
Radiological protection — Low dose rate calibration of instruments for environmental and area monitoring

*Radioprotection — Étalonnage d'instruments à faible débit de dose
pour la surveillance de zone et de l'environnement*





COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

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
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols	3
5 Calibration methods under laboratory conditions	3
5.1 Characterization of the radiation field using a reference source	3
5.1.1 General	3
5.1.2 Characterization procedure of the reference radiation field	3
5.1.3 Characterization procedure of the radiation field at a distance r	4
5.1.4 Uncertainty for the calibration of the radiation field using the reference source	4
5.2 Ground level facilities with normal background dose levels	4
5.2.1 General	4
5.2.2 Dose equivalent rate evaluation using the inverse square of distance	4
5.2.3 Detector calibration procedure	5
5.2.4 Uncertainty contributions to the detector calibration uncertainty	5
5.3 Ground level facilities with added shielding at lower than normal background levels	5
5.3.1 General	5
5.3.2 Description of the ground level facility with added shielding	5
5.3.3 Detector calibration procedure	5
5.3.4 Uncertainty contributions to the detector calibration uncertainty	6
5.4 Underground facilities with ultra-low background dose levels	6
5.4.1 General	6
5.4.2 Description of the facility	6
5.4.3 Uncertainty contributions to the detector calibration uncertainty	6
6 Routine checking	7
6.1 General	7
6.2 Description of the method	7
6.2.1 Introduction	7
6.2.2 Irradiation setup for regular checking	7
6.2.3 Criteria for routine checks	7
7 On-site calibration	8
7.1 General	8
7.2 The method using a portable calibrated radioactive source	8
7.2.1 General	8
7.2.2 Portable calibrated radioactive source	8
7.2.3 Procedure of calibration	8
7.2.4 Uncertainty contributions to the detector calibration uncertainty	8
7.3 The method using a reference standard instrument	8
7.3.1 General	8
7.3.2 The calibration instruments	9
7.3.3 Uncertainty contributions	9
Annex A (informative) Example of a ground level facility with added shielding	10
Annex B (informative) Reference sites for characterization of environmental dosimeters with respect to background ionizing radiation in the environment	12
Bibliography	14

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of 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 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*.

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

The ISO 4037 documentary standard is an International Standard for the calibration of dosimeters in X and gamma-ray reference fields. The air kerma rate range for which the standard applies is above $1 \mu\text{Gy}\cdot\text{h}^{-1}$ being nearly equivalent to $1 \mu\text{Sv}\cdot\text{h}^{-1}$ in terms of the operational quantities. The standard however does not address dosimeters that are currently available for environmental monitoring that can measure below $1 \mu\text{Sv}\cdot\text{h}^{-1}$. The reliability of environmental monitoring equipment is important for the evaluation of potential dose of the general public during any radiation incident such as an accident that could occur at a nuclear power plant or at any radiation facility.

This document extends the scope of ISO 4037 for calibrating area and environmental type monitors to dose rates below $1 \mu\text{Sv}\cdot\text{h}^{-1}$ to improve the reliability of environmental monitoring.

Three detector calibration methods are described in [Clause 5](#) of this document for 3 different situations: ground level facilities with normal background levels (see [5.2](#)), ground level facilities with lower than normal background levels (see [5.3](#)) and underground facilities with lower than normal background levels (see [5.4](#)). [Clause 6](#) discusses routine checks while [Clause 7](#) is dedicated to the calibration of environmental and area dosimeters that are fixed in place. These methods are based on free-in-air and simultaneous irradiation procedures, derived from those described in ISO 29661. This document extends the dose rate range of ISO 4037-1 below $1,0 \mu\text{Sv}\cdot\text{h}^{-1}$. The specific uncertainty components are described for these calibration methods.

Radiological protection — Low dose rate calibration of instruments for environmental and area monitoring

1 Scope

This document specifies the calibration methods under laboratory conditions for dosimeters used for environmental and area monitoring of X and gamma-rays with respect to the operational quantities of the International Commission on Radiation Units and Measurements (ICRU)^[1].

This document extends the dose rate range of ISO 4037-1 below 1,0 $\mu\text{Sv}\cdot\text{h}^{-1}$. The specific uncertainty components are described for these calibration methods.

This document also specifies the method for routine checking of active area dosimeters. Routine checking is not a calibration, nor does it replace a calibration, but it is a simple and effective method to routinely verify that the performance of the equipment is continuously maintained after calibration and that the calibration is still valid.

This document does not deal with the special requirements for the calibration of spectrometer-based environmental dosimeters and passive dosimeters.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4037-1, *Radiological protection — 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*

ISO 4037-2:2019, *Radiological protection — 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 from 8 keV to 1,3 MeV and 4 MeV to 9 MeV*

ISO 4037-3:2019, *Radiological protection — X and gamma reference radiation for calibrating dosimeters and dose rate meters and for determining their response as a function of photon energy — Part 3: Calibration of area and personal dosimeters and the measurement of their response as a function of energy and angle of incidence*

ISO 29661, *Reference radiation fields for radiation protection — Definitions and fundamental concepts*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 29661 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>