

Radiation protection instrumentation — Measurement of personal dose equivalents $H_p(10)$ and $H_p(0,07)$ for X, gamma and beta radiations - Direct reading personal dose equivalent and/or dose equivalent rate dosemeters

ICS 17.240

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

National foreword

This British Standard reproduces verbatim IEC 61526:1998 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee NCE/2, Health physics instrumentation, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the IEC title page, pages 2 to 34, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 March 2000

© BSI 03-2000

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 35929 8

**NORME
INTERNATIONALE
INTERNATIONAL
STANDARD**

**CEI
IEC**

61526

Première édition
First edition
1998-04

**Instrumentation pour la radioprotection –
Mesure des équivalents de dose individuels
 $H_p(10)$ et $H_p(0,07)$ pour les rayonnements X,
gamma et bêta –
Dosimètre personnel à lecture directe d'équivalent
de dose et/ou de débit d'équivalent de dose**

**Radiation protection instrumentation –
Measurement of personal dose equivalents $H_p(10)$
and $H_p(0,07)$ for X, gamma and beta radiations –
Direct reading personal dose equivalent and/or
dose equivalent rate doseimeters**



Numéro de référence
Reference number
CEI/IEC 61526:1998

CONTENTS

	Page
FOREWORD.....	3
INTRODUCTION.....	4
Clause	
1 Scope and object	5
2 Normative references	6
3 Definitions and units.....	7
4 Test nomenclature	9
5 Mechanical characteristics	10
6 General characteristics.....	10
7 General test procedures	12
8 Radiation performance requirements and tests	13
9 Electrical performance requirements and tests.....	20
10 Mechanical performance requirements and tests	21
11 Environmental characteristics, performance requirements and tests.....	22
12 Documentation	25
13 Operation and maintenance manual	25
Table 1 Reference conditions and standard test conditions.....	26
Table 2 Tests performed with variations of influence quantities.....	27
Annex A (normative) Calibration and type testing of personal dosimeters	28
Annex B (informative) Statistical fluctuations	33

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RADIATION PROTECTION INSTRUMENTATION –
MEASUREMENT OF PERSONAL DOSE EQUIVALENTS $H_p(10)$
AND $H_p(0,07)$ FOR X, GAMMA AND BETA RADIATIONS –
DIRECT READING PERSONAL DOSE EQUIVALENT
AND/OR DOSE EQUIVALENT RATE DOSEMETERS**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

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

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

FDIS	Report on voting
45B/222/FDIS	45B/229/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.

Annex A forms an integral part of this standard.

Annex B is for information only.

INTRODUCTION

This International Standard applies to dosimeters used for measuring the personal dose equivalents (rate) $H_p(10)$ and $H_p(0,07)$, from X and gamma radiation of energies 20 keV to 1,5 MeV and 10 keV to 1,5 MeV respectively, and from beta radiation of mean energy $>0,06$ MeV (the energy required to penetrate the dead layer of skin 0,07 mm). However, it should be noted that state-of-the-art methods, for photon dosimetry will, for the foreseeable future, limit this to photons with energies >20 keV, and beta emitters with mean energies $>0,25$ MeV. If the dosimeter is to be used to measure personal dose equivalent (rate) for photon energies up to 10 MeV, e.g. at a nuclear reactor installation where 6 MeV photon radiation is present, it will be necessary to determine the response at the appropriate energy.

Establishments in some countries may wish to use this type of dosimeter as the basis of a personal monitoring service approved for dose record-keeping purposes for radiation workers.

**RADIATION PROTECTION INSTRUMENTATION –
MEASUREMENT OF PERSONAL DOSE EQUIVALENTS $H_p(10)$
AND $H_p(0,07)$ FOR X, GAMMA AND BETA RADIATIONS –
DIRECT READING PERSONAL DOSE EQUIVALENT
AND/OR DOSE EQUIVALENT RATE DOSEMETERS**

1 Scope and object

This International Standard applies to dosimeters which are worn on the trunk of the body and are used for the measurement of personal dose equivalents $H_p(10)$ and $H_p(0,07)$ or personal dose equivalent rates, to its wearer from external X, gamma and beta radiation.

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

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

The only requirements specified for associated readout systems are those which affect its accuracy of readout of dose equivalent and alarm settings and those which concern the influence of the reader on the dosimeter.

No tests are specified in this standard for the performance requirements of the dosimeter in pulsed radiation fields and it is considered that a dosimeter designed to meet this standard may not be suitable for use in pulsed radiation fields.

This standard specifies, for the dosimeters 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 that affect its accuracy of readout or accuracy of alarm settings.

This standard also specifies classes of dosimeter in relation to retention of stored information (see 6.1).

