



BSI Standards Publication

Radiation protection instrumentation — Dosimetry systems with integrating passive detectors for individual, workplace and environmental monitoring of photon and beta radiation

National foreword

This British Standard is the UK implementation of EN IEC 62387:2022+A11:2022. It is derived from IEC 62387:2020. It supersedes BS EN IEC 62387:2022, which is withdrawn.

The start and finish of text introduced or altered by amendment A11 is indicated in the text by tags. Tags indicating changes to text carry the number of the CENELEC amendment. For example, text altered by CENELEC amendment A11 is indicated by A11 A11.

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 committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2023
Published by BSI Standards Limited 2023

ISBN 978 0 539 29101 8

ICS 13.280

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 January 2023.

Amendments/corrigenda issued since publication

Date	Text affected
30 November 2023	Implementation of CENELEC amendment A11:2022

English Version

Radiation protection instrumentation - Dosimetry systems with
integrating passive detectors for individual, workplace and
environmental monitoring of photon and beta radiation
(IEC 62387:2020)

Instrumentation pour la radioprotection - Systèmes
dosimétriques avec détecteurs intégrés passifs pour le
contrôle radiologique individuel, du lieu de travail et de
l'environnement des rayonnements photoniques et bêta
(IEC 62387:2020)

Strahlenschutz-Messgeräte - Dosimetriesysteme mit
integrierenden passiven Detektoren zur Personen-,
Arbeitsplatz- und Umgebungsüberwachung auf Photonen-
und Betastrahlung
(IEC 62387:2020)

This European Standard was approved by CENELEC on 2022-01-26. 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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

This document (EN IEC 62387:2022) consists of the text of IEC 62387:2020 prepared by IEC/SC 45B, Radiation protection instrumentation, of IEC/TC 45, Nuclear instrumentation.

The following dates are fixed:

- latest date by which this document has to be (dop) 2023–04–14
implemented at national level by publication of an
identical national standard or by endorsement
- latest date by which the national standards (dow) 2025–10–14
conflicting with this document have to be
withdrawn

This document supersedes EN 62387:2016 and all of its amendments and corrigenda (if any).

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

This document is read in conjunction with EN IEC 62387:2022/A11:2022.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 62387:2020 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068-2-31	NOTE Harmonized as EN 60068-2-31
IEC 60359	NOTE Harmonized as EN 60359
IEC 60904-3	NOTE Harmonized as EN IEC 60904-3
IEC/TR 62461	NOTE Harmonized as CLC IEC/TR 62461
ISO 4037-1:2019	NOTE Harmonized as EN ISO 4037-1:2021
ISO 4037-2:2019	NOTE Harmonized as EN ISO 4037-2:2021
ISO 4037-4:2019	NOTE Harmonized as EN ISO 4037-4:2021
ISO 29661:2012/AMD1:2015	NOTE Harmonized as EN ISO 29661:2017

European foreword to Amendment A11

This document (EN IEC 62387:2022/A11:2022) has been prepared by CLC/TC 45B “Radiation protection instrumentation”.

The following dates are fixed:

- latest date by which this document has to be (dop) 2023–04–14
implemented at national level by publication of
an identical national standard or by
endorsement
- latest date by which the national standards (dow) 2025–10–14
conflicting 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 shall not be held responsible for identifying any or all such patent rights.

This document is read in conjunction with EN IEC 62387:2022.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where 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 61000-4-2	-	Electromagnetic compatibility (EMC) - EN 61000-4-2 Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	-	-
IEC 61000-4-3	-	Electromagnetic compatibility (EMC) - EN IEC 61000-4-3 Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	-	-
IEC 61000-4-4	-	Electromagnetic compatibility (EMC) - EN 61000-4-4 Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	-	-
IEC 61000-4-5	-	Electromagnetic compatibility (EMC) - EN 61000-4-5 Part 4-5: Testing and measurement techniques - Surge immunity test	-	-
IEC 61000-4-6	-	Electromagnetic compatibility (EMC) - EN 61000-4-6 Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	-	-
IEC 61000-4-8	-	Electromagnetic compatibility (EMC) - EN 61000-4-8 Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	-	-
IEC 61000-4-11	-	Electromagnetic compatibility (EMC) - EN IEC 61000-4-11 Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase	-	-
IEC 61000-6-2	-	Electromagnetic compatibility (EMC) - EN IEC 61000-6-2 Part 6-2: Generic standards - Immunity standard for industrial environments	-	-

ISO 4037	series	Radiological protection - X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy	EN ISO 4037	series
ISO 4037-3	2019	Radiological protection - X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy - Part 3: Calibration of area and personal dosimeters and the measurement of their response as a function of energy and angle of incidence	EN ISO 4037-3	2021
ISO 6980	series	Nuclear energy - Reference beta-particle radiation	-	-
ISO 6980-3	-	Nuclear energy - Reference beta-particle radiation - Part 3: Calibration of area and personal dosimeters and the determination of their response as a function of beta radiation energy and angle of incidence	-	-
ISO 8529	series	Reference neutron radiations – Part 1: Characteristics and methods of production	-	-
ISO/IEC Guide 98–3	2008	Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)	-	-

