

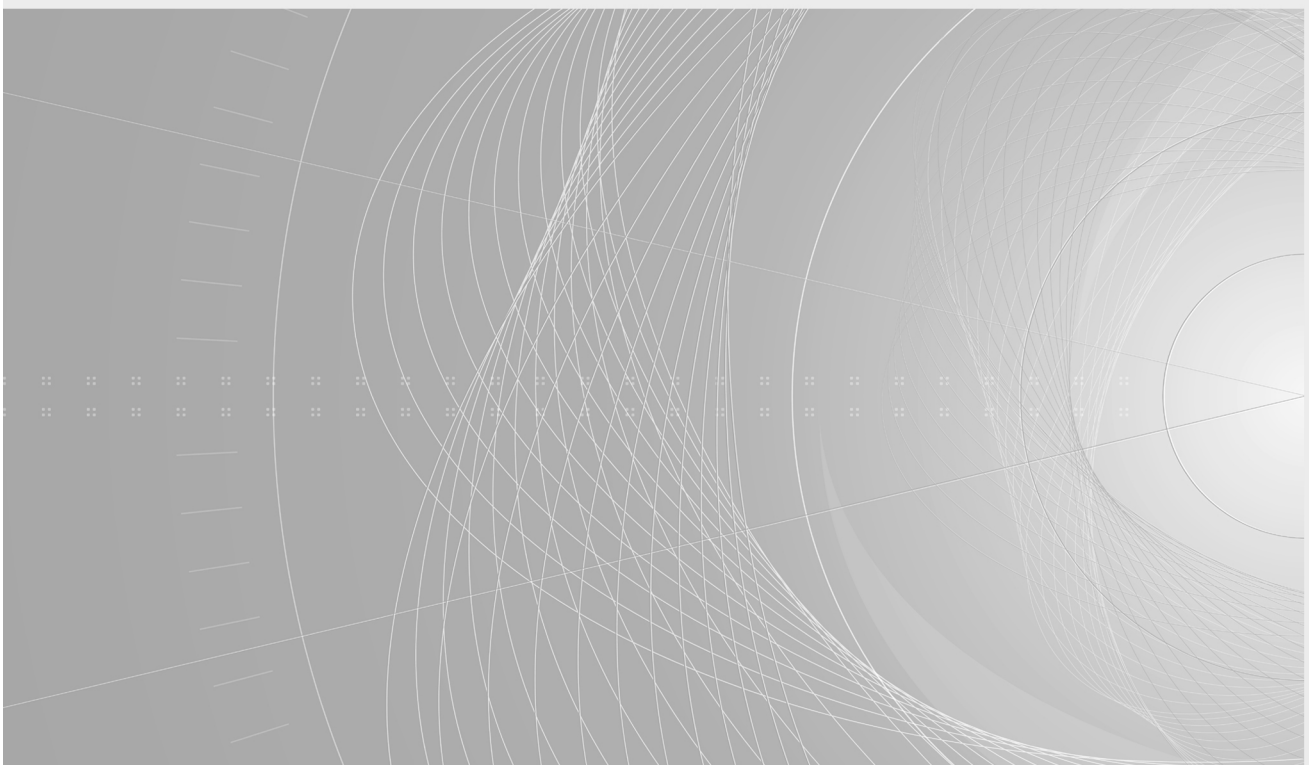
# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

---

**Radiation protection instrumentation – Security screening of humans –  
Measuring the imaging performance of X-ray systems**

**Instrumentation pour la radioprotection – Contrôle de sécurité des individus –  
Mesure des performances de l'imagerie des systèmes radiographiques aux  
rayons X**





## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2014 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 14 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

More than 55 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### Recherche de publications IEC - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 14 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

Plus de 55 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).



IEC 62709

Edition 1.0 2014-02

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Radiation protection instrumentation – Security screening of humans –  
Measuring the imaging performance of X-ray systems**

**Instrumentation pour la radioprotection – Contrôle de sécurité des individus –  
Mesure des performances de l'imagerie des systèmes radiographiques aux  
rayons X**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX

