

Radiation protection instrumentation — Portable, transportable or installed equipment to measure X or gamma radiation for environmental monitoring — Integrating assemblies

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee NCE/2, Health, Physics Instrumentation, upon which the following bodies were represented:

- AEA Technology
- Association of University Radiation Protection Officers
- British Nuclear Fuels plc
- British Steel plc
- Department of Trade and Industry (National Physical Laboratory)
- Electricity Association
- GAMBICA (BEAMA Ltd.)
- Health and Safety Executive
- Institute of Physical Sciences in Medicine (Ipsm)
- Institute of Physics
- Institution of Nuclear Engineers
- Ministry of Defence
- National Radiological Protection Board
- Society for Radiological Protection

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National foreword

This British Standard has been prepared under the direction of the Engineering Sector Board and is identical with IEC 1017-2:1994 *Radiation protection instrumentation — Portable, transportable or installed equipment to measure X or gamma radiation for environmental monitoring — Part 2: Integrating assemblies*, published by the International Electrotechnical Commission (IEC).

IEC 1017 was produced as a result of international discussions in which the United Kingdom took an active part.

Cross-references

International Standard	Corresponding British Standard
IEC 86	BS 397 <i>Primary batteries</i>
IEC 278:1968 IEC 278A:1974	BS 4308:1979 <i>Specification for documentation to be supplied with electronic measuring apparatus</i> (Identical)
IEC 359:1987	
ISO 4037:1979	BS 4889:1990 <i>Method for specifying the performance of electrical and electronic measuring equipment</i> (Technically equivalent)
	BS 5869:1980 <i>Specification for X and γ reference radiations for calibrating dosimeters and dose ratemeters and for determining their response as a function of photon energy</i> (Identical)
ISO 6980:1984	BS 6689:1986 <i>Specification for reference beta radiations for calibrating dosimeters and doseratemeters and for determining their response as a function of beta radiation energy</i> (Identical)

The Technical Committee has reviewed the provisions of IEC 50(391):1975, IEC 50(392):1976, IEC 68-2-27:1987, IEC 293:1968, IEC 293A:1970 and IEC 1018:1991, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

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, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1.1 Scope and object

Irradiation of members of the public from external radiation produced by nuclear and other establishments is subject to control, and an essential part of control is measurement of the environmental radiation levels in the neighbourhood of these establishments¹⁾.

The evaluation of the environmental air kerma from X and gamma radiation is difficult. The composition of the background air kerma is complex, with contributions from natural sources such as cosmic radiation and terrestrial radioactivity as well as from man-made radioactivity arising from the operation of nuclear facilities and fall-out from nuclear weapons tests. Furthermore, the natural background air kerma rate varies in time and space.

This part of IEC 1017 defines performance parameters for portable or installed integrating assemblies to measure the environmental air kerma. If regulations require other dose or exposure quantities to be used for the above purposes (for example, ambient dose equivalent), this standard may be applied to the performance characteristics of equipment to measure these other quantities. For example, the same numerical values for the requirements for the radiation characteristics would still apply, but the conventionally true values would be expressed in the other quantities (for example, ambient dose equivalent) and not in air kerma.

It is assumed in this standard that the term “air kerma” means the kerma to air at a point in the environmental radiation field which may include scattered radiation and that the radiation detector has a wall thick enough to give electron equilibrium.

This standard applies to portable or installed integrating assemblies intended to measure environmental air kerma due to X or gamma radiation of energy between 50 keV and 1,5 MeV²⁾ from 10 nGy up to 10 mGy (1 µrad up to 1 rad) by integration of the detector’s signal, i.e. integration of pulse count rate, ionization current, etc. Passive devices such as film dosimeters or TLD are not covered by this standard. If the assembly is to be used to measure air kerma in the area surrounding a nuclear power station when 6 MeV radiation is present, it will be necessary to determine the response at this energy.

For the purpose of radiation protection, these assemblies comprise at least:

- a detection sub-assembly (for example, ionization chamber, GM counter tube, scintillation detector, etc.);
- a measuring sub-assembly including a display device, which may be connected to the detector sub-assembly either rigidly or by means of a flexible cable, or incorporated into a single assembly. The installed assembly may also comprise a continuous recorder (for example, chart or magnetic cassette recorder or telemetry equipment).

This standard specifies, for the assemblies described above, general characteristics, general test procedures, radiation characteristics, electrical, mechanical, safety and environmental characteristics and also the identification certificate.

This standard does not provide for the measurement of beta radiation.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 1017. At the time of publication the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 1017 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 50(391):1975, *International Electrotechnical Vocabulary (IEV) — Chapter 391: Detection and measurement of ionizing radiation by electric means*.

¹⁾ The requirements specified in this standard relate to normal operations of the establishment. Should the assembly be used under emergency conditions then the requirements of IEC 1018 should also be applied to the assembly, particularly with regard to overload characteristics.

²⁾ 50 keV to 1,5 MeV has been chosen to cover the energies of the chief environmental and man-made radio-nuclides that contribute to the environmental air kerma.