CONTENTS

FOREWORD	7
INTRODUCTION	9
1 Scope	10
2 Normative references	11
3 Terms and definitions	12
4 Units and symbols	22
5 General test procedures	22
5.1 Basic test procedures	22
5.1.1 Instructions for use	22
5.1.2 Nature of tests	22
5.1.3 Reference conditions and standard test conditions	22
5.1.4 Production of reference radiation	22
5.1.5 Choice of phantom for the purpose of testing	23
5.1.6 Position of dosimeter for the purpose of testing	23
5.2 Test procedures to be considered for every test	23
5.2.1 Number of dosimeters used for each test	23
5.2.2 Consideration of the uncertainty of the conventional quantity value	23
5.2.3 Consideration of non-linearity	23
5.2.4 Consideration of natural background radiation	23
5.2.5 Consideration of several detectors or signals in a dosimeter	23
5.2.6 Performing the tests efficiently	24
6 Performance requirements: summary	24
7 Capability of a dosimetry system	25
7.1 General	25
7.2 Measuring range and type of radiation	25
7.3 Rated ranges of the influence quantities	25
7.4 Maximum rated measurement time $t_{\max}$	25
7.5 Reusability	26
7.6 Model function	26
7.7 Example for the capabilities of a dosimetry system	26
8 Requirements for the design of the dosimetry system	27
8.1 General	27
8.2 Indication of the dose value (dosimetry system)	27
8.3 Assignment of the dose value to the dosimeter (dosimetry system)	27
8.4 Information given on the devices (reader and dosimeter)	27
8.5 Retention and removal of radioactive contamination (dosimeter)	28
8.6 Algorithm to evaluate the indicated value (dosimetry system)	28
8.7 Use of dosimeters in mixed radiation fields (dosimetry system)	28
9 Instruction manual	28
9.1 General	28
9.2 Specification of the technical data	28
10 Software, data and interfaces of the dosimetry system	29
10.1 General	29
10.2 Design and structure of the software	30
10.2.1 Requirements	

10.2.2	Method of test.....	30
10.3	Identification of the software	30
10.3.1	Requirements	30
10.3.2	Method of test.....	31
10.4	Authenticity of the software and the presentation of results.....	31
10.4.1	Requirements	31
10.4.2	Method of test.....	31
10.5	Alarm and stop of system operation under abnormal operating conditions.....	31
10.5.1	Requirements	31
10.5.2	Method of test.....	32
10.6	Control of input data by the dosimetry system.....	32
10.6.1	Requirements	32
10.6.2	Method of test.....	32
10.7	Storage of data	32
10.7.1	Requirements	32
10.7.2	Method of test.....	33
10.8	Transmission of data.....	33
10.8.1	Requirements	33
10.8.2	Method of test.....	34
10.9	Hardware interfaces and software interfaces.....	34
10.9.1	Requirements	34
10.9.2	Method of test.....	34
10.10	Documentation for the software test.....	34
10.10.1	Requirements	34
10.10.2	Method of test.....	35
11	Radiation performance requirements and tests (dosimetry system).....	35
11.1	General.....	35
11.2	Coefficient of variation	36
11.3	Non-linearity	36
11.3.1	Requirements	36
11.3.2	Method of test.....	36
11.3.3	Interpretation of results.....	36
11.4	Overload characteristics, after-effects, and reusability	37
11.4.1	Requirements	37
11.4.2	Method of test.....	38
11.4.3	Interpretation of the results.....	38
11.5	Radiation energy and angle of incidence for $H_p(10)$ or $H^*(10)$ dosimeters.....	39
11.5.1	Photon radiation	39
11.5.2	Beta radiation	41
11.6	Radiation energy and angle of incidence for $H_p(3)$ or $H'(3)$ dosimeters	41
11.6.1	Photon radiation	41
11.6.2	Beta radiation	43
11.7	Radiation energy and angle of incidence for $H_p(0,07)$ or $H'(0,07)$ dosimeters	44
11.7.1	Photon radiation	44
11.7.2	Beta radiation	46
11.8	Over indication due to radiation incident from the side of an $H_p(10)$, $H_p(3)$ or $H_p(0,07)$ dosimeter	47
11.8.1	Requirements	47
11.8.2	Method of test.....	

11.8.3	Interpretation of the results	48
11.9	Indication of the presence of beta dose for $H_p(0,07)$ whole body dosimeters	48
12	Response to mixed irradiations (dosimetry system)	48
12.1	Requirements	48
12.2	Method of test	49
12.2.1	General	49
12.2.2	Preparation of the test	49
12.2.3	Practical test	49
12.3	Interpretation of the results	50
13	Environmental performance requirements and tests	50
13.1	General	50
13.1.1	General requirement	50
13.1.2	General method of test	50
13.2	Ambient temperature and relative humidity (dosemeter)	51
13.2.1	General	51
13.2.2	Requirements	51
13.2.3	Method of test	51
13.2.4	Interpretation of the results	51
13.3	Light exposure (dosemeter)	52
13.3.1	General	52
13.3.2	Requirements	52
13.3.3	Method of test	52
13.3.4	Interpretation of the results	52
13.4	Dose build-up, fading and self-irradiation (dosemeter)	52
13.4.1	General	52
13.4.2	Requirements	53
13.4.3	Method of test	53
13.4.4	Interpretation of the results	53
13.5	Sealing (dosemeter)	53
13.6	Reader stability (reader)	53
13.6.1	General	53
13.6.2	Requirements	54
13.6.3	Method of test	54
13.6.4	Interpretation of the results	54
13.7	Ambient temperature (reader)	54
13.7.1	General	54
13.7.2	Requirements	54
13.7.3	Method of test	54
13.7.4	Interpretation of the results	55
13.8	Light exposure (reader)	55
13.8.1	General	55
13.8.2	Requirements	55
13.8.3	Method of test	55
13.8.4	Interpretation of the results	56
13.9	Primary power supply (reader)	56
13.9.1	General	56
13.9.2	Requirements	56
13.9.3	Method of test	56
13.9.4	Interpretation of the results	57

