IEC 61577-6

Edition 1.0 2026-03

INTERNATIONAL STANDARD

Radiation protection instrumentation - Radon and radon decay product measuring instruments -
Part 6: Passive integrating radon measurement system using solid-state nuclear track detectors

ICS 13.280

ISBN 978-2-8327-1109-5

IEC 61577-6:2026-03(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2026 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTRODUCTION 5
1 Scope 6
2 Normative references 6
3 Terms and definitions, quantities and units 6
3.1 Terms and definitions 6
3.2 Quantities and units 9
4 Principle of measurement 9
4.1 Solid-state nuclear track detector (SSNTD) 9
4.2 Diffusion chamber 10
4.3 Visualization and analysis of particle tracks 10
4.4 Basic measures to assuring the quality of measurements 11
4.4.1 Storage and handling of the plastic for SSNTDs 11
4.4.2 Background detection 11
4.4.3 Calibration factor 11
4.4.4 Excluding of non-controlled exposures from passive radon devices 12
4.4.5 Influence of environmental conditions 12
4.4.6 Quality assurance and quality control 12
5 Technical components of the passive integrating measurement system 12
5.1 General 12
5.2 Passive radon device 13
5.3 Etching equipment 13
5.4 Image processing and track detection unit 13
5.5 Data analysis and reporting unit 14
5.6 Power supply 14
6 General test requirements 14
6.1 Test atmosphere 14
6.2 Standard test and reference conditions 14
6.3 Execution of tests 15
6.4 Periodic tests 15
7 Requirements and test methods for passive radon devices 15
7.1 Measurement accuracy 15
7.1.1 Requirements 15
7.1.2 Test method 15
7.2 Statistical fluctuation 16
7.2.1 Requirements 16
7.2.2 Test method 16
7.3 Linearity of response 16
7.3.1 Requirements 16
7.3.2 Test method 17
7.4 Cross-interference to thoron 17
7.4.1 Requirements 17
7.4.2 Test method 17
7.5 Ambient temperature 17
7.5.1 Requirements 17
7.5.2 Test method 17
7.6 Relative humidity 18

7.6.1 Requirements 18
7.6.2 Test method 18
8 Quality control requirements for SSNTD processing 19
8.1 General 19
8.2 Exposure of SSNTDs for quality control 19
8.3 Stability of etching temperature 20
8.3.1 Chemical etching 20
8.3.2 Electrochemical etching 20
8.4 Stability of image processing and track detection 20
9 Documentation 20
9.1 Operation and maintenance instructions 20
9.2 Technical records and test report 20
Bibliography 22

Figure 1 – Etched alpha particle tracks in various plastics observed under an optical microscope with identical magnification 11

Table 1 – Reference conditions and standard test conditions 14
Table 2 – Test protocols [9] 16

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

Radiation protection instrumentation - Radon and radon decay product measuring instruments - Part 6: Passive integrating radon measurement system using solid-state nuclear track detectors

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61577-6 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
45B/1100/FDIS	45B/1111/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61577 series, published under the general title *Radiation protection instrumentation - Radon and radon decay product measuring instruments*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,

– withdrawn, or

– revised.

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 ending in a stable lead isotope.

In normal conditions, due to the very short half-life of ^{219}Rn, its activity and the activity of its Radon Decay Products (RnDP)[1] are considered negligible compared to the activity of the two other series. Its health effects are therefore not important. Thus, in this document ^{219}Rn and its decay products are not considered.

Radon isotopes and their corresponding short-lived 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 can be exposed to very significant levels of RnDP. The conformity of the technical characteristics of radon measuring devices with specific requirements contributes to a harmonized quality level of the measurements and thus supports the confidence in the measurement results and the acceptance of the decisions made.

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 [1][2]: This part is dedicated to the tests of ^{222}Rn and ^{220}Rn measuring instruments.

IEC 61577-3 [2]: This part is dedicated to the tests of $RnDP_{222}$ and $RnDP_{220}$ measuring instruments.

IEC 61577-4 [3]: This part details how a STAR is constructed and how it can be used for testing.

IEC TR 61577-5 [4]: This part provides basic data and technical information to support the design of measuring instruments for ^{222}Rn, ^{220}Rn and their decay products and practical application of the instruments for the measurement.

IEC 61577-6: This part is dedicated to the tests of passive integrating ^{222}Rn measurement systems.

---

1 RnDP is the acronym of Radon Decay Products and it is equivalent to Radon Progeny.

2 Numbers in square brackets refer to the Bibliography.

1 Scope

This part of IEC 61577 describes the specific requirements for instruments measuring the exposure to airborne radon (^{222}Rn) outdoors and indoors. The exposure is the time-integrated radon activity concentration in air accumulated over the exposure period.

This document applies to radon integration measurement systems equipped with solid-state nuclear track detectors (SSNTD) installed in an enclosed volume. The air containing ^{222}Rn enters the volume by diffusion.

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.

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

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

3 Terms and definitions, quantities and units

3.1 Terms and definitions

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

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

– IEC Electropedia: available at https://www.electropedia.org/

– ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
activity
number dN of spontaneous nuclear transitions or nuclear disintegrations for a radionuclide of amount N produced during a short time interval dt, divided by this time interval

[SOURCE: IEC 60050-395:2014 [5], 395-01-05, modified – The formula and the notes to entry have been omitted.]

