

BS EN 61577-4:2014



BSI Standards Publication

Radiation protection instrumentation — Radon and radon decay product measuring instruments —

Part 4: Equipment for the production of
reference atmospheres containing radon
isotopes and their decay products (STAR)

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National foreword

This British Standard is the UK implementation of EN 61577-4:2014. It is derived from IEC 61577-4:2009. It supersedes BS IEC 61577-4:2009, which is withdrawn.

BSI, as a member of CEN, is obliged to publish EN 61577-4 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval as a European Standard.

This was due to the fact that the instruction in subclause 7.1, to measure nuclear disintegration on the filter by an alpha and a gamma spectrometer simultaneously, was considered to be too prescriptive. It is the opinion of the UK committee that alpha spectrometry of a suitable standard is adequate on its own, and that filter samples could be counted using alpha, beta, or gamma spectrometry, either individually or in any combination deemed appropriate by the measurement laboratory.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by tags **C** **C**.

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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31 January 2015	This corrigendum renumbers BS IEC 61577-4:2009 as BS EN 61577-4:2014

English Version

**Radiation protection instrumentation - Radon and radon decay
product measuring instruments - Part 4: Equipment for the
production of reference atmospheres containing radon isotopes
and their decay products (STAR)
(IEC 61577-4:2009 , modified)**

Instrumentation pour la radioprotection - Instruments de
mesure du radon et des descendants du radon - Partie 4:
Dispositif pour la réalisation d'atmosphères de référence
contenant des isotopes du radon et leurs descendants
(STAR)
(CEI 61577-4:2009 , modifiée)

Strahlenschutz-Messgeräte - Geräte für die Messung von
Radon und Radon-Folgeprodukten - Teil 4: Einrichtungen
für die Herstellung von Referenzatmosphären mit
Radonisotopen und ihren Folgeprodukten (STAR)
(IEC 61577-4:2009 , modifiziert)

This European Standard was approved by CENELEC on 2014-11-17. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

This document (EN 61577-4:2014) consists of the text of IEC 61577-4:2009 prepared by IEC/SC 45B "Radiation protection instrumentation" of IEC/TC 45 "Nuclear instrumentation", together with the common modifications prepared by CLC/TC 45B "Radiation protection instrumentation".

The following dates are fixed:

- latest date by which this document has to be implemented (dop) 2015-11-17
at national level by publication of an identical
national standard or by endorsement
- latest date by which the national standards conflicting (dow) 2017-11-17
with this document have to be withdrawn

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

Endorsement notice

The text of the International Standard IEC 61577-4:2009 was approved by CENELEC as a European Standard with agreed common modifications.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-111	1996	International Electrotechnical Vocabulary - Chapter 111: Physics and chemistry	-	-
IEC 60050-393	2003	International Electrotechnical Vocabulary - Part 393: Nuclear instrumentation - Physical phenomena and basic concepts	-	-
IEC 60050-394	2007	International Electrotechnical Vocabulary - Part 394: Nuclear instrumentation - Instruments, systems, equipment and detectors	-	-
IEC 61577	series	Radiation protection instrumentation - Radon and radon decay product measuring instruments	EN 61577	series
ISO/IEC 17025	-	General requirements for the competence of testing and calibration laboratories	EN ISO/IEC 17025	-
ISO/IEC Guide 99	2007	International vocabulary of metrology - Basic and general concepts and associated terms (VIM)	-	-
ICRP 32	-	Annals of the ICRP, Publication N° 32, Limits for inhalation of Radon Daughters by Workers, Vol. 6, N°1, 1981, Pergamon Press	-	-
ICRP 38	-	Annals of the ICRP, Publication N° 38, Radionuclide transformations, Energy and Intensity of Emissions, Vol. 11 – 13, 1983, Pergamon Press	-	-
ICRP 65	-	Annals of the ICRP, Publication N° 65, ICRP Publication 65: Protection against Radon-222 at Home and at Work, Vol. 23/2, 1994, Pergamon Press	-	-

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INTRODUCTION

Radon is a radioactive gas produced by the decay of ^{226}Ra , ^{223}Ra and ^{224}Ra , respectively decay products of ^{238}U , ^{235}U and ^{232}Th which are present in the earth's crust. By decay, radon isotopes (i.e. ^{222}Rn , ^{219}Rn , ^{220}Rn) produce three decay chains, each ending in a stable lead isotope.

NOTE In normal conditions, due to the very short half-life of ^{219}Rn , its activity and the activity of its RnDP¹ are considered negligible compared to the activity of the two other series. Its health effects are therefore not important. Thus in this standard ^{219}Rn and its decay products are not considered.

Radon isotopes and their corresponding short-lived Radon Decay Products (RnDP) (i.e. ^{218}Po , ^{214}Pb , ^{214}Bi , ^{214}Po for ^{222}Rn , and ^{216}Po , ^{212}Pb , ^{212}Bi , ^{212}Po , ^{208}Tl for ^{220}Rn) are of considerable importance, as they constitute the major part of the radiological exposure to natural radioactivity for the general public and workers. In some workplaces, for instance in underground mines, spas and waterworks, the workers are exposed to very significant levels of RnDP. These radionuclides are present in variable quantities in the air, in a gaseous form for the radon isotopes, and as very fine particles for the decay products. It is worthwhile for health physicists to be able to measure with a great accuracy the level of this kind of natural radioactivity in the atmosphere. Because the very particular behaviour of these radioactive elements in the atmosphere and in the corresponding measuring instruments, it is necessary to formalize the way such instruments could be tested.

