INTERNATIONAL STANDARD

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Radiological protection — 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

Radioprotection — 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 1: Caractéristiques des rayonnements et méthodes de production

Reference number
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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies and radiological protection*, Subcommittee SC 2, *Radiological protection*.

This second edition cancels and replaces the first edition (ISO 4037-1:1996), which has been technically revised. The main changes are:

— introduction of two types of reference fields, matched reference fields and characterized reference fields;

— introduction of validation for matched reference fields;

— introduction of limits for the allowed deviation of parameters like high voltage, filter purity and filter thickness from their nominal values. These limits now depend on the definition depth of the phantom related quantity. This is done to achieve an overall uncertainty (k = 2) of about 6 % to 10 % for the phantom related operational quantities.

A list of all the parts in the ISO 4037 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This maintenance release of this document incorporates the improvements to high voltage generators from 1996 to 2017 (e.g., the use of high frequency switching supplies providing nearly constant potential), and the spectral measurements at irradiation facilities equipped with such generators (e.g., the catalogue of X-ray spectra by Ankerhold[4]). It also incorporates all published information with the aim to adjust the requirements for the technical parameters of the reference fields to the targeted overall uncertainty of about 6 % to 10 % for the phantom related operational quantities of the International Commission on Radiation Units and Measurements (ICRU)[5]. It does not change the general concept of the existing ISO 4037.

ISO 4037 focusing on photon reference radiation fields is divided into four parts. ISO 4037-1 gives the methods of production and characterization of reference radiation fields in terms of the quantities spectral photon fluence and air kerma free-in-air. ISO 4037-2 describes the dosimetry of the reference radiation qualities in terms of air kerma and in terms of the phantom related operational quantities of the International Commission on Radiation Units and Measurements (ICRU)[5]. ISO 4037-3 describes the methods for calibrating and determining the response of dosemeters and doserate meters in terms of the phantom related operational quantities of the ICRU[5]. ISO 4037-4 gives special considerations and additional requirements for calibration of area and personal dosemeters in low energy X reference radiation fields, which are reference fields with generating potential lower or equal to 30 kV.

The general procedures described in ISO 29661 are used as far as possible in this document. Also, the symbols used are in line with ISO 29661.

Radiological protection — 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

1 Scope

This document specifies the characteristics and production methods of X and gamma reference radiation for calibrating protection-level dosemeters and doserate meters with respect to the phantom related operational quantities of the International Commission on Radiation Units and Measurements (ICRU)[5]. The lowest air kerma rate for which this standard is applicable is 1 μGy h^{-1}. Below this air kerma rate the (natural) background radiation needs special consideration and this is not included in this document.

For the radiation qualities specified in Clauses 4 to 6, sufficient published information is available to specify the requirements for all relevant parameters of the matched or characterized reference fields in order to achieve the targeted overall uncertainty (k = 2) of about 6 % to 10 % for the phantom related operational quantities. The X ray radiation fields described in the informative Annexes A to C are not designated as reference X-radiation fields.

NOTE The first edition of ISO 4037-1, issued in 1996, included some additional radiation qualities for which such published information is not available. These are fluorescent radiations, the gamma radiation of the radionuclide ^{241}Am, S-Am, and the high energy photon radiations R-Ti and R-Ni, which have been removed from the main part of this document. The most widely used radiations, the fluorescent radiations and the gamma radiation of the radionuclide ^{241}Am, S-Am, are included nearly unchanged in the informative Annexes A and B. The informative Annex C gives additional X radiation fields, which are specified by the quality index.

The methods for producing a group of reference radiations for a particular photon-energy range are described in Clauses 4 to 6, which define the characteristics of these radiations. The three groups of reference radiation are:

a) in the energy range from about 8 keV to 330 keV, continuous filtered X radiation;

b) in the energy range 600 keV to 1,3 MeV, gamma radiation emitted by radionuclides;

c) in the energy range 4 MeV to 9 MeV, photon radiation produced by accelerators.

The reference radiation field most suitable for the intended application can be selected from Table 1, which gives an overview of all reference radiation qualities specified in Clauses 4 to 6. It does not include the radiations specified in the Annexes A, B and C.

The requirements and methods given in Clauses 4 to 6 are targeted at an overall uncertainty (k = 2) of the dose(rate) value of about 6 % to 10 % for the phantom related operational quantities in the reference fields. To achieve this, two production methods are proposed:

The first one is to produce "*matched reference fields*", whose properties are sufficiently well-characterized so as to allow the use of the conversion coefficients recommended in ISO 4037-3. The existence of only a small difference in the spectral distribution of the "matched reference field" compared to the nominal reference field is validated by procedures, which are given and described in detail in ISO 4037-2. For matched reference radiation fields, recommended conversion coefficients are given in ISO 4037-3 only for specified distances between source and dosemeter, e.g., 1,0 m and 2,5 m.