IEC 62387

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Radiation protection instrumentation – Passive integrating dosimetry systems for personal and environmental monitoring of photon and beta radiation

Instrumentation pour la radioprotection – Systèmes dosimétriques intégrés passifs pour la surveillance de l'individu et de l'environnement des rayonnements photoniques et bêta

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RADIATION PROTECTION INSTRUMENTATION – PASSIVE INTEGRATING DOSIMETRY SYSTEMS FOR PERSONAL AND ENVIRONMENTAL MONITORING OF PHOTON AND BETA RADIATION

FOREWORD

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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 standard cancels and replaces IEC 62387-1 published in 2007. This edition constitutes a technical revision.

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

- Extension of the photon energy range for dosemeters to measure $H_p(0,07)$ from the old range of 8 keV to 250 keV to the new range of 8 keV to 10 MeV.
- Addition of performance requirements for dosemeters to measure $H_p(3)$ for both photon and beta radiation. Such dosemeters can be used to monitor the eye lens dose.
- Addition of performance requirements for dosemeters to measure $H'(0,07)$ for both photon and beta radiation.
- Correction and clarification of several subsections to obtain a better applicability.

- Alignment of IEC performance requirements on dosimetry systems for measuring personal dose equivalents with the recommendations on accuracy stated in ICRP Publication 75, *General Principles for the Radiation Protection of Workers*. Further information is given in the new informative Annex E.

With these changes it also covers the scope of ISO 12794:2000, *Nuclear energy – Radiation protection – Individual thermoluminescence dosemeters for extremities and eyes*.

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

FDIS	Report on voting
45B/743/FDIS	45B/752/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.

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INTRODUCTION

A dosimetry system may consist of the following elements:

a) a passive device, referred to here 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;
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 dosemeters, or those needed to ensure the effectiveness of the whole system.

RADIATION PROTECTION INSTRUMENTATION – PASSIVE INTEGRATING DOSIMETRY SYSTEMS FOR PERSONAL AND ENVIRONMENTAL MONITORING OF PHOTON AND BETA RADIATION

1 Scope

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

– the personal dose equivalent $H_p(10)$ (for whole body dosimetry),
– the personal dose equivalent $H_p(3)$ (for eye lens dosimetry),
– the personal dose equivalent $H_p(0{,}07)$ (for both whole body and extremity dosimetry),
– the ambient dose equivalent $H^*(10)$ (for environmental dosimetry), or
– the directional dose equivalent $H'(0{,}07)$ (for environmental dosimetry).

NOTE 1 The term “environmental dosimetry” means ambient, area, and environmental monitoring in this standard.

This standard 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 prevailing dose quantity. 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 standard

Measuring quantity	Mandatory energy range for photon radiation	Maximum energy range for testing photon radiation	Mandatory energy range for beta-particle radiation[a]	Maximum energy range for testing beta-particle radiation[a]
$H_p(10)$, $H^*(10)$	80 keV to 1,25 MeV	12 keV to 10 MeV	–	–
$H_p(3)$	30 keV to 250 keV	8 keV to 10 MeV	0,8 MeV almost equivalent to an E_{max} of 2,27 MeV	0,7 MeV[b] to 1,2 MeV almost equivalent to E_{max} from 2,27 MeV to 3,54 MeV
$H_p(0{,}07)$, $H'(0{,}07)$	30 keV to 250 keV	8 keV to 10 MeV	0,8 MeV almost equivalent to an E_{max} of 2,27 MeV	0,06 MeV[c] to 1,2 MeV almost equivalent to E_{max} from 0,225 MeV to 3,54 MeV

[a] The following beta radiation source 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] 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).

[c] 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).

NOTE 2 In this standard, “dose” means dose equivalent, unless otherwise stated.

NOTE 3 For $H_p(10)$ and $H^*(10)$ no beta radiation is considered. Reasons: 1) $H_p(10)$ and $H^*(10)$ are a conservative estimate for the effective dose which is not a suitable quantity for beta radiation. 2) No conversion coefficients are available in ICRU 56, ICRU 57 or ISO 6980-3.

NOTE 4 The maximum energy ranges are the energy limits within which type tests according to this standard are possible.

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 standard 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 dosemeters.

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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), *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy*

ISO 4037-3:1999, *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 3: Calibration of area and personal dosemeters 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 dosemeters 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.

NOTE The terms are listed in alphabetical order.

3.1
ambient dose equivalent
$H^*(d)$
at a point in a radiation field, dose equivalent that would be 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 $H^*(10)$. [IEV 393-14-95][1]

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

3.2
calibration factor
N_0
quotient of the conventional true value of a quantity $C_{r,0}$ and the indicated value $G_{r,0}$ at the point of test for a reference radiation under reference conditions

$$N_0 = \frac{C_{r,0}}{G_{r,0}}$$

Note 1 to entry: The reciprocal of the calibration factor is equal to the response under reference conditions. In contrast to the calibration factor, which refers to the reference conditions only, the response refers to any conditions prevailing at the time of measurement.

Note 2 to entry: This definition is of special importance for non-linear dosemeters.

Note 3 to entry The reference value $C_{r,0}$ for the dose is given in Table 7.

[SOURCE: ISO 4037-3:1999, Definition 3.2.12, modified – The descriptive statement, the symbol as well as the three original notes have been modified and the original example has been removed]

3.3
coefficient of variation
v
ratio of the standard deviation s to the arithmetic mean $\overline{G}$ of a set of n indicated values G_j (indicated value)

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

[SOURCE: IEC 60050-394:2007[2], 394-40-14, modified – “indicated values” has replaced “measurements” and the letters representing quantities in the descriptive statement and in the formula have been modified]

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1 IEC 60050-393 will be replaced by IEC 60050-395.

2 IEC 60050-394 will be replaced by IEC 60050-395.

3.4
conventional true value
conventional true value of a quantity
C
value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose

Note 1 to entry: "Conventional true value" is sometimes called “assigned value”, “best estimate of the value”, “conventional value” or “reference value”.

[SOURCE: GUM B.2.4]

3.5
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.

3.6
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, modified – The symbol k has been added]

3.7
detector
radiation detector
apparatus or substance used to convert incident ionizing radiation energy into a signal suitable for indication and/or measurement

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 IEV, the term reads “radiation detector”.

[SOURCE: IEC 60050-394:2007, 394-24-01, modified – The term “detector” has been added as the first preferred term]

3.8
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

$$D = G - G_r$$