

X and gamma reference radiation for calibrating dosimeters and doserate 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

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National foreword

This British Standard reproduces verbatim ISO 4037-2:1997 and implements it as the UK national standard. It supersedes BS 5869:1980 which is withdrawn.

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.

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO title page, pages ii to iv, pages 1 to 25 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.

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on 15 March 1998

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INTERNATIONAL STANDARD

ISO
4037-2

First edition
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X and gamma reference radiation for calibrating dosimeters and doserate 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**

*Rayonnements X et gamma de référence pour l'étalonnage des dosimètres
et des débitmètres et pour la détermination de leur réponse en fonction de
l'énergie des photons —*

*Partie 2: Dosimétrie pour la radioprotection dans les gammes d'énergie de
8 keV à 1,3 MeV et de 4 MeV à 9 MeV*



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Descriptors: Nuclear radiation, radiation protection, radiation measuring instruments, exposure dose-rate meters, calibration, reference sources, gamma radiation, X rays, dosimetry.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4037-2 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiation protection*.

This first edition of ISO 4037-2, along with ISO 4037-1, cancels and replaces the first edition of ISO 4037:1979, which has been technically revised.

ISO 4037 consists of the following parts, under the general title *X and gamma reference radiation 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;*
- *Part 2: Dosimetry of X and gamma reference radiation for radiation protection over the energy ranges 8 keV to 1,3 MeV and 4 MeV to 9 MeV;*
- *Part 3: Calibration of area and personal dosimeters.*

Annex A and Annex B of this part of ISO 4037 are for information only.

Introduction

The term “dosimetry” is used in this part of ISO 4037 to describe the method by which the value of a physical quantity characterizing the interaction of radiation with matter may be measured at a given point by the use of a calibrated standard instrument. Dosimetry is the basis for the calibration of radiation protection instruments and devices and the determination of their response as a function of the energy of the radiation of interest.

At present, the quantities in which photon secondary-standard instruments or sources are calibrated for use in radiological protection calibration laboratories relate to measurements made in free air, i.e. air kerma.

NOTE Throughout this part of ISO 4037, kerma is used as an abbreviation for air kerma.

In order to correlate measured physical quantities with the magnitude of a biological effect, a quantity of the dose equivalent type [1] is required for use in radiation protection. ICRU has defined such quantities [2] and a further International Standard will be issued containing tables of conversion coefficients from air kerma to these dose equivalent quantities (see ISO 4037-3).

1 Scope

This part of ISO 4037 specifies the procedures for the dosimetry of X and gamma reference radiation for the calibration of radiation protection instruments over the energy range from approximately 8 keV to 1,3 MeV and from 4 MeV to 9 MeV. The methods of production and nominal kerma rates obtained from these reference radiations are given in ISO 4037-1.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4037. At the time of the publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on the part of ISO 4037 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

ISO 4037-3:—, *X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy — Part 3: Calibration of area and personal dosimeters*²⁾.

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

VIM, 1984, *International Vocabulary of Basic and General Terms in Metrology*, BIPM-IEC-ISO-OIML.

3 Definitions

For the purposes of this part of ISO 4037, the definitions given in ICRU Report 33, in the *International Vocabulary of Basic and General Terms in Metrology* (VIM) and the following definitions apply.

3.1

reference conditions

conditions of use for a measuring instrument prescribed for performance testing or conditions to ensure valid comparison of results of measurements [VIM]

NOTE The reference conditions generally specify reference values or reference ranges for the parameters affecting the measuring instrument. For the purposes of this part of ISO 4037, the reference values for temperature, atmospheric pressure and relative humidity are as follows:

- ambient temperature: 293,15 K;
- atmospheric pressure: 101,3 kPa;
- relative humidity: 65 %.

¹⁾ To be published. (Revision of ISO 4037:1979)

²⁾ To be published.