The purpose of the standard is to specify the design requirements and the performance characteristics of personal dosimeters used for the determination of the total personal dose equivalents and/or the total personal dose equivalent rates separately displayed for depths of 10 mm, $H_p(10)$ and 0,07 mm, $H_p(0,07)$ in the body of the wearer from X, gamma and beta radiations. Such dosimeters are designed to measure the sum of the X, gamma and beta dose equivalent (rate) although they may, in addition, also separately indicate a dose equivalent (rate) from each of these components.

This standard does not provide for the measurement of personal dose equivalent from neutrons, nor are passive devices such as photographic film dosimeters, thermoluminescent dosimeters, solid-state nuclear track detectors or quartz fibre electrometers covered by this standard.

2 Normative references

The following normative documents contain provisions which, through references in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(151):1978, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*
Amendment 1 (1987)

IEC 60050(393):1996, *International Electrotechnical Vocabulary (IEV) – Chapter 393: Nuclear instrumentation: Physical phenomena and basic concepts*

IEC 60050(394):1995, *International Electrotechnical Vocabulary (IEV) – Chapter 394: Nuclear instrumentation: Instruments*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests, Test Ea and guidance: Shock*

IEC 60086, *Primary batteries*

IEC 60359:1987, *Expression of the performance of electrical and electronic measuring equipment*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test*

IEC 61000-4-3:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radiofrequency, electromagnetic field immunity test*

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

ISO 4037-1:1996, *X and gamma reference radiations for calibrating dosimeters and dose-rate 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 dosimeters and dose-rate meters and for determining their response as a function of photon energy – Part 2: Dosimetry for radiation protection over the energy ranges 8 keV to 1,3 MeV and 4 MeV to 9 MeV*

ISO 6980:1996, *Reference beta radiations for calibrating dosimeters and dose-rate meters and for determining their response as a function of beta-radiation energy*

ISO 8529:1989, *Neutron reference radiations for calibrating neutron-measuring devices used for radiation protection purposes and for determining their response as a function of neutron energy*

ICRU Report 33:1980, *Radiation quantities and units*

ICRU Report 39:1985, *Determination of dose equivalents resulting from external radiation sources*

ICRU Report 47:1991, *Determination of dose equivalents from external photon and electron radiations*

BIPM (Bureau International des Poids et Mesures):1991, *The international system of units (SI)*

3 Definitions and units

Except as specified below, all technical terms are as defined in IEC 60050(393) and IEC 60050(394) and IEC 60359. For the purpose of this International Standard the following definitions apply.

3.1

conventional true value of a quantity

best estimate of the value, determined by a primary or secondary standard or by a reference instrument that has been calibrated against a primary or secondary standard

3.2

error of indication

difference between the indicated value of a quantity, H_i , and the conventional true value of that quantity, H_t , at the point of measurement. It is expressed as $H_i - H_t$.

3.3

relative error of indication

quotient of the error of indication of a measured quantity by the conventional true value of that measured quantity. It may be expressed as a percentage:

$$I = \frac{(H_i - H_t) \times 100}{H_t} \%$$

3.4

response

response, R , of a dosimeter is the ratio of the dosimeter's indicated value to the conventional true value

$$R = \frac{H_i}{H_t}$$

3.5

relative intrinsic error

relative error of indication to a specified reference radiation under specified reference conditions

3.6

effective range of measurement

range of values of the quantity to be measured over which the performance of a dosimeter meets the requirements of this standard

3.7

coefficient of variation

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

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

3.8

reference point of a dosimeter

reference point of a dosimeter is physically marked on the outside of the dosimeter used to position it at a point where the conventionally true value of the quantity to be measured is known (see figure A.1)

3.9

point of measurement

point at which conventional true values are determined and at which reference point of the dosimeter is placed for test purposes

3.10

reference orientation and calibration direction

reference orientation of the dosimeter with respect to the direction of radiation as indicated by the manufacturer

3.11

tissue

where the word "tissue" is used in this standard, the specification given in ICRU 33 is implied

3.12

dose equivalent

dose equivalent, H , is the product of D and Q , at the point of interest in tissue, where D is the absorbed dose and Q is the quality factor:

$$H = D Q$$

Note – For beta, X and gamma radiation, Q may be taken as equal to unity for external radiation.

3.13

dose equivalent rate $\dot{H}$

quotient of dH by dt , where dH is the increment of dose equivalent in the time interval dt

$$\dot{H} = \frac{dH}{dt}$$

Units of dose equivalent rate are any quotient of the sievert or its decimal multiples or submultiples by a suitable unit of time (e.g. mSv h⁻¹, etc).

3.14

personal dose equivalent $H_p(d)$

dose equivalent in soft tissue below a specified point on the body at a depth, d . The value of d is indicated in millimetres.

