



BSI Standards Publication

Radiation protection instrumentation — Radon and radon decay product measuring instruments

Part 3: Specific requirements for radon
decay product measuring instruments

National foreword

This British Standard is the UK implementation of EN 61577-3:2014. It is derived from IEC 61577-3:2011. It supersedes BS IEC 61577-3:2012, which is withdrawn.

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 **Ⓒ** **Ⓒ**.

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.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2015.
Published by BSI Standards Limited 2015

ISBN 978 0 580 83101 0

ICS 13.280; 17.240

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2012.

Amendments/corrigenda issued since publication

Date	Text affected
31 January 2015	This corrigendum renumbers BS IEC 61577-3:2012 as BS EN 61577-3:2014.

English Version

**Radiation protection instrumentation - Radon and radon decay
product measuring instruments - Part 3: Specific requirements
for radon decay product measuring instruments
(IEC 61577-3:2011 , modified)**

Instrumentation pour la radioprotection - Instruments de
mesure du radon et des descendants du radon - Partie 3:
Exigences spécifiques concernant les instruments de
mesure des descendants du radon
(CEI 61577-3:2011 , modifiée)

Strahlenschutz-Messgeräte - Geräte für die Messung von
Radon und Radon-Folgeprodukten - Teil 3: Besondere
Anforderungen an Messgeräte für Radonfolgeprodukte
(IEC 61577-3:2011 , 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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



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 61577-3:2014) consists of the text of IEC 61577-3:2011 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.

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 60050-394	-	International Electrotechnical Vocabulary (IEV) - Part 394: Nuclear instrumentation - Instruments, systems, equipment and detectors	-	-
IEC 60068-2-27	-	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 61000-6-4	-	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments	EN 61000-6-4	-
IEC 61140	-	Protection against electric shock - Common aspects for installation and equipment	EN 61140	-
IEC 61187	-	Electrical and electronic measuring equipment - Documentation	EN 61187	-
IEC 61577-1	-	Radiation protection instrumentation - Radon and radon decay product measuring instruments - Part 1: General principles	-	-
IEC 61577-4	-	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)	EN 61577-4	-
ISO/IEC Guide 98-3	2008	Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)	-	-

CONTENTS

INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	8
4 General design considerations	10
4.1 Design considerations for the measurements	10
4.1.1 Deposition of radon decay products on surfaces	10
4.1.2 Airflow system	11
4.2 Design considerations for handling and maintenance	11
4.2.1 Portability	11
4.2.2 Application under heavy environmental conditions	11
4.2.3 Automatic operation.....	11
4.2.4 Reliability	11
4.2.5 Capability for operational testing	12
4.2.6 Adjustment and maintenance facilities	12
4.2.7 Acoustic noise level.....	12
4.2.8 Electromagnetic interference	12
4.2.9 Storage	12
5 Technical components.....	12
5.1 Sampling assembly	12
5.2 Radiation detection assembly	13
5.3 Data processing and recording	13
5.4 Measurement display	13
5.5 Power supply.....	14
6 Test conditions	14
6.1 General	14
6.2 Standard test conditions	15
6.3 Execution of tests	15
6.4 Test sources	15
6.4.1 Solid sources.....	15
6.4.2 Reference atmospheres.....	15
7 Requirements and tests concerning radiation detection performance.....	16
7.1 Reference response to a test source	16
7.1.1 Requirements	16
7.1.2 Test method	16
7.2 Cross interference to other radon isotopes	16
7.2.1 Requirements	16
7.2.2 Test method	16
7.3 Linearity of indication	17
7.3.1 Requirements	17
7.3.2 Test method	17
7.4 Instrument statistical fluctuation	17
7.4.1 Requirements	17
7.4.2 Test method	17
7.5 Response time	18