W

ICS 13.280

ISBN 978-2-8322-1422-0

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope and object.....	7
2 Normative references .....	7
3 Terms and definitions, abbreviations, quantities and units .....	8
3.1 Terms and definitions.....	8
3.2 Abbreviations.....	11
3.3 Quantities and units .....	11
4 Imaging performance evaluation procedures.....	11
4.1 General characteristics and test procedures .....	11
4.2 Location of testing .....	11
4.3 Body phantom and test objects .....	12
4.4 Spatial resolution test .....	13
4.4.1 Purpose.....	13
4.4.2 Test object description.....	13
4.4.3 Procedure.....	14
4.4.4 Evaluation and record.....	14
4.5 Wire detection test.....	14
4.5.1 Purpose.....	14
4.5.2 Test object description.....	14
4.5.3 Procedure.....	15
4.5.4 Evaluation and record.....	15
4.6 Materials detection on body test.....	15
4.6.1 General .....	15
4.6.2 Purpose.....	15
4.6.3 Test object description.....	16
4.6.4 Procedure.....	16
4.6.5 Evaluation and record.....	16
4.7 Materials detection in air test .....	16
4.7.1 General .....	16
4.7.2 Purpose.....	16
4.7.3 Test object description.....	16
4.7.4 Procedure.....	17
4.7.5 Evaluation and record.....	17
4.8 Penetration test .....	17
4.8.1 General .....	17
4.8.2 Purpose.....	17
4.8.3 Test object description.....	17
4.8.4 Procedure.....	17
4.8.5 Evaluation and record.....	17
5 Minimum acceptable imaging performance .....	17
6 Environmental requirements .....	18
Annex A (normative) Mechanical drawings of the test objects .....	20
Annex B (informative) Example of reporting form .....	31
Annex C (informative) Image resolution measurement using the pentalith.....	33
C.1 General.....	33

C.2	Strategy .....	33
C.3	Pentalith description .....	33
C.4	Pass/fail criterion .....	36
C.5	Repeatability.....	37
Annex D (informative) Comparison of whole body imaging systems .....		38

Figure 1	– Generic illustration of the testing configuration showing a HDPE body phantom with a test object on one end supported 1 m off the ground .....	12
Figure 2	– Body phantom and test objects .....	13
Figure A.1	– Components of the test phantom .....	20
Figure A.2	– Material detection in air phantom .....	21
Figure A.3	– Subassembly of the material detection in air phantom (Figure A.2), metal comb, three teeth.....	21
Figure A.4	– Subassembly of the material detection in air phantom (Figure A.2), metal comb, two teeth .....	22
Figure A.5	– Subassembly of the material detection in air phantom (Figure A.2), metal comb, one tooth.....	22
Figure A.6	– Subassembly of the material detection in air phantom (Figure A.2), plastic comb .....	23
Figure A.7	– Subassembly of the material detection in air phantom (Figure A.2), mounting sheet .....	23
Figure A.8	– Material detection on body 1 .....	24
Figure A.9	– Material detection on body 2 .....	24
Figure A.10	– Wire detection phantom .....	25
Figure A.11	– Subassembly of the wire detection phantom (Figure A.10), mounting base .....	25
Figure A.12	– Subassembly of the wire detection phantom (Figure A.10), cover.....	26
Figure A.13	– Spatial resolution phantom.....	27
Figure A.14	– Subassembly of the spatial resolution phantom (Figure A.13), mounting base .....	27
Figure A.15	– Subassembly of the spatial resolution phantom (Figure A.13); hole placement in mounting base .....	28
Figure A.16	– Subassembly of the spatial resolution phantom (Figure A.13), cover.....	29
Figure A.17	– Body phantom, 55 mm thick.....	29
Figure A.18	– Body phantom, 75 mm thick.....	29
Figure A.19	– Body phantom, 50 mm thick.....	30
Figure A.20	– Storing space.....	30
Figure C.1	– Dimensional design of the pentalith pattern .....	34
Figure C.2	– Example of a pentalith overlying a pixel grid .....	34
Figure C.3	– Example of a pentalith test phantom suitable for optical measurements .....	35
Figure C.4	– Example of a pentalith test phantom suitable for X-ray imaging .....	35
Figure C.5	– Example of using image thresholding as an objective pass/fail criterion.....	37
Table 1	– Wire sizes for the wire detection test.....	15
Table 2	– Minimum acceptable imaging performance at the reference location .....	18
Table 3	– Standard test conditions .....	18
Table D.1	– Comparison of whole body imaging systems for security screening.....	38

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RADIATION PROTECTION INSTRUMENTATION –  
SECURITY SCREENING OF HUMANS –  
MEASURING THE IMAGING PERFORMANCE OF X-RAY SYSTEMS**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62709 has been prepared by subcommittee 45B: Radiation protection instrumentation, of IEC technical committee 45: Nuclear instrumentation.

The text of this standard is based on the following documents:

FDIS	Report on voting
45B/780/FDIS	45B/786/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## INTRODUCTION

This standard establishes standard test methods and test objects for measuring the imaging performance of X-ray systems for security screening of humans. For each image quality test, this standard also sets minimum acceptable levels of performance. These procedures and minimum acceptable requirements should not be construed as an all-inclusive measure of performance for any situation. Depending on the circumstances and detection needs, user institutions will continue to generate their own requirements and are encouraged to do so. Rather, it is hoped that this standard will provide a starting point for evaluating systems, provide a uniform set of readily available information to compare equipment, and offer a standard procedure for periodic quality control testing.

Four annexes are included. Annex A (normative) provides mechanical drawings of the imaging test objects. Sample test report forms are given in Annex B (informative). Annex C (informative) provides a generic description of the pentolith, the spatial resolution test object. Annex D (informative) seeks to describe the different types of security systems presently being used for whole-body imaging.