Remark:

In order to facilitate its use, the IEC 61577 series is divided into the following different parts:

IEC 61577-1: This emphasizes the terminology and units of the specific field of radon and radon decay products (RnDP) measurement techniques and presents briefly the concept of System for Test Atmospheres with Radon (STAR) used for test and calibration of radon and RnDP measuring devices.

IEC 61577-2: This part is dedicated to the tests of ^{222}Rn and ^{220}Rn measuring instruments.

IEC 61577-3: This part is dedicated to the tests of RnDP_{222} and RnDP_{220} measuring instruments.

IEC 61577-4: Details how a STAR is constructed and how it can be used for testing.

¹ RnDP is the acronym of Radon Decay Products and it is equivalent to Radon Progeny (see [1] in the Bibliography).

RADIATION PROTECTION INSTRUMENTATION ± RADON AND RADON DECAY PRODUCT MEASURING INSTRUMENTS ±

Part 4: Equipment for the production of reference atmospheres containing radon isotopes and their decay products (STAR)

1 Scope and object

The IEC 61577 series covers the general features concerning test and calibration of radon and radon decay products measuring instruments. It is also intended to help define type tests, which have to be conducted in order to qualify these instruments. These type tests are described in IEC 61577-2 and IEC 61577-3. This standard addresses only the instruments and associated methods for measuring isotopes 220 and 222 of radon and their subsequent short-lived decay products in gases.

IEC 61577-4 concerns the System for Test Atmospheres with Radon (STAR) needed for testing, in a reference atmosphere, the instruments measuring radon and RnDP. The clauses that follow do neither claim to solve all the problems involved in the production of equipment for setting up reference atmospheres for radon and its decay products, nor to describe all the methods for doing so. They do however set out to be a guide enabling those faced with such problems to choose the best methods for adoption in full knowledge of the facts.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60050-111:1996, *International Electrotechnical Vocabulary (IEV) ± Chapter 111: Physics and chemistry*

IEC 60050-393:2003, *International Electrotechnical Vocabulary (IEV) ± Part 393: Nuclear instrumentation ± Physical phenomena and basic concepts*

IEC 60050-394:2007, *International Electrotechnical Vocabulary (IEV) ± Part 394: Nuclear instrumentation ± Instruments, systems, equipment and detectors*

IEC 61577 (all parts),  *Radiation protection instrumentation - Radon and radon decay product measuring instruments* 

ISO/IEC Guide 99:2007, *International vocabulary of metrology ± Basic and general concepts and associated terms (VIM)*

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

ICRP 32: *Annals of the ICRP, Publication N°32, Limits for inhalation of Radon Daughters by Workers*, Vol. 6, N°1, 1981, Pergamon Press

ICRP 38: *Annals of the ICRP, Publication N°38, Radionuclides transformations, Energy and Intensity of Emissions*, Vol. 11 - 13, 1983, Pergamon Press

ICRP 65: *Annals of the ICRP, Publication N° 65, ICRP Publication 65: Protection Against Radon-222 at Home and at Work, Vol. 23/2, 1994, Pergamon Press*

3 Terms, definitions and units

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

Throughout the whole standard, the term RADON is used to denote all the radon isotopes, which are covered by this standard. When a particular isotope is to be referred to, it will be indicated by its chemical symbol preceded by its mass number (e.g. ^{220}Rn , ^{222}Rn). For historical reasons, ^{220}Rn is also called thoron.

The term RADON DECAY PRODUCTS or its abbreviation (RnDP) denotes the whole set of short-lived decay products, which are concerned by this standard. A particular isotope is indicated by its chemical symbol preceded by its mass number. The subscripts ^{222} , ^{220} added to the symbol RnDP refer to the whole set of short-lived decay products of the corresponding radon isotope (^{218}Po , ^{214}Pb , ^{214}Bi , ^{214}Po), (^{216}Po , ^{212}Pb , ^{212}Bi , ^{212}Po , ^{208}Tl).

All the nuclear data used in this standard refers to ICRP 38, as this standard applies mainly to instruments used for radiation protection purposes.

3.1 General terms and definitions

3.1.1 activity

A

quotient, for an amount of radionuclide in a particular energy state at a given time, of dN by dt , where dN is the expectation value of the number of spontaneous nuclear transitions from this energy state in the time interval of duration dt :

$$A = \frac{dN}{dt}$$

NOTE This quantity is expressed in becquerels (Bq).

[IEV 393-14-12]

3.1.2 volumic activity activity concentration

C_A

quotient of the activity by the total volume of the sample

NOTE 1 For a gas, it is necessary to indicate the temperature and pressure conditions for which the volumic activity, expressed in becquerel per cubic metre, is measured, for example standard temperature and pressure (STP).

NOTE 2 This quantity is expressed in becquerels per cubic metre ($\text{Bq}\cdot\text{m}^{-3}$).

[IEV 393-14-16]

3.1.3 primary standard

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

NOTE The concept of primary standard is equally valid for base quantities and derived quantities.

[VIM, 5.4, modified]