NOTE 1 – This quantity, $H_p(d)$, can be measured with a detector worn at the surface of the body and covered with an appropriate thickness of tissue equivalent (or surrogate) material, but the required response characteristics may also be built into the design of the dosimeter.

NOTE 2 – The recommended depth, d , for measuring strongly penetrating radiation is 10 mm, and $H_p(d)$ may be written as $H_p(10)$.

NOTE 3 – The recommended depth, d , for weakly-penetrating radiation is 0,07 mm, and $H_p(d)$ may then be written as $H_p(0,07)$.

NOTE 4 – Dosimeters which meet the requirements of this standard provide an assessment of both $H_p(10)$ and $H_p(0,07)$.

NOTE 5 – The calibration and type testing of dosimeters is dealt with in annex A.

NOTE 6 – An assessment of $H_p(10)$ is meant to give a reasonable estimate of the limiting quantity effective dose from penetrating external radiation and $H_p(0,07)$ is meant to give an estimate of the equivalent dose to skin.

NOTE 7 – The transfer of data in both directions, i.e. from the dosimeter to the readout system, and from the readout system to the dosimeter, should be accurate to within one digit of the least significant decade.

NOTE 8 – The dosimeter should provide direct reading and may also have indirect reading by its associated readout system of dose equivalent and/or dose equivalent rate. The visual and/or audible alarms for dose equivalent rate and/or dose equivalent should be presettable.

NOTE 9 – The associated readout system, if supplied, may be used for the setting of the dosimeter alarm levels and/or for readout/record-keeping of the readings.

NOTE 10 – As the dosimeter is designed to measure the personal dose equivalents $H_p(10)$ and $H_p(0,07)$ and is worn by the individual, it is not appropriate for use as a portable measuring device for the measurement of ambient or directional dose equivalents. Where a dose rate facility is provided it should be capable of being inhibited.

3.15 units

in the present standard the units of the international system (SI) are used. The definition of radiation quantities and dosimetric terms are given in IEC 60050(393) and IEC 60050(394). Nevertheless, the following units may be acceptable in common usage:

- for energy: electron-volt (symbol eV)
1 eV = $1,602 \times 10^{-19}$ J;
- for time: years, days, hours (symbol h), minutes (symbol min).

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

The SI unit of dose equivalent is the sievert (symbol Sv).

4 Test nomenclature

4.1 qualification tests

qualification tests are performed in order to verify that requirements of a specification are fulfilled. Qualification tests are subdivided into type tests and routine tests, as defined below.

4.1.1 type test

a test of one or more devices made to a certain design to show that the design meets certain specifications [IEV 151-04-15]

4.1.2 routine test

a test to which each individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria [IEV 151-04-16]

4.2 acceptance test

a contractual test to prove to the customer that the device meets certain conditions of its specification [IEV 151-04-20]

4.3 supplementary test

test intended to provide supplementary information on certain characteristics of the dosimeters

5 Mechanical characteristics

5.1 Size

The dimensions shall not exceed 15 cm in length, 3 cm in depth, 8 cm in width, excluding any clip or retaining device, and in addition the volume shall not exceed 250 cm³ excluding the clip or other fixing arrangement.

5.2 Mass

The mass shall not exceed 200 g.

5.3 Case

The case should be smooth, rigid, shock resistant, dust and showerproof. Means shall be provided for fixing the dosimeter to clothing, e.g. a strong clip or a ring or a lanyard. Due regard should be given to the necessary orientation of the detector and alarm indicators.

5.4 Switches

If external switches are provided, these shall be adequately protected from accidental or unauthorized operation. Operation of such switches shall not interfere with the integrating function of the dosimeter. Switches should be operable beneath a plastic bag and with gloved hands, if this method is used for controlling the spread of contamination.

6 General characteristics

6.1 Dosimeter classification

- Class 1: dosimeter which retains the stored dose information under all normal circumstances.
- Class 2: dosimeter whose stored dose information may be lost in the event of the loss of the principal power supply.

6.2 Scale markings

The indication for direct reading dosimeters shall be digital and shall be shown in units of dose equivalent or dose equivalent rate, for example microsieverts (μSv) or microsieverts per hour (μSv h⁻¹) respectively. The display shall be clearly visible and be easy to read by the wearer. The display shall clearly indicate the quantity being measured.

6.3 Dosimeter markings

The reference point for calibration and test purposes shall be indicated on the outside of the dosimeter (see 3.8). The reference orientation with respect to the wearer shall also be marked on the dosimeter.

6.4 Retention of radioactive contamination

The dosimeter shall be designed to minimize the retention of contamination and to ease its removal. A dosimeter may be provided with an additional protective cover; if fitted, the dosimeter shall still conform to the requirements of this standard.