14	Electromagnetic performance requirements and tests (dosimetry system)	57
14.1	General	57
14.2	Requirements	57
14.3	Method of test	58
14.4	Interpretation of the results	58
15	Mechanical performance requirements and tests	58
15.1	General requirement	58
15.2	Drop (dosemeter)	59
15.2.1	Requirements	59
15.2.2	Method of test	59
15.2.3	Interpretation of the results	59
16	Documentation	60
16.1	Type test report	60
16.2	Certificate issued by the laboratory performing the type test	60
Annex A	(normative) Confidence limits	73
A.1	General	73
A.2	Confidence interval for the mean, $\bar{x}$	73
A.3	Confidence interval for a combined quantity	74
Annex B	(informative) Causal connection between readout signals, indicated value and measured value	76
Annex C	(informative) Overview of the necessary actions that have to be performed for a type test according to this document	77
Annex D	(informative) Uncertainty of dosimetry systems	78
Annex E	(informative) Conversion coefficients $h_{pD}(0,07;source;\alpha)$, $h'_{D}(0,07;source;\alpha)$, $h_{pD}(3;source;\alpha)$, and $h'_{D}(3;source;\alpha)$ from personal absorbed dose in 0,07 mm depth, $D_p(0,07)$, to the corresponding dose equivalent quantities for radiation qualities defined in ISO 6980-1	79
Annex F	(informative) Computational method of test for mixed irradiations	83
Bibliography		85
Figure 1	– Stepwise irradiation of an $H^*(10)$ dosimeter at 90° angle of incidence	40
Figure A.1	– Test for confidence interval	73
Figure B.1	– Data evaluation in dosimetry systems	76
Figure F.1	– Flow chart of a computer program to perform tests according to 12.2	84
Table 1	– Mandatory and maximum energy ranges covered by this document	10
Table 2	– Values of c_1 and c_2 for w different dose values and n indications for each dose value	37
Table 3	– Angles of incidence of irradiation for $H_p(10)$ and $H^*(10)$ dosimeters	39
Table 4	– Angles of incidence of irradiation for $H_p(3)$ and $H^*(3)$ dosimeters	42
Table 5	– Angles of incidence of irradiation for $H_p(0,07)$ and $H^*(0,07)$ dosimeters	45
Table 6	– Symbols	61
Table 7	– Reference conditions and standard test conditions	63
Table 8	– Performance requirements for $H_p(10)$ dosimeters	64
Table 9	– Performance requirements for $H_p(3)$ dosimeters	65
Table 10	– Performance requirements for $H_p(0,07)$ dosimeters	66

Table 11 – Performance requirements for $H^*(10)$ dosimeters	67
Table 12 – Performance requirements for $H'(3)$ dosimeters	68
Table 13 – Performance requirements for $H'(0,07)$ dosimeters	69
Table 14 – Environmental performance requirements for dosimeters and readers	70
Table 15 – Electromagnetic disturbance performance requirements for dosimetry systems according to Clause 14	71
Table 16 – Mechanical disturbances performance requirements for dosimeters	72
Table 17 – List of abbreviations	72
Table A.1 – Student's t -value for a double sided 95 % confidence interval	74
Table C.1 – Schedule for a type test of a dosimeter for $H_p(10)$ fulfilling the requirements within the mandatory ranges	77
Table E.1 – Conversion coefficients $h_{pD}(0,07;source;\alpha)_{slab}$ from personal absorbed dose in 0,07 mm depth, $D_p(0,07)$, to the dose equivalent $H_p(0,07)$ for the slab phantom for radiation qualities defined in ISO 6980-1	79
Table E.2 – Conversion coefficients $h_{pD}(0,07;source;\alpha)_{rod}$ from personal absorbed dose in 0,07 mm depth, $D_p(0,07)$, to the dose equivalent $H_p(0,07)$ for the rod phantom for radiation qualities defined in ISO 6980-1	80
Table E.3 – Conversion coefficients $h'_D(0,07;source;\alpha)$ from personal absorbed dose in 0,07 mm depth, $D_p(0,07)$, to the dose equivalent $H'(0,07)$ for the ICRU sphere for radiation qualities defined in ISO 6980-1	81
Table E.4 – Conversion coefficients $h_{pD}(3;source;\alpha)_{cylinder}$ from personal absorbed dose in 0,07 mm depth, $D_p(0,07)$, to the dose equivalent $H_p(3)$ for the cylinder phantom for radiation qualities defined in ISO 6980-1	82
Table E.5 – Conversion coefficients $h'_D(3;source;\alpha)$ from personal absorbed dose in 0,07 mm depth, $D_p(0,07)$, to the dose equivalent $H'(3)$ for the ICRU sphere for radiation qualities defined in ISO 6980-1	82
Table F.1 – Example of dosimeter response table and range limits	83

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RADIATION PROTECTION INSTRUMENTATION –
DOSIMETRY SYSTEMS WITH INTEGRATING PASSIVE DETECTORS
FOR INDIVIDUAL, WORKPLACE AND ENVIRONMENTAL MONITORING
OF PHOTON AND BETA RADIATION**

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

International Standard IEC 62387 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation.

This second edition cancels and replaces the first edition of IEC 62387 published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- Modification of title.
- Addition of performance requirements for dosimeters to measure $H'(3)$ for both photon and beta radiation.
- Adoption of the cylinder instead of the slab phantom for the quantity $H_p(3)$.
- Correction and clarification of several subclauses to obtain a better applicability.

The text of this standard is based on the following documents:

FDIS	Report on voting
45B/945/FDIS	45B/954/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

A dosimetry system may consist of the following elements:

- a) a passive device, referred to herein as a *detector*, which, after the exposure to radiation, stores a signal for use in measuring one or more quantities of the incident radiation field;
- b) a “dosemeter”, that incorporates some means of identification and contains one or more detectors and may contain electronic components, e.g. for the readout (e.g., in a direct ion storage (DIS) dosimeter);
- c) a “reader” which is used to readout the stored information (signal) from the detector, in order to determine the radiation dose;
- d) a “computer” with appropriate “software” to control the reader, store the signals transmitted from the reader, calculate, display and store the evaluated dose in the form of an electronic file or paper copy;
- e) “additional equipment” and documented procedures (instruction manual) for performing associated processes such as deleting stored dose information, cleaning dosimeters, or those needed to ensure the effectiveness of the whole system.

