IEC 61526

Edition 3.0 2010-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Radiation protection instrumentation – Measurement of personal dose equivalents $H_p(10)$ and $H_p(0,07)$ for X, gamma, neutron and beta radiations – Direct reading personal dose equivalent meters

Instrumentation pour la radioprotection – Mesure des équivalents de dose individuels $H_p(10)$ et $H_p(0,07)$ pour les rayonnements X, gamma, neutron et bêta – Appareils de mesure à lecture directe de l’équivalent de dose individuel

IEC 61526:2010

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RADIATION PROTECTION INSTRUMENTATION – MEASUREMENT OF PERSONAL DOSE EQUIVALENTS $H_p(10)$ AND $H_p(0,07)$ for X, GAMMA, NEUTRON AND BETA RADIATIONS – DIRECT READING PERSONAL DOSE EQUIVALENT METERS

FOREWORD

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International Standard IEC 61526 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation.

This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision. This edition includes the following significant technical changes with regard to the previous edition:

– Inclusion of terms and definitions from ISO/IEC Guide 99:2007 (VIM:2008).
– Full consistency with IEC/TR 62461:2006 "*Radiation protection instrumentation – Determination of uncertainty in measurement*".
– Improved determination of constancy of the dose response and statistical fluctuations.
– Abolition of classes of personal dose equivalent meters in relation to retention of stored information.
– Inclusion of usage categories of personal dosemeters in Annex C.

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

FDIS	Report on voting
45B/648/FDIS	45B/666/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- withdrawn,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.

INTRODUCTION

This International Standard applies to active, direct reading personal dose equivalent meters and monitors used for measuring the personal dose equivalents $H_p(10)$ and $H_p(0,07)$ for X, gamma, neutron and beta radiations.

For the personal dose equivalent $H_p(10)$ or the personal dose equivalent rate $\dot{H}_p(10)$ and for X and gamma radiations, two minimum rated ranges for the photon energy are given. The first from 20 keV to 150 keV is for workplaces where low energy X-rays are used, e.g., in medical diagnostic, the second from 80 keV to 1,5 MeV is for workplaces where high energy X-rays and/or gamma sources are used, e.g., in industry. For neutron radiation the minimum rated range of neutron energy is from 0,025 eV (thermal neutrons) to 5 MeV. The rated ranges can be extended to all energies covered by the respective standards for reference radiation fields.

For the personal dose equivalent $H_p(0,07)$ and for X and gamma radiations, a minimum rated range for the photon energy from 20 keV to 150 keV is given and for beta radiation, the minimal rated range is from 0,2 MeV to 0,8 MeV. The rated ranges can be extended to all energies covered by the respective standards for reference radiation fields.

Examples of extended rated ranges are given in Annex C.

In some applications, for example, at a nuclear reactor installation where 6 MeV photon radiation is present, measurement of personal dose equivalent (rate) $H_p(10)$ for photon energies up to 10 MeV should be required. In some other applications, measurement of $H_p(10)$ down to 10 keV should be required.

For personal dose equivalent meters, requirements for measuring the dose quantities $H_p(10)$ and $H_p(0,07)$ and for monitoring of the dose rate quantities $\dot{H}_p(10)$ and $\dot{H}_p(0,07)$ are given. The measurement of these dose rate quantities is an option for personal dose equivalent meters.

Establishments in some countries may wish to use this type of personal dose equivalent meter as the dosemeter to provide the dose of record by an approved dosimetry service.

RADIATION PROTECTION INSTRUMENTATION – MEASUREMENT OF PERSONAL DOSE EQUIVALENTS $H_p(10)$ AND $H_p(0,07)$ for X, GAMMA, NEUTRON AND BETA RADIATIONS – DIRECT READING PERSONAL DOSE EQUIVALENT METERS

1 Scope and object

This International Standard applies to personal dose equivalent meters with the following characteristics:

a) They are worn on the trunk or the extremities of the body.

b) They measure the personal dose equivalents $H_p(10)$ and $H_p(0,07)$ from external X and gamma, neutron and beta radiations, and may measure the personal dose equivalent rates $\dot{H}_p(10)$ and $\dot{H}_p(0,07)$.

c) They have a digital indication.

d) They may have alarm functions for the personal dose equivalents or personal dose equivalent rates.