IEC 50(392):1976, *International Electrotechnical Vocabulary (IEV) — Chapter 392: Nuclear instrumentation — Supplement to chapter 391.*

IEC 68-2-27:1987, *Environmental testing — Part 2: Tests — Test Ea and guidance: Shock.*

IEC 86, *Primary batteries.*

IEC 278:1968, *Documentation to be supplied with electronic measuring apparatus.*

IEC 278A:1974, *First supplement.*

IEC 293:1968, *Supply voltages for transistorized nuclear instruments.*

IEC 293A:1970, *First supplement: Stabilized d.c. power supplies — Tolerances of voltages.*

IEC 359:1987, *Expression of the performance of electrical and electronic measuring equipment.* Amendment No. 1 (1991)

IEC 1018:1991, *High range beta and photon dose and dose rate portable instruments for emergency radiation protection purposes.*

ISO 4037:1979, *X and gamma reference radiations for calibrating dosimeters and dose ratemeters and for determining their response as a function of photon energy.*

Addendum 1:1983, *High rate series of filtered X-radiations.*

Addendum 2:1989, *Photon reference radiations at energies between 4 MeV and 9 MeV.*

Amendment 1:1983, *Low rate series of filtered X-radiations.*

ISO 6980:1984, *Reference beta radiations for calibrating dosimeters and dose ratemeters and for determining their response as a function of beta radiation energy.*

1.3 Definitions

Except as specified below, all technical terms are as defined in IEC 50, particularly IEC 50(391) and IEC 50(392) which will be replaced by IEC 50(393) and IEC 50(394), respectively, and IEC 359.

For the purposes of this part of IEC 1017, the following definitions apply:

1.3.1

portable air kerma meter

assembly designed to be easily carried (see 2.1.3) and intended to measure the air kerma due to X or gamma radiation at various places, including one or several radiation detectors and associated sub-assemblies or basic function units

1.3.2

installed air kerma meter

installed air kerma meter normally fixed in position. It may be equipped with means of recording the air kerma, and with remote read-out capabilities such as telemetry

1.3.3

conventionally true value of a quantity

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

1.3.4

error of indication

difference between the indicated value of a quantity K_I and the conventionally true value of that quantity at the point of measurement K_T

1.3.5

response

response, R , of an assembly is the ratio of the assembly's indicated value to the conventionally true value:

$$R = \frac{K_I}{K_T}$$

1.3.6

relative error of indication

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

$$I (\%) = \frac{K_I - K_T}{K_T} \times 100$$

1.3.7

relative intrinsic error

relative error of indication of an assembly with respect to a quantity when subjected to a specified reference radiation under specified reference conditions

1.3.8

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:

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

1.3.9**reference point of an assembly**

reference point of an assembly is a physical mark on the assembly to be used in order to position the assembly at a point where the conventionally true value of the quantity to be measured is known

1.3.10**point of test**

point at which the reference point of the assembly is placed and at which the conventionally true value of air kerma is known. For all tests involving the use of radiation, the reference point of the assembly shall be placed at the point of test and, apart from the test for variation in response with angle of incidence, in the orientation indicated by the manufacturer, i.e. with the radiation field incident from the manufacturer's stated calibration direction

1.3.11 qualification tests

Qualification tests are performed in order to verify that the requirements of a specification are fulfilled.

Qualification tests are sub-divided into type tests and routine tests, as defined below.

1.3.11a**type tests**

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

1.3.11b**routine tests**

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

1.3.12**acceptance test**

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

1.3.13**supplementary tests**

tests intended to provide supplementary information on certain characteristics of the assemblies

1.4 Units

In the present standard the units of the International System (SI)³⁾ are used. The definitions of radiation quantities and dosimetric terms⁴⁾ are given in IEC 50(391) and IEC 50(392) which will be replaced by IEC 50(393) and IEC 50(394) respectively. The corresponding old units (not SI) are indicated in parenthesis. Nevertheless, the following units may be used:

— for energy: electron-volt (symbol: eV)

1 eV = 1,602 10⁻¹⁹ J;

— for time: year, (symbol: y), day (symbol: d), hour (symbol: h), minutes (symbol: min).

Multiples and submultiples of SI units will be used, when practicable, according to the SI system.

Section 2. Assembly design**2.1 General characteristics****2.1.1 Effective range of measurement**

The effective range of measurement shall be not less than the following:

2.1.1.1 For assemblies with an analogue type of display (for example, linear or logarithmic), from 10 % to 100 % of the scale maximum angular deflection on each scale range.

2.1.1.2 For assemblies with a digital display, from the first non-zero indication in the second least significant digit up to the maximum indication on each range. (As an example, for a display with a maximum indication 199,9 the effective range must extend from 1,0 to 199,9.)

The indication shall be expressed in units of air kerma, for example Gy (rad). For most applications, the effective range of measurement shall be from 10 nGy (1 µrad) to 10 mGy (1 rad). The requirements of this standard are also applicable where an assembly has an upper limit lower or higher than 10 mGy (1 rad). Where more than one detector is used for measurement over the complete range, automatic switching shall be provided between the detectors and also for range changing, the changing of detector, measuring and read-out scale shall be simultaneous.

In the case of an assembly with linear scales, the scaling factor between adjacent ranges shall not exceed 10.

If an assembly with a logarithmic scale is provided with switched measurement ranges, there shall be an overlap of one decade between adjacent ranges.

³⁾ International Bureau of Weights and Measures: *Le Système International d'Unités (SI)*, 5th edition (1985).

⁴⁾ Report 33 of the International Commission on Radiation Units and Measurements (ICRU) (published April 1980) and Publication 26 of the International Commission on Radiation Protection (ICRP).