RADIATION PROTECTION INSTRUMENTATION – DOSIMETRY SYSTEMS WITH INTEGRATING PASSIVE DETECTORS FOR INDIVIDUAL, WORKPLACE AND ENVIRONMENTAL MONITORING OF PHOTON AND BETA RADIATION

1 Scope

This document applies to all kinds of passive dosimetry systems that are used for measuring:

- the personal dose equivalent $H_p(10)$ (for individual whole body monitoring),
- the personal dose equivalent $H_p(3)$ (for individual eye lens monitoring),
- the personal dose equivalent $H_p(0,07)$ (for both individual whole body skin and local skin for extremity monitoring),
- the ambient dose equivalent $H^*(10)$ (for workplace and environmental monitoring),
- the directional dose equivalent $H'(3)$ (for workplace and environmental monitoring), or
- the directional dose equivalent $H'(0,07)$ (for workplace and environmental monitoring).

This document applies to dosimetry systems that measure external photon and/or beta radiation in the dose range between 0,01 mSv and 10 Sv and in the energy ranges given in Table 1. All the energy values are mean energies with respect to the fluence. The dosimetry systems usually use electronic devices for the data evaluation and thus are often computer controlled.

Table 1 – Mandatory and maximum energy ranges covered by this document

Measuring quantity	Mandatory mean energy range for photon radiation	Maximum mean energy range for testing photon radiation	Mandatory mean energy range for beta-particle radiation ^a	Maximum mean energy range for testing beta-particle radiation ^a
$H_p(10)$, $H^*(10)$	80 keV to 1,25 MeV ^b	12 keV to 7 MeV	–	–
$H_p(3)$, $H'(3)$	30 keV to 250 keV	8 keV to 7 MeV	0,8 MeV ^c	0,7 MeV ^c to 1,2 MeV
$H_p(0,07)$, $H'(0,07)$	30 keV to 250 keV	8 keV to 1,25 MeV ^b	0,8 MeV for $H_p(0,07)$ and 0,24 MeV to 0,8 MeV for $H'(0,07)$	0,07 MeV ^d to 1,2 MeV ^e

A11
A11

^a The following beta radiation sources are suggested for the different mean energies: For 0,06 MeV: ¹⁴⁷Pm; for 0,8 MeV: ⁹⁰Sr/⁹⁰Y; for 1,2 MeV: ¹⁰⁶Ru/¹⁰⁶Rh.

^b 1,25 MeV is the mean energy of photon radiation from ⁶⁰Co.

^c For beta-particle radiation, an energy of 0,7 MeV is required to reach the radiation sensitive layers of the eye lens in a depth of about 3 mm (approximately 3 mm of ICRU tissue).

^d For beta-particle radiation, an energy of 0,07 MeV is required to penetrate the dead layer of skin of 0,07 mm (approximately 0,07 mm of ICRU tissue).

^e 0,07 MeV, 0,8 MeV and 1,2 MeV beta mean energy are almost equivalent to an $E_{\max}$ of 0,225 MeV, 2,27 MeV and 3,54 MeV, respectively.

NOTE 1 In this document, “dose” means dose equivalent, unless otherwise stated.

NOTE 2 For $H_p(10)$ and $H^*(10)$ no beta radiation is considered. Reasons:

- a) $H_p(10)$ and $H^*(10)$ are a conservative estimate for the effective dose which is not a suitable quantity for beta radiation.
- b) No conversion coefficients are available in ICRU 56, ICRU 57 or ISO 6980-3.

NOTE 3 The maximum energy ranges are the energy limits within which type tests according to this document are possible.

NOTE 4 Direct ion storage (DIS) dosimeters are covered in this document as they are often operated without an online display but a separate reader.

The test methods concerning the design (Clause 8), the instruction manual (Clause 9), the software (Clause 10), environmental influences (Clause 13), electromagnetic influences (Clause 14), mechanical influences (Clause 15), and the documentation (Clause 16) are independent of the type of radiation. Therefore, they can also be applied to other dosimetry systems, e.g. for neutrons, utilizing the corresponding type of radiation for testing.

This document is intended to be applied to dosimetry systems that are capable of evaluating doses in the required quantity and unit (Sv) from readout signals in any quantity and unit. The only correction that may be applied to the evaluated dose (indicated value) is the one resulting from natural background radiation using extra dosimeters.

NOTE 5 The correction due to natural background can be made before or after the dose calculation.

A11 NOTE Z Some tests can be performed also for dosimeters containing active parts. Those tests not matching this document are expected to be performed according to IEC 61526. **A11**

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 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

ISO 4037 (all parts), *Radiological protection – X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy*

ISO 4037-3:2019, *Radiological protection – X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy – Part 3: Calibration of area and personal dosimeters and the measurement of their response as a function of energy and angle of incidence*

ISO 6980 (all parts), *Nuclear energy – Reference beta-particle radiation*

ISO 6980-3, *Nuclear energy – Reference beta-particle radiation – Part 3: Calibration of area and personal dosimeters and the determination of their response as a function of beta radiation energy and angle of incidence*

ISO 8529 (all parts), *Reference neutron radiations*

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

3 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:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

Several quantities with specific subscripts are explained in Table 6.

3.1

ambient dose equivalent

$H^*(d)$

dose equivalent at a point in a radiation field, produced by the corresponding expanded and aligned field, in the ICRU sphere at a depth, d , on the radius opposing the direction of the aligned field

Note 1 to entry: The recommended depth, d , for environmental monitoring in terms of $H^*(d)$ is 10 mm, and $H^*(d)$ may be written as $H^*(10)$.

[SOURCE: IEC 60050-395:2014, 395-05-43 – Note 1 to entry is note 3 in the source]

3.2

calibration coefficient

N_0

quotient of the conventional quantity value to be measured and the corrected indication of the dosimeter, $G_{r,0}$, normalized to reference conditions

Note 1 to entry: The calibration coefficient for the reference radiation quality U and the angle of incidence α is equivalent to the calibration factor multiplied by the instrument coefficient. It is given by

$$N_0 = \frac{C_{r,0}}{G_{r,0}} = C_f(U, \alpha) \cdot c_i$$

where

$C_{r,0}$ is the conventional quantity value, see 3.5

$G_{r,0}$ is the corrected indication, see 3.14

$C_f(U, \alpha)$ is the calibration factor for the radiation quality U and the angle of incidence α , see 3.3, and

c_i is the instrument constant, see 3.18.

