INTERNATIONAL STANDARD

ISO 4037-3

Second edition
2019-01

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 3: Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence

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 3: Étalonnage des dosimètres de zone et individuels et mesurage de leur réponse en fonction de l'énergie et de l'angle d'incidence

Reference number
ISO 4037-3:2019(E)

© ISO 2019

COPYRIGHT PROTECTED DOCUMENT

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

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

Published in Switzerland

Contents

Page

© ISO 2019 – All rights reserved

 © ISO 2019 – All rights reserved

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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www. iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 4037-3:1999), which has been technically revised.

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

© ISO 2019 – All rights reserved

Introduction

The 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[1]). 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)[2]. 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)[2]. This document 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[2]. 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 ≤30 kV.

The determination of the response of dosemeters and doserate meters is essentially a three-step or two-step process. First, a basic quantity such as air kerma is measured free-in-air at the point of test. Then the appropriate operational quantity is derived by the application of the conversion coefficient that relates the quantity measured to the selected operational quantity. These two steps may be merged into a single-step if a standard for the phantom related quantities is used. Finally, the device under test is placed at the point of test for the determination of its response. Depending on the type of dosemeter under test, the irradiation is either carried out on a phantom or free-in-air for personal and area dosemeters, respectively. For area and individual monitoring this document describes details of the methods and provides, if applicable, the recommended conversion coefficients to be used for the determination of the response of dosemeters and doserate meters in terms of the phantom related operational quantities of the ICRU for photons. The use of these recommended conversion coefficients requires that the corresponding radiation quality of the reference field used for the irradiation is validated. For all non-validated radiation qualities, the recommended conversion coefficients cannot be used. For these radiation qualities, the dosimetry with respect to the phantom related operational quantities of the ICRU – see ISO 4037-2:2019, Clause 6 – or the spectrometry – see ISO 4037-2:2019, Annex B – should be performed. For tube potentials of 30 kV and below ISO 4037-4 gives special requirements.

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

© ISO 2019 – All rights reserved

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 3: Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence

1 Scope

This document specifies additional procedures and data for the calibration of dosemeters and doserate meters used for individual and area monitoring in radiation protection. The general procedure for the calibration and the determination of the response of radiation protection dose(rate)meters is described in ISO 29661 and is followed as far as possible. For this purpose, the photon reference radiation fields with mean energies between 8 keV and 9 MeV, as specified in ISO 4037-1, are used. In Annex D some additional information on reference conditions, required standard test conditions and effects associated with electron ranges are given. For individual monitoring, both whole body and extremity dosemeters are covered and for area monitoring, both portable and installed dose(rate)meters are covered.

Charged particle equilibrium is needed for the reference fields although this is not always established in the workplace fields for which the dosemeter should be calibrated. This is especially true at photon energies without inherent charged particle equilibrium at the reference depth *d*, which depends on the actual combination of energy and reference depth *d*. Electrons of energies above 65 keV, 0,75 MeV and 2,1 MeV can just penetrate 0,07 mm, 3 mm and 10 mm of ICRU tissue, respectively, and the radiation qualities with photon energies above these values are considered as radiation qualities without inherent charged particle equilibrium for the quantities defined at these depths. This document also deals with the determination of the response as a function of photon energy and angle of radiation incidence. Such measurements can represent part of a type test in the course of which the effect of further influence quantities on the response is examined.

This document is only applicable for air kerma rates above 1 µGy/h.

This document does not cover the in-situ calibration of fixed installed area dosemeters.

The procedures to be followed for the different types of dosemeters are described. Recommendations are given on the phantom to be used and on the conversion coefficients to be applied. Recommended conversion coefficients are only given for matched reference radiation fields, which are specified in ISO 4037-1:2019, Clauses 4 to 6. ISO 4037-1:2019, Annexes A and B, both informative, include fluorescent radiations, the gamma radiation of the radionuclide ^{241}Am, S-Am, for which detailed published information is not available. ISO 4037-1:2019, Annex C, gives additional X radiation fields, which are specified by the quality index. For all these radiation qualities, conversion coefficients are given in Annexes A to C, but only as a rough estimate as the overall uncertainty of these conversion coefficients in practical reference radiation fields is not known.

NOTE The term dosemeter is used as a generic term denoting any dose or doserate meter for individual or area monitoring.

© ISO 2019 – All rights reserved