This standard is therefore applicable to the measurement of the following combinations of dose quantities (including the respective dose rates) and radiation

1) $H_p(10)$ and $H_p(0,07)$ from X and gamma radiations;

2) $H_p(10)$ and $H_p(0,07)$ from X, gamma and beta radiations;

3) $H_p(10)$ from X and gamma radiations;

4) $H_p(10)$ from neutron radiations;

5) $H_p(10)$ from X, gamma and neutron radiations;

6) $H_p(0,07)$ from X, gamma and beta radiations.

NOTE 1 When reference is made in this standard to "dose", this is meant to indicate personal dose equivalent, unless otherwise stated.

NOTE 2 When reference is made in this standard to "dosemeter", this is meant to include all personal dose equivalent meters, unless otherwise stated.

This standard specifies requirements for the dosemeter and, if supplied, for its associated readout system.

This standard specifies, for the dosemeters described above, general characteristics, general test procedures, radiation characteristics as well as electrical, mechanical, safety and environmental characteristics. The only requirements specified for associated readout systems are those which affect its accuracy of readout of the personal dose equivalent and alarm settings and those which concern the influence of the reader on the dosemeter.

This standard also specifies in Annex C usage categories with respect to different measuring capabilities.

This standard does not cover special requirements for accident or emergency dosimetry although the dosemeters may be used for this purpose. The standard does not apply to dosemeters used for measurement of pulsed radiation, such as radiation emanating from most medical diagnostic X-ray facilities, linear accelerators or similar equipment.

2 Normative references

The following referenced documents are indispensable for the application 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 60050-393:2003, *International Electrotechnical Vocabulary (IEV) – Part 393: Nuclear instrumentation – Physical phenomena and basic concepts*

IEC 60050-394:2007, *International Electrotechnical Vocabulary (IEV) – Part 394: Nuclear instrumentation – Instruments, systems, equipment and detectors*

IEC 60068-2-31:2008, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60086-1:2006, *Primary batteries – Part 1: General*

IEC 60086-2:2006, *Primary batteries – Part 2: Physical and electrical specifications*

IEC 60359:2001, *Electrical and electronic measurement equipment – Expression of performance*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amendment 1 (1999) [1]

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2008, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61187:1993, *Electrical and electronic measuring equipment – Documentation*

IEC/TR 62461:2006, *Radiation protection instrumentation – Determination of uncertainty in measurement*

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1 There exists a consolidated edition (2.1) which includes IEC 60529 (1989) and its Amendment 1 (1999).

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

ISO/IEC Guide 98-3:2008/Suppl.1:2008, *Propagation of distributions using a Monte Carlo method and Corr.1 (2009)*

ISO 4037-1:1996, *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 1: Radiation characteristics and production methods*

ISO 4037-2:1997, *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 2: Dosimetry for radiation protection over the energy ranges from 8 keV to 1,3 MeV and 4 MeV to 9 MeV*

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 4037-4:2004, *X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy – Part 4: Calibration of area and personal dosemeters in low energy X reference radiation fields*

ISO 6980-1:2006, *Nuclear energy – Reference beta-particle radiation – Part 1: Method of production*

ISO 6980-2:2004, *Nuclear energy – Reference beta-particle radiation – Part 2: Calibration fundamentals related to basic quantities characterizing the radiation field*

ISO 6980-3:2006, *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 8529-1:2001, *Reference neutron radiations – Part 1: Characteristics and methods of production*

ISO 8529-2:2000, *Reference neutron radiations – Part 2: Calibration fundamentals of radiation protection devices related to the basic quantities characterizing the radiation field*