Concerning the dimension of the calibration factor and the calibration coefficient, see notes to 3.3 and 3.18.

Note 2 to entry: The reciprocal of the calibration coefficient is the response under reference conditions. The value of the calibration factor may vary with the magnitude of the quantity to be measured. In such cases a dosimeter is said to have a non-constant response (or a non-linear indication).

[SOURCE: ISO 29661:2012, 3.1.5, modified – Note 3 to entry has been deleted]

3.3

calibration factor

$C_f(U, \alpha)$

factor by which the product of the corrected indication, $G_{r,0}$, and the associated instrument constant, c_i , of the dosimeter is multiplied to obtain the conventional quantity value to be measured under reference conditions

Note 1 to entry: The calibration factor is dimensionless.

[SOURCE: ISO 29661:2012, 3.1.7]

3.4

coefficient of variation

v

ratio of the standard deviation s to the arithmetic mean $\bar{G}$ of a set of n indicated values G_j (indicated value)

$$v = \frac{s}{\bar{G}} = \frac{1}{\bar{G}} \sqrt{\frac{1}{n-1} \sum_{j=1}^n (G_j - \bar{G})^2}$$

3.5

conventional quantity value

C

quantity value attributed by agreement to a quantity for a given purpose

Note 1 to entry: The conventional quantity value C is the best estimate of the quantity to be measured, determined by a primary standard or a secondary or working measurement standard which are traceable to a primary standard.

[SOURCE: ISO/IEC Guide 99:2007, 2.12]

3.6

correction for non-linearity

r_n

quotient of the response R_n under conditions where only the value of the dose equivalent is varied, and the reference response R_0

$$r_n = \frac{R_n}{R_0}$$

Note 1 to entry: For a linear dosimetry system, r_n is equal to unity.

3.7

coverage factor

k

numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

Note 1 to entry: A coverage factor k is typically in the range 2 to 3.

Note 2 to entry: In case of a normal distribution, using a coverage factor of 2 results in an expanded uncertainty that defines an interval around the result of a measurement that contains approximately 95 % of the distribution of values that could reasonably be attributed to the measurand. For other distributions, the coverage factor may be larger.

[SOURCE: GUM 2.3.6:1995, modified – The symbol k has been added]

3.8 detector radiation detector

A11 apparatus or substance which, in the presence of radiation, provides by either direct or indirect means a signal or other indication suitable for use in measuring one or more quantities of the incident radiation **A11**

Note 1 to entry: The detector usually requires a separate reader to read out the signal. That means the detector usually is not able to provide a signal without any external reading process.

Note 2 to entry: A passive detector does not need an external power supply to collect and store dose information.

Note 3 to entry: In IEC, the term reads “radiation detector”.

[SOURCE: IEC 60050-881:1983, 881-13-01, modified – The term “detector” has been added as the first preferred term **A11** and the Notes 1, 2 and 3 to entry have been added] **A11**

3.9 deviation

D

difference between the indicated values for the same value of the measurand of a dosimetry system, when an influence quantity assumes, successively, two different values

$$D = G - G_r$$

where

G the indicated value under the effect, and

G_r the indicated value under reference conditions

Note 1 to entry: The original term in IEC 311-07-03 reads “variation (due to an influence quantity)”. In order not to mix up variation (of the indicated value) and variation of the response, in this standard, the term is called “deviation”.

Note 2 to entry: The deviation can be positive or negative resulting in an increase or a decrease of the indicated value, respectively.

[SOURCE: IEC 60050-300-311:2001, 311-07-03, modified – “deviation” has replaced “variation (due to an influence quantity)” and “dosimetry system” has replaced “an indicating measuring instrument, or the values of a material measure” and Notes 1 and 2 to entry have been added]

3.10 directional dose equivalent

H'(d)

at a point in a radiation field, dose equivalent that would be produced by the corresponding expanded field, in the ICRU sphere at a depth, *d*, on the radius in a specified direction

Note 1 to entry: The currently recommended depth, *d*, for environmental monitoring with respect to local skin and lens of the eye is 0,07 mm and 3 mm, respectively, and *H'(d)* may be written as *H'(0,07)* and *H'(3)*, respectively.

[SOURCE: ICRU 51:1993, modified – Note 1 to entry has been added]

3.11 dosimeter

radiation meter designed to measure quantities such as an absorbed dose or dose equivalent

Note 1 to entry: In a wider sense, this term is used for meters designed to measure other quantities related to radiation such as exposure, fluence, etc. Such use is deprecated.

Note 2 to entry: This apparatus may require a separate reader to read out the absorbed dose or dose equivalent.

Note 3 to entry: A dosimeter usually consists of a detector and a badge, for example thermoluminescence detector (TLD) badge with filters.

Note 4 to entry: A dosimeter may contain electronic components (e.g. for the readout (e.g. in a direct ion storage (DIS) dosimeter)).

[SOURCE: IEC 60050-395:2014, 395-05-02, modified – Notes 3 and 4 to entry have been added]

3.12

dosimetry system

dosimeter, reader and all associated equipment and procedures used for assessing the indicated value

3.13

expanded uncertainty

U

quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

Note 1 to entry: The expanded uncertainty is obtained by multiplying the combined standard uncertainty by a coverage factor.

Note 2 to entry: A confidence level of 95 % is recommended for the use of this document.

[SOURCE: GUM:1995, 2.3.5]

3.14

indicated value indication

G

value of the measurand given directly by a measuring instrument on the basis of its calibration curve

Note 1 to entry: In this standard, the indicated value is the one given by the dosimetry systems as the final result of the evaluation algorithm (for example, display of the software, print out) in units of dose equivalent (Sv), see 8.2.

Note 2 to entry: For details, see Annex B.

