepared by Technical Committee ISO/TC 85 "Nuclear energy, nuclear technologies, and radiological protection" in collaboration with Technical Committee CEN/TC 430 “Nuclear energy, nuclear technologies, and radiological protection” the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2020, and conflicting national standards shall be withdrawn at the latest by April 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 11665-1:2015.

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Measurement of radioactivity in the environment — Air: radon-222 —

Part 1: Origins of radon and its short-lived decay products and associated measurement methods

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

Partie 1: Origine du radon et de ses descendants à vie courte, et méthodes de mesure associées

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Full document details: BS EN ISO 11665-1:2019

Contents

Page

Foreword ... **iv**

Introduction ... **v**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms, definitions and symbols ... **1**
3.1 Terms and definitions ... 1
3.2 Symbols ... 8

4 Principle ... **10**

5 Equipment ... **10**

6 Sampling ... **10**
6.1 General ... 10
6.2 Sampling objective ... 11
6.3 Sampling characteristics ... 11
6.4 Sampling conditions ... 11
6.4.1 Installation of sampling device ... 11
6.4.2 Sampling duration ... 12
6.4.3 Volume of air sampled ... 13

7 Detection ... **13**
7.1 Silver-activated zinc sulphide ZnS(Ag) scintillation ... 13
7.2 Gamma-ray spectrometry ... 13
7.3 Liquid scintillation ... 13
7.4 Air ionization ... 14
7.5 Semi-conductor (alpha detection) ... 14
7.6 Solid-state nuclear track detectors (SSNTD) ... 14
7.7 Discharge of polarised surface inside an ionization chamber ... 14

8 Measurement ... **14**
8.1 Methods ... 14
8.2 Influence quantities ... 15
8.3 Calibration ... 16
8.4 Quality control ... 16

9 Expression of results ... **16**

10 Test report ... **16**

Annex A (informative) **Radon and its decay products — General information** ... **18**

Annex B (informative) **Example of results of spot, integrated and continuous measurements of radon-222 activity concentration** ... **28**

Annex C (informative) **Example of a test report** ... **30**

Bibliography ... **31**

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Documents
Document Sharing Hub

Full document details: BS EN ISO 11665-1:2019

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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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 11665-1:2012), of which it constitutes a minor revision. The changes compared to the previous edition are as follows:

— update of the Introduction;

— in A.2.4, details added for change in radon activities concentration in time and space in buildings;

— update of the Bibliography.

A list of all the 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 (see Annex A for further information). Solid elements, also radioactive, followed by stable lead are produced by radon disintegration[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 [2][3][4][5].

Radon is today considered to be the main source of human exposure to natural radiation. UNSCEAR[6] 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 (see Annex A). 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 and building materials, 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 and ISO 13164 series for water[59].

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 $Bq \cdot m^{-3}$ is recommended by the World Health Organization[5]. Wherever this is not possible, this reference level should not exceed 300 $Bq \cdot m^{-3}$. 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 $Bq \cdot m^{-3}$[5].

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.

ISO 11665 consists of several parts (see Figure 1) dealing with:

— measurement methods for radon-222 and its short-lived decay products (see ISO 11665-2, ISO 11665-3, ISO 11665-4, ISO 11665-5 and ISO 11665-6);

NOTE 1 There are many methods for measuring the radon-222 activity concentration and the potential alpha energy concentration of its short-lived decay products. The choice of measurement method depends on the expected level of concentration and on the intended use of the data, such as scientific research and health-related assessments[8][9].

— measurement methods for the radon-222 exhalation rate (see ISO 11665-7 and ISO 11665-9);

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NOTE 2 ISO 11665-7 refers back to ISO 11665-5 and ISO 11665-6.

— measurement methods for the radon-222 in the soil (see ISO 11665-11);

— methodologies for radon-222 measurements in buildings (see ISO 11665-8);

— measurement methods for the radon-222 diffusion coefficient (see ISO/TS 11665-12 and ISO/TS 11665-13)

NOTE 3 ISO 11665-8 refers back to ISO 11665-4 for radon measurements for initial investigation purposes in a building and to ISO 11665-5, ISO 11665-6 and ISO 11665-7 for measurements for any additional investigation.