3.1.2
activity concentration
activity per unit volume of the sample

[SOURCE: IEC 60050-395:2014, 395-01-09, modified – The notes to entry have been omitted.]

3.1.3
characteristic diffusion time
time required for radon to enter a diffusion chamber and reach at least 90 % of its external concentration within the chamber

3.1.4
client
person or organization deploying passive radon devices for measurements and using the resources of a radon service for this purpose

3.1.5
coefficient of variation
V
ratio of the standard deviation s to the arithmetic mean $\bar{x}$ of a set of n measurements x_i given by the following formula:

$$V = \frac{s}{\bar{x}} = \frac{1}{x_{\mathrm{m}}}\sqrt{\frac{\sum\left(x_i - \bar{x}\right)^2}{n-1}}$$

Note 1 to entry: The coefficient of variation can be expressed in percent (%) of the arithmetic mean.

[SOURCE: IEC 61577-2:2014, 3.9]

3.1.6
conventional quantity value
υ_c
quantity value attributed by agreement to a quantity for a given purpose

Note 1 to entry: The term "conventional true quantity value" is sometimes used for this concept, but its use is discouraged.

Note 2 to entry: Sometimes a conventional quantity value is an estimate of a true quantity value.

Note 3 to entry: A conventional quantity value is generally accepted as being associated with a suitably small measurement uncertainty, which might be zero.

[SOURCE: ISO/IEC GUIDE 99:2007 [6], 2.12, modified – Examples have been omitted.]

3.1.7
cross-interference
ratio of the response of the instrument to the radiation from interfering radionuclide to the response of the radiation from the radionuclide of interest

[SOURCE: IEC 61577-2:2014, 3.8]

3.1.8
diffusion chamber
enclosed volume into which radon enters by passive diffusion

3.1.9
absolute error
algebraic difference between the indicated value and a comparison value

Note 1 to entry: The comparison value should be a conventional quantity value.

[SOURCE: IEC 60050-311:2001 [7], 311-01-05, modified – The notes to entry have been replaced by a new Note 1 to entry.]

3.1.10
relative error
ratio of the absolute error to a comparison value

Note 1 to entry: The comparison value should be a conventional quantity value.

Note 2 to entry: The conventional quantity value in this document is associated with the comparison value established in the radon reference atmosphere.

[SOURCE: IEC 60050-311:2001, 311-01-17, modified – The notes to entry have been replaced by a new Note 1 to entry and Note 2 to entry.]

3.1.11
etching
chemical or electrochemical process for treating SSNTD to make latent tracks optically visible

Note 1 to entry: In the chemical etching process, a chemical solvent is used as an etchant.

Note 2 to entry: In the electrochemical etching process, a sinusoidal electrical voltage is applied in addition to the chemical etching in order to intensify the effect of the etching.

3.1.12
time-integrated radon activity concentration
time integral over the activity concentration of radon for a defined period of time

Note 1 to entry: The unit is $Bq \cdot h \cdot m^{-3}$.

Note 2 to entry: The term "exposure to radon" can also be used for the same meaning of "time-integrated radon activity concentration" in this document.

3.1.13
exposure period
period for which someone/something is subject to ionizing radiation

Note 1 to entry: In the context of this document, period for which someone/something is exposed to radon.

3.1.14
radon
^{222}Rn
radon isotope with mass number 222

3.1.15
radon reference atmosphere
volume of air containing radon to realize the measurand of radon activity concentration

Note 1 to entry: A radon reference atmosphere is provided by a System for Test Atmospheres with Radon (STAR facility). The components and operation of a STAR are described in IEC 61577-4.

Note 2 to entry: A radon reference atmosphere represents a secondary standard for the radon activity concentration that combines the primary quantities of radon activity and volume.

3.1.16
radon service
entity operating a passive integrating radon measurement system

Note 1 to entry: A radon service carries out all activities required to evaluate exposed measuring devices and determine radon exposure. It works in accordance with defined procedures and quality assurance requirements. The radon service communicates the measurement result to the client.

3.1.17
passive sampling
sampling which involves only natural diffusion

3.1.18
passive radon device
diffusion chamber with a detector suitable for registering the radiation from ^{222}Rn and its progeny

Note 1 to entry: The passive radon devices covered by this document use solid-state nuclear track detectors. This allows the devices to be operated for autonomous long-term measurements without additional electronic support.

Note 2 to entry: The passive radon device can be designed for on-site measurements indoors and outdoors or for wearing on a person's body.

3.1.19
solid-state nuclear track detector
SSNTD
solid material in which penetrating nuclear particles change chemical bonds and thus create latent tracks that can be made visible by subsequent chemical processing

Note 1 to entry: The latent tracks are formed along the entry path of the nuclear particle.

Note 2 to entry: For the measurement of radon and progeny, the solid material shall be sensitive to alpha particles.

3.1.20
test atmosphere
volume of air containing radon that is established for testing radon measuring instruments

Note 1 to entry: The radon activity concentration of a test atmosphere is traced back to a radon reference atmosphere.

Note 2 to entry: A test atmosphere is provided by a System for Test Atmospheres with Radon (STAR facility). The components and operation of a STAR are described in IEC 61577-4.