ISO 8529-3:1998, *Reference neutron radiations – Part 3: Calibration of area and personal dosemeters and determination of response as a function of energy and angle of incidence*

ISO 12789-1:2008, *Reference radiation fields – Simulated workplace neutron fields – Part 1: Characteristics and methods of production*

ISO 12789-2:2008, *Reference radiation fields – Simulated workplace neutron fields – Part 2: Calibration fundamentals related to the basic quantities*

ICRU report 51:1993, *Quantities and units in radiation protection dosimetry*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-393, IEC 60050-394, IEC 60359 and ICRU Report 51, as well as the following terms and definitions, apply.

3.1
acceptance test
contractual test to prove to the customer that the device meets certain conditions of its specification

[IEV 394-20-09; IEV 151-16-23; IEV 394-40-05]

3.2
calibration (for the purpose of this standard)
quantitative determination of the reference calibration factor, N_0, and the correction for non-constant response, r_n, under a controlled set of standard test conditions for which all the m relative response values, r_q, are unity and all the l deviations, D_p, are zero

3.3
calibration factor
N
quotient of the conventional true value of a quantity, H_r, and the indicated value, G_r, at the point of test for a specified reference radiation under specified reference conditions. It is expressed as

$$N = \frac{H_\mathrm{r}}{G_\mathrm{r}}$$

NOTE 1 (See ISO 4037-3) The calibration factor N is dimensionless when the instrument indicates the quantity to be measured. A dosemeter indicating the conventional quantity value correctly has the calibration factor of one.

NOTE 2 (See ISO 4037-3) 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 condition prevailing at the time of measurement.

NOTE 3 (See ISO 4037-3) The value of the calibration factor may vary with the magnitude of the quantity to be measured. In such cases, a dosemeter is said to have a non-constant response.

3.4
coefficient of variation
ratio of the standard deviation s to the arithmetic mean $\bar{x}$ of a set of n measurements x_i given by the following formula:

$$v = \frac{s}{\bar{x}} = \frac{1}{\bar{x}}\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}$$

[IEV 394-40-14]

3.5
combined standard measurement uncertainty
combined standard uncertainty
u_c
standard measurement uncertainty that is obtained using the individual standard measurement uncertainties associated with the input quantities in a measurement model

NOTE In case of correlations of input quantities in a measurement model, covariances must also be taken into account when calculating the combined standard measurement uncertainty; see also ISO/IEC Guide 98-3:2008,2.3.4.

[ISO/IEC Guide 98-3:2008, 2.31]

3.6
conventional quantity value
conventional value of a quantity
conventional value
quantity value attributed by agreement to a quantity for a given purpose

NOTE 1 The term “conventional true quantity value” is sometimes used for this concept, but its use is discouraged.

NOTE 2 Sometimes a conventional quantity value is an estimate of a true quantity value.

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

[ISO/IEC Guide 98-3:2008, 2.12]

NOTE 4 In this standard the quantity is the dose equivalent (rate).

3.7
correction for non-constant response
r_n
quotient of the response, R, under specified conditions where only the quantity to be measured is varied and the reference response, R_0. It is expressed as

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

NOTE For an instrument with constant response, r_n is equal to one.

3.8
detector assembly
assembly of a radiation detector and the associated components needed for the calibration or the determination of the response

NOTE The calibration result is only valid for this detector assembly.

EXAMPLE A personal dosemeter is to be calibrated using a phantom. The combination of personal dosemeter and phantom and possibly further reading instruments and cables comprise one detector assembly.

[ISO/DIS 29661, 3.1.10]

3.9
deviation
D
difference between the indicated values for the same value of the measurand of a dose equivalent (rate) meter, when an influence quantity assumes, successively, two different values

[IEV 311-07-03, modified]

$$D = G - G_r$$

where G is the indicated value under the effect of an influence quantity and
G_r is the indicated value under reference conditions.

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

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

NOTE 3 The deviation is of special importance for influence quantities of type S.