[SOURCE: IEC 60050-300-311:2001, 311-01-08, modified – The original note has been replaced by new $\overline{A_{11}}$ Notes 1 and 2 $\overline{A_{11}}$ to entry]

3.15

influence quantity

quantity that is not the measurand but that affects the result of the measurement

Note 1 to entry: For example, temperature of a length measuring instrument.

Note 2 to entry: If the effect on the result of a measurement of an influence quantity depends on another influence quantity, these influence quantities are treated as a single one. In this standard, this is the case for two pairs of influence quantities:

- a) radiation energy and angle of incidence,
- b) ambient temperature and relative humidity.

[SOURCE: GUM:1995, B.2.10, modified – Examples 1, 2 and 3 have been removed and Notes 1 and 2 to entry have been added]

3.16

influence quantity of type F

influence quantity whose effect on the indicated value is a change in response

Note 1 to entry: An example is radiation energy and angle of radiation incidence.

Note 2 to entry: F stands for factor. The indication due to radiation is multiplied by a factor due to the influence quantity.

3.17

influence quantity of type S

influence quantity whose effect on the indicated value is a deviation independent of the indicated value

Note 1 to entry: An example is the electromagnetic disturbance.

Note 2 to entry: All requirements for influence quantities of type S are given with respect to the value of the deviation D .

Note 3 to entry: S stands for sum. The indication is the sum of the indication due to radiation and due to the disturbance.

3.18

instrument constant

c_i

constant by which the indication of the dosimeter G or – if corrections or a normalization were applied – the corrected indication $G_{r,0}$ is multiplied to convert it to the same unit as the measurand

Note 1 to entry: Adapted from ICRU Report 76.

Note 2 to entry: If the instrument's indication is already expressed in the same unit as the measurand the instrument constant, c_i , is unnecessary. This is the case in this standard.

[SOURCE: ISO 29661:2012, 3.1.17]

3.19

lower limit of the measuring range

H_{low}

lowest dose value included in the measuring range

Note 1 to entry: H_{low} is equivalent to H_0 in ISO 14146:2018.

3.20

mandatory range

mandatory range of use

smallest range specified for an influence quantity or instrument parameter over which the dosimetry system must operate to be in compliance with this document

Note 1 to entry: The mandatory ranges of the influence quantities dealt with in this document are given in the second column of Table 8 to Table 16.

3.21

maximum rated measurement time

t_{max}

longest continuous period of time over which the dose is accumulated and over which all requirements of this document are fulfilled

Note 1 to entry: The maximum rated measurement time depends on the lower limit of the measuring range H_{low} , the fading, and other influences.

Note 2 to entry:  The beginning of this period of time can for example be erasing the dose by heating (for TLDs) or by light (for OSL detectors), or a dose reset by means of software (for DIS). 

3.22

measured value

M

value that can be obtained from the indicated value G by applying the model function for the measurement

Note 1 to entry: For “model function”, see 3.25.

Note 2 to entry: For details, see Annex B.

3.23

measuring range

range defined by two values of the measurand, or quantity to be supplied, within which the limits of uncertainty of the measuring instrument are specified

Note 1 to entry: In this standard, the measuring range is the range of dose equivalent, in which the requirements of this standard are fulfilled and thus the uncertainty is limited.

[SOURCE: IEC 60050-300-311:2001, 311-03-12, modified – The original note has been replaced by a new Note 1 to entry]

3.24

personal dose equivalent

$H_p(d)$

dose equivalent in soft tissue, at an appropriate depth, d , below a specified point on the body

Note 1 to entry: The recommended depths are 10 mm for penetrating radiation, 3 mm to monitor the eye lens dose, and 0,07 mm to monitor skin dose.

Note 2 to entry: Soft tissue means ICRU 4-element tissue, see ICRU Report 39.

[SOURCE: ICRU 51:1993, modified – Notes 1 and 2 to entry have been added]

3.25

model function

mathematical model of the measurement that transforms the (set of) observation(s) into the result of the measurement

Note 1 to entry: The model function combines the indicated value G with the reference calibration coefficient N_0 , the correction for non-linearity r_n , the l deviations D_p ($p = 1..l$) for the influence quantities of type S, and the m relative response values r_q ($q = 1..m$) for the influence quantities of type F. An example of a model function is

$$M = \frac{N_0}{r_n \prod_{q=1}^m r_q} \left[G - \sum_{p=1}^l D_p \right].$$

A model function is necessary to evaluate the uncertainty of the measured value according to the GUM (see GUM:1995, 3.1.6, 3.4.1 and 4.1).

Note 2 to entry: The calculations according to the model function are usually not performed, only in the case that specific influence quantities are well known and an appropriate correction is applied.

Note 3 to entry: For details, see Annex B.

3.26

point of test

point in the radiation field at which the conventional quantity value of the quantity to be measured is known

[SOURCE: ISO 29661:2012, 3.1.23, modified – “to be measured” has been added]

3.27

preparation

normal treatment of dosimeters or detectors before a dose measurement, which the dosimeters or detectors are intended to be subjected to in routine use

Note 1 to entry: For example, a procedure to erase stored dose information, reset the dose information by means of software, cleaning.

3.28

rated range

rated range of use

specified range of values which an influence quantity can assume without causing a deviation or variation of the response exceeding specified limits

Note 1 to entry: In IEC 60050-300-311:2001, 311-07-05, the term reads “nominal range of use”. In this document, “rated range” is used in order to avoid complicated terms like “the range of use of an influence quantity” but to have terms that are easily readable like “the rated range of an influence quantity”.

Note 2 to entry: Influence quantities can be either of type S or of type F.

[SOURCE: IEC 60050-300-311:2001, 311-07-05, modified – “rated range” has replaced “nominal range” and “deviation or variation of the response” has replaced “variation”; Notes 1 and 2 to entry have been added]

3.29

reader

dosemeter reader

instrument used to read one or more detectors in a dosimeter

Note 1 to entry: Signal of a passive dosimeter can be amount of light, amount of charge, transparency of film and so on. Each type of passive dosimeter thus has very a different type of reader.

 Text deleted .

3.30

readout

process of measuring the stored dose information of a detector in a reader

Note 1 to entry: If the dosimeter contains  electronic  components, e.g. DIS dosimeters, the resulting signal may be corrected for influences such as temperature, fading, etc.

3.31

reference conditions

set of specified values and/or ranges of values of influence quantities under which the uncertainties admissible for a dosimetry system are the smallest

[SOURCE: IEC 60050-300-311:2001, 311-06-02, modified – After “uncertainties” the words “, or limits of error,” have been deleted and “dosimetry system” has replaced “measuring instrument”]

3.32

reference direction

direction, in the coordinate system of a dosimeter, with respect to which the angle to the direction of radiation incidence is measured in unidirectional fields

[SOURCE: ISO 29661:2012, 3.1.29]

3.33

reference orientation

(dosimeter) orientation for which the direction of the incident radiation coincides with the reference direction of the dosimeter

[SOURCE: ISO 29661:2012, 3.1.31]

3.34**reference point of a dosimeter**

physical mark or marks on the outside of the dosimeter (possibly described in the manual) to be used in order to position it with respect to the point of test; if there is no mark or marks on the outside of the dosimeter, the geometric centre of the dosimeter should be taken as the reference point

3.35**reference response** R_0

response for a reference value $C_{r,0}$ of the quantity to be measured under reference conditions

$$R_0 = \frac{G_{r,0}}{C_{r,0}}$$

where $G_{r,0}$ is the corresponding indicated value

Note 1 to entry: The reference response is the reciprocal of the reference calibration coefficient.

Note 2 to entry: The reference values for the dose are given in Table 7.

3.36**relative expanded uncertainty** U_{rel}

expanded uncertainty divided by the measurement result

3.37**relative response** r

quotient of the response R and the reference response R_0

$$r = \frac{R}{R_0}$$

3.38**response of a radiation measuring assembly** R

ratio, under specified conditions, given by the relation:

$$R = \frac{G}{C}$$

where

G is the indicated value of the quantity measured by the equipment or assembly under test (dosimetry system), and

C is the conventional quantity value of this quantity

Note 1 to entry: The value of the response may vary with the dose being measured. In such cases, a dosimetry system is said to be non-linear.

[SOURCE: IEC 60050-395:2014, 395-03-72, modified – The letters representing quantities have been modified, “value” has been replaced by “indicated value of the quantity”, “(dosimetry system)” has been added and the original notes have been replaced by a new Note 1 to entry]

3.39**result of a measurement**

set of values attributed to a measurand, including a value, the corresponding uncertainty, and the unit of the measurand

Note 1 to entry: The central value of the whole (set of values) can be selected as *measured value* M (see 3.22) and a parameter characterizing the dispersion as *uncertainty* (see 3.43).

Note 2 to entry: The result of a measurement is related to the *indicated value given by the instrument* G (see 3.14) and to the values of correction obtained by calibration and by the use of a *model* (see 3.25).

Note 3 to entry: The estimation of M can be based on one or more indicated values.

[SOURCE: IEC 60050-300-311: 2001, 311-01-01, modified – “including a value, the corresponding uncertainty, and the unit of the measurand” has been added, the original Notes 1, 4, and 5 have been deleted, and Notes 1 and 2 to entry have been aligned to terms used in this document]

3.40 signal

S

quantity obtained in a reader after readout of a detector from which the indicated value of the dose equivalent is evaluated

Note 1 to entry: Examples are the charge measured in a photomultiplier tube due to TL-light; the area of a certain region from a glow curve of a TL detector; a fitting parameter evaluated from a glow curve analysis.

Note 2 to entry: In principle, it is possible to obtain more than one signal from one detector (for example several fitting parameters from a glow curve analysis).

Note 3 to entry: Using more than one detector always means using more than one signal.

Note 4 to entry: The “signal” is similar to the “readout value” in ISO 12794:2000, 3.13.

Note 5 to entry: For details, see Annex B.

3.41 standard deviation experimental standard deviation

s

for a series of n measurements of the same measurand, the quantity s characterizing the dispersion of the results

$$s = \sqrt{\frac{1}{n-1} \sum_{j=1}^n (G_j - \bar{G})^2}$$

where

G_j is the result of the j -th measurement, and

$\bar{G}$ is the arithmetic mean of the n results considered

Note 1 to entry: Considering the series of n values as sample of a distribution, $\bar{G}$ is an unbiased estimate of the mean μ , and s^2 is an unbiased estimate of the variance σ^2 of that distribution.

Note 2 to entry: The expression $s/\sqrt{n}$ is an estimate of the standard deviation of the distribution of $\bar{G}$ and is called the “experimental standard deviation of the mean”.

Note 3 to entry: “Experimental standard deviation of the mean” is sometimes incorrectly called “standard error of the mean”.

[SOURCE: GUM:1995, B.2.17, modified – The preferred term “standard deviation” has been added, as well as the symbol s , and the formula has been modified]

3.42 standard test conditions

conditions represented by the range of values of a set of influence quantities under which a calibration or a determination of response is carried out

Note 1 to entry: Appropriate corrections to reference conditions should be made.

Note 2 to entry: Ideally, calibrations should be carried out under reference conditions. As this is not always achievable (e.g. for ambient air pressure) or convenient (e.g. for ambient temperature) a (small) interval around the reference values is acceptable. Values for the standard test conditions together with the reference conditions are given in Table 7.

Note 3 to entry: During type tests, all values of influence quantities which are not the subject of the test are fixed within the interval of the standard test conditions.

[SOURCE: ISO 29661:2012, 3.1.36, modified – Note 3 to entry has been added]

3.43 standard uncertainty

u

uncertainty of the result of a measurement expressed as a standard deviation

Note 1 to entry: Standard uncertainty is a more general term than standard deviation, for example, standard uncertainty may also contain uncertainty contributions evaluated using non statistical methods.

