



BSI Standards Publication

Industrial non-destructive testing equipment — Electron linear accelerator

National foreword

This British Standard is the UK implementation of EN IEC 62976:2019+A1:2022. It is identical to IEC 62976:2017, incorporating amendment 1:2021. It supersedes BS IEC 62976:2017, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

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 committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2023
Published by BSI Standards Limited 2023

ISBN 978 0 539 16304 9

ICS 27.120.01

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 30 September 2017.

Amendments/corrigenda issued since publication

Date	Text affected
30 June 2019	This corrigendum renumbers BS IEC 62976:2017 as BS EN IEC 62976:2019
31 July 2023	Implementation of IEC amendment 1:2021 with CENELEC endorsement A1:2022

English Version

Industrial non-destructive testing equipment - Electron linear
accelerator
(IEC 62976:2017)

Appareils destinés aux essais non destructifs pour le
secteur industriel - Accélérateur électronique linéaire
(IEC 62976:2017)

Industrielle Ausrüstung für die zerstörungsfreie Prüfung -
Elektronenlinearbeschleuniger
(IEC 62976:2017)

This European Standard was approved by CENELEC on 2019-05-22. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

This document (EN IEC 62976:2019) consists of the text of IEC 62976:2017 prepared by IEC/TC 45 "Nuclear instrumentation".

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-05-22
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-05-22

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62976:2017 was approved by CENELEC as a European Standard without any modification.

European foreword to Amendment 1

This document (EN IEC 62976:2019/A1:2022) consists of the text of document IEC 62976:2019/AMD1:2021, prepared by IEC/SC 45B "Radiation protection instrumentation" of IEC/TC 45 "Nuclear instrumentation".

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-06-16
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2025-12-16

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN-CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national standards body/national committee. A complete listing of these bodies can be found on the CEN and CENELEC websites.

Endorsement notice

The text of the International Standard IEC 62976:2019/AMD1:2021 was approved by CEN-CENELEC as a European Standard without any modification.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO 780	2015	Packaging – Distribution packaging – Graphical symbols for handling and storage of packages	EN ISO 780	2015
ISO 19232-1	2013	Non-destructive testing – Image quality of radiographs – Part 1: Determination of the image quality value using wire-type image quality indicators	EN ISO 19232-1	2013
ISO/IEC Guide 37	2012	Instructions for use of products by consumers	-	-

This page deliberately left blank

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Equipment sets, names and work conditions.....	8
4.1 Equipment sets	8
4.2 Name convention	8
4.3 Operating conditions	9
4.3.1 Environmental requirement.....	9
4.3.2 Power supply.....	9
5 Technical requirements	9
5.1 Appearance	9
5.2 Control system.....	9
5.2.1 Design principle.....	9
5.2.2 Operation of start and stop	9
5.2.3 Functions of control system	9
5.3 Performance	10
5.3.1 X-ray beam energy	10
5.3.2 X-ray homogeneity.....	10
5.3.3 X-ray beam air kerma rate	10
5.3.4 X-ray beam focal spot.....	11
5.3.5 X-ray beam asymmetry	11
5.3.6 X-ray sensitivity	11
5.3.7 Dose leakage	12
5.4 Electrical safety	12
5.4.1 Protective grounding.....	12
5.4.2 Insulation resistance.....	12
5.4.3 Dielectric strength.....	12
5.4.4 Protection against electric shock	12
5.5 Reliability.....	12
5.5.1 Continuous operation.....	12
5.5.2 Recovery	12
5.5.3 Restart	12
6 Test methods.....	12
6.1 General requirements	12
6.1.1 Testing conditions	12
6.1.2 Instruments and devices	13
6.2 Visual inspection.....	14
6.3 Control system test.....	14
6.4 Performance test	14
6.4.1 X-ray beam energy	14
6.4.2 X-ray homogeneity.....	15
6.4.3 X-ray beam air kerma rate	16
6.4.4 X-ray beam focal spot.....	16
6.4.5 X-ray beam asymmetry	18
6.4.6 X-ray sensitivity	18

6.4.7	Leakage dose rate	18
6.5	Electrical safety testing	19
6.5.1	Protective grounding	19
6.5.2	Insulation resistance	19
6.5.3	Dielectric strength	19
6.5.4	Protection against electric shock	19
6.6	Reliability test	19
6.6.1	Continuous operation	19
6.6.2	Recovery	19
6.6.3	Restart	19
7	Inspection rules	20
7.1	Inspection classification	20
7.2	Inspection items	20
7.3	Criterion rule	20
8	Marking, packaging, transportation, storage and accompanying documents	20
8.1	Marking	20
8.1.1	Accelerator signs	20
8.1.2	Component nameplates	21
8.1.3	Labels	21
8.1.4	Warning signs	21
8.2	Packaging	21
8.3	Transportation	21
8.4	Storage	21
8.5	Accompanying documents	22
8.5.1	Instructions	22
8.5.2	Product certification	22
8.5.3	Other documents	22
Figure 1	– Naming convention	8
Figure 2	– Sketch map of the test module	13
Figure 3	– Sketch map of the copper block with a swivelling edge	14
Figure 4	– Schematic diagram of X ray beam radial uniformity measurement	15
Figure 5	– Schematic diagram of the testing module in front of the detector	16
Figure 6	– Schematic diagram of the “Sandwich” test module placement	17
Figure 7	– Schematic diagram of the copper block test module placement	17
Figure 8	– Diagram of leakage dose measurement points	19
Table 1	– Specifications of several commonly used accelerator models	9
Table 2	– Half value layer of materials corresponding to commonly used X-ray beam energies	10
Table 3	– X-ray homogeneity of commonly used X-ray beam energies	10
Table 4	– X-ray beam air kerma rate of different models	11
Table 5	– Detection range of equivalent steel thickness corresponding to commonly used X-ray beam energies	11
Table 6	– Testing conditions	13
Table 7	– Inspection items of the accelerator	20

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL NON-DESTRUCTIVE TESTING EQUIPMENT –
ELECTRON LINEAR ACCELERATOR**

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 62976 has been prepared by technical committee 45: Nuclear instrumentation.

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

FDIS	Report on voting
45/821/FDIS	45/824/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.