3.2

standard test conditions

value (or range of values) of the influence quantities [VIM] or instrument parameters that are specified for the dosimetry of the radiation fields

NOTE The range of values for ambient temperature, atmospheric pressure and relative humidity are as follows:

ambient temperature: 291,15 K to 295,15 K;

ambient pressure: 86 kPa to 106 kPa;

relative humidity: 30 % to 75%.

Working outside this range may result in reduced accuracy.

3.3

ionization chamber

ionization detector consisting of a chamber filled with a suitable gas, in which an electric field, insufficient to induce gas multiplication, is provided for the collection at the electrodes of charges associated with the ions and the electrons produced in the sensitive volume of the detector by the ionizing radiation [3]

NOTE The ionization chamber includes the sensitive volume, the collecting and polarizing electrodes, the guard electrode, if any, the chamber wall, the parts of the insulator adjacent to the sensitive volume and any necessary caps to ensure electron equilibrium.

3.4

ionization chamber assembly

ionization chamber and all other parts to which the chamber is permanently attached, except the measuring assembly

NOTE For a cable-connected chamber, it includes the stem, the electrical fitting and any permanently attached cable or pre-amplifier. For a thin-window chamber, it includes any block of material in which the ionization chamber is permanently embedded.

3.5

measuring assembly

device for measuring the current or charge from the ionization chamber and converting it into a form suitable for display, control or storage

3.6

reference point of the ionization chamber

point to which the measurement of the distance from the radiation source to the chamber at a given orientation refers

NOTE The reference point should be marked on the assembly by the manufacturer of the instrument. If this proves impossible, the reference point should be indicated in the accompanying documentation supplied with the instrument.

3.7

point of test

location of the reference point of the ionization chamber for calibration purposes and at which the conventionally true kerma rate (see 3.11) is known

3.8

chamber orientation effect

change in the ionization current from the ionization chamber as the directional incidence of the reference radiation is varied

3.9

calibration factor

<ionization chamber assembly with an associated measuring assembly> ratio of the conventional true value of the quantity the instrument is intended to measure divided by the indication of the instrument, corrected to stated reference conditions

3.10

calibration factor

<ionization chamber calibrated on its own without a specified measuring assembly> factor which converts the ionization current or charge, corrected to reference conditions, to the conventional true value of the dosimetric quantity at the reference point of the chamber

3.11**true value**

value which characterizes a quantity perfectly defined, in the conditions which exist when that quantity is considered

NOTE The true value of a quantity is an ideal concept and, in general, cannot be known exactly. Indeed, quantum effects may preclude the existence of a unique true value [VIM].

3.12**conventional true value of a quantity**

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

EXAMPLE: Within an organization, the result of a measurement obtained with a secondary standard instrument may be taken as the conventional true value of the quantity to be measured.

NOTE A conventional true value is, in general, regarded as being sufficiently close to the true value for the difference to be insignificant for the given purpose.

3.13**response**

ratio between the indication of the measuring assembly and the conventional true value of the measured quantity at the position of the reference point in space

NOTE The response usually varies with the spectral and directional distribution of the incident radiation.

3.14**response time**

time interval between the instant when a stimulus is subjected to a specified abrupt change and the instant when the response reaches and remains within specified limits of its final steady value [VIM]

3.15**deviation from linearity**

δ

percentage deviation from linearity given by:

$$\delta = 100 (mQ/Mq - 1)$$

where

M and Q refer to the indication and input at a chosen test point, respectively;

m is the indication observed for some other input signal q .

NOTE For multirange instruments, the above definition is applicable to each range.

3.16**leakage current**

total detector current flowing at the operating bias in the absence of radiation [3]

3.17**zero drift**

slow variation with time of the indication of the measuring assembly when the input is short-circuited

3.18**zero shift**

sudden change in the scale reading of either polarity of a measuring assembly when the setting control is changed from the “zero” mode to the “measure” mode, with the input connected to an ionization chamber in the absence of ionizing radiation other than ambient radiation

3.19**primary standard**

standard of a particular quantity which has the highest metrological qualities in a given field

3.20**secondary standard**

standard, the value of which is fixed by direct or indirect comparison with a primary standard