

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Protective devices against diagnostic medical X-radiation –
Part 1: Determination of attenuation properties of materials**

**Dispositifs de protection radiologique contre les rayonnements X pour
diagnostic médical –
Partie 1: Détermination des propriétés d'atténuation des matériaux**



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Part 1: Determination of attenuation properties of materials**

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DIAGNOSTIC MEDICAL X-RADIATION –****Part 1: Determination of attenuation properties of materials****FOREWORD**

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International Standard IEC 61331-1 has been prepared by subcommittee 62B: Diagnostic imaging equipment, of IEC technical committee 62: Electrical equipment in medical practice.

This second edition cancels and replaces the first edition of IEC 61331-1, published in 1994. It constitutes a technical revision. This second edition has been adapted to apply to the present technology. In particular, this second edition is consistently applicable to lead- and non-lead-containing materials. The essential changes and extensions are:

- extension of the scope to cover photon-emitting radionuclides;
- improved methods to determine the ATTENUATION RATIO;
- addition of the so-called inverse BROAD BEAM CONDITION;
- addition of a method to calculate the ATTENUATION RATIO of photon-emitting radionuclides;
- definition of new standard X- and gamma RADIATION QUALITIES used for testing;
- addition of the so-called LEAD EQUIVALENT class;

- tables of ATTENUATION RATIOS, BUILD-UP FACTORS and first HALF-VALUE LAYERS for the standard RADIATION QUALITIES filtered with different thicknesses of lead.

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

FDIS	Report on voting
62B/936/FDIS	62B/942/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.

In this standard, the following print types are used:

- requirements and definitions: roman type;
- informative material appearing outside of tables, such as notes, examples and references: in smaller type. Normative text of tables is also in a smaller type;
- TERMS DEFINED IN CLAUSE 3 OF THIS STANDARD OR AS NOTED: SMALL CAPS.

The verbal forms used in this standard conform to usage described in Annex H of the ISO/IEC Directives, Part 2. For the purposes of this standard, the auxiliary verb:

- “shall” means that compliance with a requirement or a test is mandatory for compliance with this standard;
- “should” means that compliance with a requirement or a test is recommended but is not mandatory for compliance with this standard;
- “may” is used to describe a permissible way to achieve compliance with a requirement or test.

A list of all parts of the IEC 61331 series, published under the general title *Protective devices against diagnostic medical X-radiation*, can be found on the IEC website.

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.

PROTECTIVE DEVICES AGAINST DIAGNOSTIC MEDICAL X-RADIATION –

Part 1: Determination of attenuation properties of materials

1 Scope

This part of IEC 61331 applies to materials in sheet form used for the manufacturing of PROTECTIVE DEVICES against X-RADIATION of RADIATION QUALITIES generated with X-RAY TUBE VOLTAGES up to 400 kV and gamma radiation emitted by radionuclides with photon energies up to 1,3 MeV.

This Part 1 is not intended to be applied to PROTECTIVE DEVICES when these are to be checked for the presence of their ATTENUATION properties before and after periods of use.

This Part 1 specifies the methods of determining and indicating the ATTENUATION properties of the materials.

The ATTENUATION properties are given in terms of:

- ATTENUATION RATIO;
- BUILD-UP FACTOR;
- ATTENUATION EQUIVALENT;

together with, as appropriate, an indication of homogeneity and mass per unit area.

Ways of stating values of ATTENUATION properties in compliance with this part of the International Standard are included.

Excluded from the scope of this International Standard are:

- methods for periodical checks of PROTECTIVE DEVICES, particularly of PROTECTIVE CLOTHING,
- methods of determining ATTENUATION by layers in the RADIATION BEAM, and
- methods of determining ATTENUATION for purposes of protection against IONIZING RADIATION provided by walls and other parts of an installation.

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.

IEC 60601-1:2005, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*
IEC 60601-1:2005/AMD1:2012

IEC 60601-1-3:2008, *Medical electrical equipment – Part 1-3: General requirements for basic safety and essential performance – Collateral Standard: Radiation protection in diagnostic X-ray equipment*
IEC 60601-1-3:2008/AMD1:2013

IEC/TR 60788:2004, *Medical electrical equipment – Glossary of defined terms*

Monographie BIPM-5:2013, *Table of Radionuclides*¹

NISTIR 5632:2004, *Tables of X-Ray Mass Attenuation Coefficients and Mass Energy-Absorption Coefficients (version 1.4)* [on-line, cited 2014-01-30] Available at <http://www.nist.gov/pml/data/xraycoef/>²

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC/TR 60788:2004, IEC 60601-1:2005 and IEC 60601-1:2005/AMD 1:2012, IEC 60601-1-3:2008 and IEC 60601-1-3:2008/AMD 1:2013 and the following apply.

3.1

ATTENUATION RATIO

ratio of the value of a SPECIFIED RADIATION QUANTITY in the centre of a SPECIFIED RADIATION BEAM of SPECIFIED RADIATION QUALITY, with the attenuating material under consideration outside the beam, to the value at the same position and under the same conditions with this attenuating material placed in the beam

4 Methods to determine the ATTENUATION RATIO

4.1 General

There are four different conditions described in this standard to determine ATTENUATION RATIOS, F :

F_N ATTENUATION RATIO measured with a NARROW BEAM CONDITION (4.2)

F_B ATTENUATION RATIO measured with a BROAD BEAM CONDITION (4.3)

F_{IB} ATTENUATION RATIO measured with an inverse BROAD BEAM CONDITION (4.4)

$F_{N,R}$ ATTENUATION RATIO calculated for a photon-emitting radionuclide, R (4.5)

4.2 NARROW BEAM CONDITION

4.2.1 General description

The ATTENUATION RATIO F_N for a given test material (or test object) shall be measured according to the arrangement for NARROW BEAM CONDITION as shown in Figure 1. This arrangement is designed to measure the ATTENUATION of the X-RAY BEAM only due to primary photons. The probability that secondary photons such as fluorescence photons or Compton scattered photons from the test object reach the RADIATION DETECTOR is minimized. The aperture in the DIAPHRAGM shall be just large enough to produce the smallest beam covering the radiation detector. An additional DIAPHRAGM (number 5 in Figure 1) shall be used to shield the RADIATION DETECTOR from SCATTERED RADIATION produced in the test object. The distance a from the test object to the reference point of the RADIATION DETECTOR on the beam axis shall be at least ten times the diameter d of the detector or ten times the diameter t of the RADIATION BEAM at the distal surface of the test object, whatever is larger, i.e. $a \geq 10 \max(d, t)$. The minimal distance of the wall or the floor from the detector (position 6 in the Figure 1) in the direction of the beam shall be 700 mm.

4.2.2 AIR KERMA RATE measurements

The AIR KERMA RATE shall be measured under three different conditions with the same RADIATION DETECTOR at the same position, where

¹ Bureau International de Poids et Mesures, Pavillon de Breteuil, F-92310 Sèvres, ISBN 92-822-2204-7 (set).

² National Institute of Standards and Technology (NIST), U.S.Department of Commerce.