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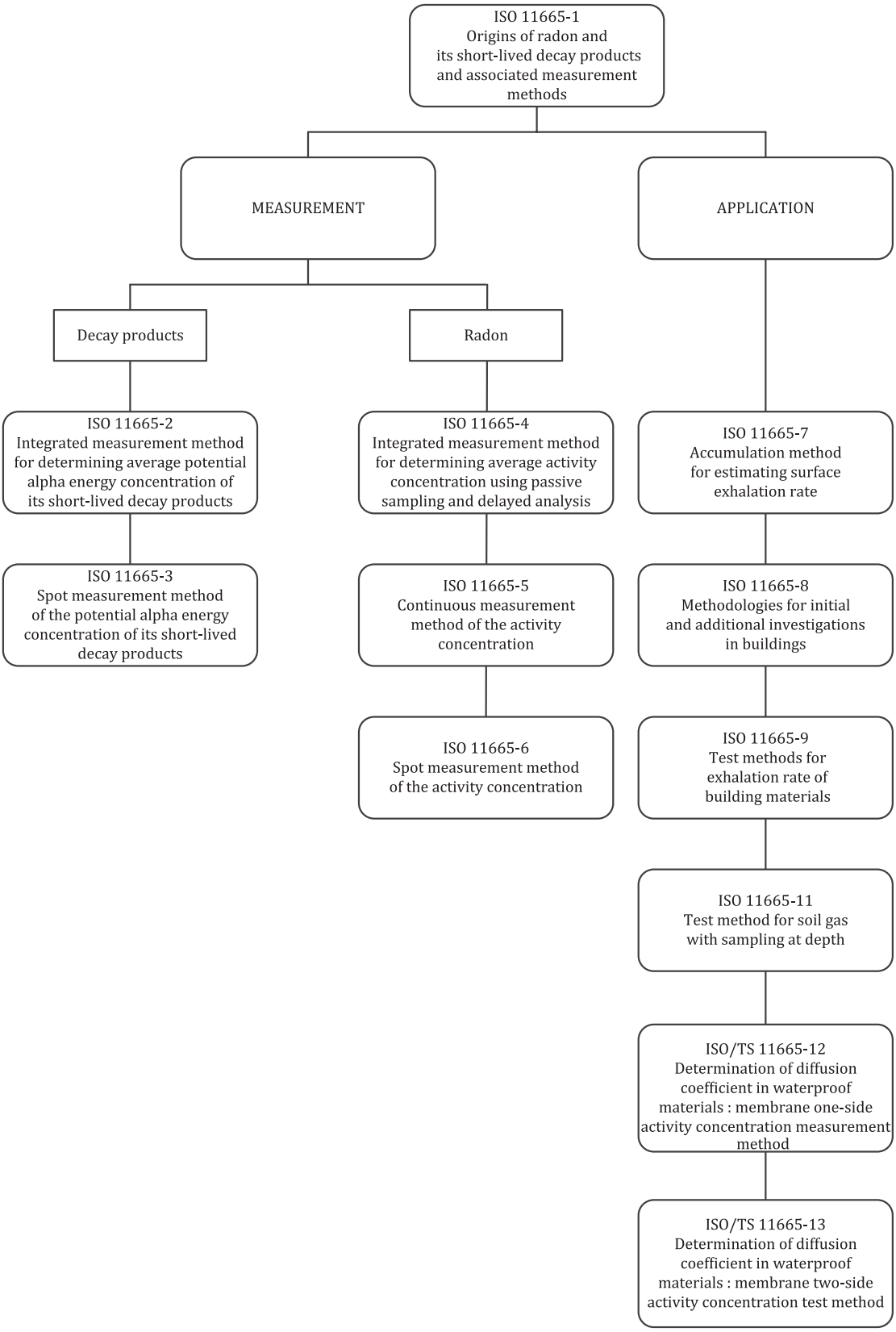

Figure 1 — Structure of the ISO 11665 series

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Measurement of radioactivity in the environment — Air: radon-222 —

Part 1: Origins of radon and its short-lived decay products and associated measurement methods

1 Scope

This document outlines guidance for measuring radon-222 activity concentration and the potential alpha energy concentration of its short-lived decay products in the air.

The measurement methods fall into three categories:

a) spot measurement methods;

b) continuous measurement methods;

c) integrated measurement methods.

This document provides several methods commonly used for measuring radon-222 and its short-lived decay products in air.

This document also provides guidance on the determination of the inherent uncertainty linked to the measurement methods described in its different parts.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 17025, *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*

IEC 61577-2, *Radiation protection instrumentation — Radon and radon decay product measuring instruments — Part 2: Specific requirements for* ^{222}*Rn and* ^{220}*Rn measuring instruments*

IEC 61577-3, *Radiation protection instrumentation — Radon and radon decay product measuring instruments — Part 3: Specific requirements for radon decay product measuring instruments*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

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