7.5.1	Requirements	18
7.5.2	Test method	18
7.6	Signal accumulation	18
7.6.1	Requirements	18
7.6.2	Test method	19
8	Requirements and tests concerning air circuit performance	19
8.1	General	19
8.2	Flow-rate stability	19
8.2.1	Requirements	19
8.2.2	Test method	19
8.3	Accuracy of the flow-rate measurement	19
8.3.1	Requirements	19
8.3.2	Test method	19
8.4	Effect of filter pressure drop	20
8.4.1	Requirements	20
8.4.2	Test method	20
8.5	Low sampling flow-rate indication	20
8.5.1	Requirements	20
8.5.2	Test method	20
9	Requirements and tests concerning environmental performance	20
9.1	Response to ambient gamma radiation	20
9.1.1	Requirements	20
9.1.2	Test method	21
9.2	Number concentration of aerosols	21
9.2.1	Requirements	21
9.2.2	Test method	21
9.3	Ambient temperature	21
9.3.1	Requirements	21
9.3.2	Test method	21
9.4	Relative humidity and condensed moisture	21
9.4.1	Requirements	21
9.4.2	Test method	22
9.5	Atmospheric pressure	22
10	Requirements and tests concerning electrical performance	22
10.1	Warm-up time	22
10.1.1	Requirements	22
10.1.2	Test method	22
10.2	Power supply variations	22
10.2.1	Requirements	22
10.2.2	Test method	23
10.3	Battery test	23
10.3.1	Requirements	23
10.3.2	Test method	23
11	Requirements and tests concerning mechanical performance	23
11.1	Requirements	23
11.2	Test method	23
12	Operation and maintenance manual	24
13	Type test report and certificate	24

Table 1 – Reference conditions and standard test conditions (unless otherwise indicated by the manufacturer).....	25
Table 2 – Tests of the radiation detection performance	26
Table 3 – Tests performed with variation of influence quantities.....	26
Table 4 – Tests of the air circuit.....	26

INTRODUCTION

Radon is a radioactive trace 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. The radon isotope ^{220}Rn generally is called thoron¹.

NOTE In normal conditions, due to the very short half-life of ^{219}Rn , its activity and the activity of its RnDP² 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 such as underground mines, spas and waterworks, the workers are exposed to very significant levels of RnDP. Various quantities of these radionuclides are airborne in a gaseous form for the radon isotopes and as particulates for the radon 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 of the unique 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.

The standard series IEC 61577 covers specific requirements concerning test and calibration of radon and radon decay product measuring instruments. In order to facilitate its use, the IEC 61577 series is divided into the following different parts:

IEC 61577-1 (Normative): This part deals with the terminology and units used in the specific area of radon and radon decay products (RnDP) measurements and describes briefly the System for Test Atmospheres with Radon (STAR) used for test and calibration of radon and RnDP measuring devices.

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

IEC 61577-3 (Normative): This part is dedicated to the test of RnDP₂₂₂ and RnDP₂₂₀ measuring instruments.

IEC 61577-4 (Normative): This part describes the construction of a STAR and its use for testing.

IEC 61577-5 (Informative): This is a technical guide concerning special features of radon and radon decay products as well as their measurement.

¹ The term *thoron* is not used in this standard. Instead, the term *radon* is used to denote the radionuclides ^{220}Rn and ^{222}Rn . In the case of only one radionuclide being explicitly specified, the atomic mass number and the chemical symbol will be given.

² RnDP is the acronym of Radon Decay Products which are sometimes denoted as radon progeny. The term *Radon Decay Product* or its abbreviation (RnDP) denotes the whole set of short-lived decay products that are the focus of 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 (RnDP₂₂₂: ^{218}Po , ^{214}Pb , ^{214}Bi , ^{214}Po , and RnDP₂₂₀: ^{216}Po , ^{212}Pb , ^{212}Bi , ^{212}Po , ^{208}Tl).

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

Part 3: Specific requirements for radon decay product measuring instruments

1 Scope

This part of IEC 61577 describes the specific requirements for instruments measuring the volumetric activity of airborne short-lived radon decay products and/or their ambient potential alpha-energy concentration outdoors, in dwellings, and in workplaces including underground mines.

This standard applies practically to all types of electronic instruments that are based on grab sampling, continuous sampling technique and electronic integrating measurement methods. The measurement of activity retained by a sampling device, for example a filtering device, can be performed both during sampling or after the completion of a collection cycle.

The different types of instrumentation used for measurements are stated in IEC 61577-1.

2 Normative references

The following references are indispensable in applying this document. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61187, *Electrical and electronic measuring equipment – Documentation*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

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

IEC 61577-4, *Radon and radon decay product measuring instruments. Equipment for the production of reference atmospheres containing radon isotopes and their decay products (STAR)* ☐

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050-394 apply as well as the following: