

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

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

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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)

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European foreword

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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

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

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



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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

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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	30

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.....	47

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 $h'_{pD}(0,07;source;\alpha)$ 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 $h'_{pD}(3;source;\alpha)$ 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**

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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:

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45B/945/FDIS	45B/954/RVD

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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	0,24 MeV to 0,8 MeV	0,07 MeV ^d to 1,2 MeV ^e
^a The following beta radiation sources are suggested for the different mean energies: For 0,06 MeV: ¹⁴⁷ Pm; for 0,8 MeV: ⁹⁰ Sr/ ⁹⁰ Y; for 1,2 MeV: ¹⁰⁶ Ru/ ¹⁰⁶ Rh. ^b 1,25 MeV is the mean energy of photon radiation from ⁶⁰ Co. ^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.

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 dose rate 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 dose rate 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).