[SOURCE: GUM 2.3.1, modified – Note 1 to entry has been added, as well as the symbol u]

3.44 type test

conformity test made on one or more items representative of the production

[SOURCE: IEC 60050-151:2001, 151-16-16]

3.45 upper limit of the measuring range

H_{up}

highest dose value included in the measuring range

3.46 area monitoring

monitoring in which a workplace or an area in the environment is monitored by taking dose (rate) measurements

Note 1 to entry: Area monitoring is performed in terms of $H'(0,07)$, $H'(3)$ or $H^*(10)$.

Note 2 to entry: Definition orientated at ICRP 103 and ICRP 116.

3.47 workplace monitoring

area monitoring using dose (rate) measurements made in the working environment

Note 1 to entry: Usually contrasted with individual monitoring.

Note 2 to entry: Workplace monitoring is performed in terms of $H'(0,07)$, $H'(3)$ or $H^*(10)$.

3.48 environmental monitoring

area monitoring by the measurement of external dose (rate) in the environment

Note 1 to entry: Environmental monitoring is performed in terms of $H'(0,07)$, $H'(3)$ or $H^*(10)$.

3.49 individual monitoring

monitoring using dose (rate) measurements by equipment worn by individual workers, or measurements of quantities of radioactive material in or on their bodies

Note 1 to entry: Also called personal monitoring. Usually contrasted with workplace monitoring.

Note 2 to entry: Individual monitoring is performed in terms of $H_p(0,07)$, $H_p(3)$ or $H_p(10)$.

[SOURCE: IAEA Glossary:2016, modified – “dose (rate)” has been added and Note 2 to entry has been added]

4 Units and symbols

In this document, units of the international system (SI) are used. Nevertheless, the following units may be acceptable in common usage:

- for energy: electron-volt (symbol eV). $1 \text{ eV} = 1,602 \times 10^{-19} \text{ J}$;
- for time: year, month, day, hour (symbol h), minute (symbol min).

Multiples and submultiples of SI units may be used, according to the SI system.

The SI unit of dose equivalent is 1 J kg^{-1} .

The special name for the unit of the dose equivalent is sievert (symbol Sv). $1 \text{ Sv} = 1 \text{ J kg}^{-1}$.

A list of symbols is given in Table 6.

A list of abbreviations is given in Table 17.

5 General test procedures

5.1 Basic test procedures

5.1.1 Instructions for use

The instructions for use of the dosimetry systems have to be unambiguously given in the manual, see Clause 9. These instructions have to be the same for all parts of the type test and for the routine use as well.

5.1.2 Nature of tests

The tests listed in this document are considered to be type tests, see Annex C.

5.1.3 Reference conditions and standard test conditions

Reference conditions are given in the second column of Table 7 (at the end of the document). The tests shall be carried out under standard test conditions given in the third column of Table 7 unless otherwise specified.

All influence quantities shall be maintained within the limits set for standard test conditions given in Table 7, except for those influence quantities currently under test, unless otherwise specified in the test procedure.

5.1.4 Production of reference radiation

The nature, construction and conditions for the use of ionizing radiation shall conform to the recommendations in the following documents:

- a) ISO 4037 series for photon radiation,
- b) ISO 6980 series for beta radiation, and
- c) ISO 8529 series for neutron radiation.

5.1.5 Choice of phantom for the purpose of testing

For tests involving the use of a phantom, ISO phantoms as described in ISO 4037-3:2019, 7.3.1, shall be used. The required irradiation geometry is specified in the appropriate ISO reference standard (ISO 4037-3 or ISO 6980-3).

5.1.6 Position of dosimeter for the purpose of testing

For tests involving the use of radiation, the reference point of the dosimeter shall be placed at the point of test and the dosimeter shall be oriented in the reference orientation. This is not applicable for tests to determine the response depending on the angle of incidence.

5.2 Test procedures to be considered for every test

5.2.1 Number of dosimeters used for each test

The number n of dosimeters (or irradiations) used for any test need not be the same for each test but may be determined using Annex A. However, it may be convenient to use, arbitrarily, 4, 5, 8, 10 or 20 dosimeters (or irradiations), in which case the Student's t -value, obtained from Annex A, Table A.1, would be 3,18; 2,78; 2,37; 2,26; or 2,09; respectively.

NOTE Using Annex A, the performance requirements are demonstrated to be met to 95 % confidence.

5.2.2 Consideration of the uncertainty of the conventional quantity value

The relative expanded uncertainty $U_{C,rel}$ of the conventional quantity value C of the dose equivalent shall be considered. It shall be less than 8 % at a 95 % coverage interval. The testing laboratory shall determine $U_{C,rel}$ according to the GUM.

NOTE According to 3.13, the confidence level is 95 %.

5.2.3 Consideration of non-linearity

The effect of a non-linearity due to dose dependence shall be taken into account.

A practical method is to start the tests with the non-linearity and perform the other tests in a dose region where the non-linearity is negligible (1 % to 2 %).

5.2.4 Consideration of natural background radiation

For the measurement of low dose equivalents or at low dose equivalent rates, it is necessary to take into account the contribution of natural background radiation to the dose equivalent. This is usually done by taking a significant number of dosimeters (at minimum 10 dosimeters) as background dosimeters. These are treated in the same way as the ones under test, but not irradiated. The mean indicated value of these dosimeters has to be subtracted from the indicated value of the dosimeters under test.

5.2.5 Consideration of several detectors or signals in a dosimeter

If more than one signal (see 3.40) or detector (see 3.8) is used to evaluate the indicated value, each signal or detector shall be tested separately. Separate tests are necessary when the different signals are used to evaluate the indicated value in different regions of the measuring range or in different regions of an influence quantity.

NOTE If this applies, this means that the complete amount of testing according to this document is multiplied by the number of signals being used in different ranges.

EXAMPLE 1 If a second detector or signal is used to evaluate the dose above a dose equivalent of 200 mSv, for this detector or signal all the requirements according to this document have to be measured within its operating range, i.e. above a dose equivalent of 200 mSv.