

BS IEC 62709:2014



BSI Standards Publication

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

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of IEC 62709:2014.

The UK participation in its preparation was entrusted to Technical Committee NCE/2, Radiation protection and measurement.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2014.
Published by BSI Standards Limited 2014

ISBN 978 0 580 75053 3
ICS 13.280

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2014.

Amendments/corrigenda issued since publication

Date	Text affected
-------------	----------------------



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 pentolith.....	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.

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

1 Scope and object

This International Standard applies to security screening systems that utilize X-ray radiation and are used to inspect people who are not inside vehicles, containers, or enclosures. Specifically, this standard applies to systems used to detect objects carried on or within the body of the individual being inspected. This standard does not include requirements related to electromagnetic compatibility, radiological, electrical and mechanical safety. These requirements are covered in IEC 62463:2010.

The following types of systems are included in the scope of this standard:

- Systems designated as fixed, portal, transportable, mobile or gantry.
- Systems employing detection of primary radiation, backscattered radiation, forward-scattered radiation, (see Annex D) or some combination of these modalities to form two-dimensional X-ray images.
- Systems that are primarily imaging but that also may have complementary features such as material discrimination, automatic active or passive detection alerts. This standard will not address how to test these complementary features.

The objective is to provide standard methods of measuring and reporting imaging quality characteristics that enable system manufacturers, potential system users and other interested parties to:

- a) Establish a consistent indicator of the expected technical performance of screening systems used for the inspection of individuals. Such technical performance testing complements explicit detection testing and evaluation. In this standard “detection” refers to items in an image.
- b) Provide repeatable and verifiable imaging performance data that can be used to compare systems from different vendors.
- c) Establish a baseline that can be used over time to calibrate the system or detect any performance degradation. (It is not intended that the entire test method be employed for daily quality assurance testing.)
- d) Establish minimum acceptable performance requirements for the systems described above.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE Users of this standard should note that standards referenced herein may not fulfil the legal requirements and practices in all countries, or jurisdictions. Care should be taken to ensure regulatory compliance.

IEC 60050-393:2003, *International Electrotechnical Vocabulary (IEV) – Part 393: Nuclear instrumentation – Physical phenomena and basic concepts*

IEC 60050-394:2007, *International Electrotechnical Vocabulary (IEV) – Part 394: Nuclear instrumentation – Instruments, systems, equipment and detectors*