Mis Cocume

ELEKTRILISED MEDITSIINISEADMED. DIGITAAL-RÖNTGENPILDISEADMETE KARAKTERISTIKUD. OSA 1-1: TUVASTUSKVANTSAAGISE MÄÄRAMINE. RADIOGRAAFILISTES PILDISEADMETES KASUTATAVAD DETEKTORID

Medical electrical equipment - Characteristics of digital x-ray imaging devices - Part 1-1: Determination of the detective quantum efficiency - Detectors used in radiographic imaging



5

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

<u> </u>	
See Eesti standard EVS-EN 62220-1-1:2015 sisaldab Euroopa standardi EN 62220-1-1:2015 ingliskeelset teksti.	This Estonian standard EVS-EN 62220-1-1:2015 consists of the English text of the European standard EN 62220-1-1:2015.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 12.06.2015.	Date of Availability of the European standard is 12.06.2015.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile <u>standardiosakond@evs.ee</u>.

### ICS 11.040.50

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega: Aru 10, 10317 Tallinn, Eesti; koduleht <u>www.evs.ee</u>; telefon 605 5050; e-post <u>info@evs.ee</u>

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Aru 10, 10317 Tallinn, Estonia; homepage <u>www.evs.ee</u>; phone +372 605 5050; e-mail <u>info@evs.ee</u>

# EUROPEAN STANDARD

## EN 62220-1-1

NORME EUROPÉENNE EUROPÄISCHE NORM

June 2015

ICS 11.040.50

Supersedes EN 62220-1:2004

**English Version** 

## Medical electrical equipment - Characteristics of digital x-ray imaging devices - Part 1-1: Determination of the detective quantum efficiency - Detectors used in radiographic imaging (IEC 62220-1-1:2015)

Appareils électromédicaux - Caractéristiques des appareils d'imagerie à rayonnements x - Partie 1-1: Détermination de l'efficacité quantique de détection - Détecteurs utilisés en imagerie radiographique (IEC 62220-1-1:2015) Medizinische elektrische Geräte - Merkmale digitaler Röntgenbildgeräte - Teil 1-1: Bestimmung der detektiven Quanten-Ausbeute - Bildempfänger für Röntgenbildgebung (IEC 62220-1-1:2015)

This European Standard was approved by CENELEC on 2015-04-16. 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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, 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: Avenue Marnix 17, B-1000 Brussels

© 2015 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

## Foreword

The text of document 62B/968/FDIS, future edition 2 of IEC 62220-1-1, prepared by SC 62B, "Diagnostic imaging equipment", of IEC TC 62, "Electrical equipment in medical practice " was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62220-1-1:2015.

The following dates are fixed:

•	latest date by which the document has to be implemented at national level by	(dop)	2016-01-16
	publication of an identical national standard or by endorsement		
•	latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-04-16

This document supersedes EN 62220-1:2004.

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

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

## **Endorsement notice**

The text of the International Standard IEC 62220-1-1:2015 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 62220-1-2:2007 NOTE Harmonized as EN 62220-1-2:2007.   IEC 61262-5:1994 NOTE Harmonized as EN 61262-5:1994.   IEC 60601-2-54 NOTE Harmonized as EN 60601-2-54.	
IEC 61262-5:1994   NOTE   Harmonized as EN 61262-5:1994.     IEC 60601-2-54   NOTE   Harmonized as EN 60601-2-54.	
IEC 60601-2-54 NOTE Harmonized as EN 60601-2-54.	

## Annex ZA

(normative)

# Normative references to international publications with their corresponding European publications

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 1 When 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: <a href="http://www.cenelec.eu">www.cenelec.eu</a>.

Publication IEC 60336	<u>Year</u> -	<u>Title</u> Medical electrical equipment - X-ray tube assemblies for medical diagnosis -	<u>EN/HD</u> EN 60336	<u>Year</u> -
IEC 61267	2005	Characteristics of focal spots Medical diagnostic X-ray equipment - Radiation conditions for use in the determination of characteristics	EN 61267	2006
IEC/TR 60788	2004	Radiation conditions for use in the determination of characteristics Medical electrical equipment - Glossary of defined terms		

3

## Annex ZZ

(informative)

## **Coverage of Essential Requirements of EU Directives**

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and within its scope the Standard covers all relevant essential requirements given in Annex I of EC Directive 93/42/EEC of 14 June 1993 concerning medical devices.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned.

WARNING: Other requirements and other EC Directives can be applied to the products falling within the scope of this standard.

## CONTENTS

FC	OREWO	RD	4
IN	TRODU	ICTION	6
1	Scop	e	7
2	Norm	ative references	7
3	Term	s and definitions	8
4	Requ	irements	10
	4.1	Operating conditions	10
	4.2	X-RAY EQUIPMENT	10
	4.3	RADIATION QUALITY	10
	4.4	TEST DEVICE	11
	4.5	Geometry	12
	4.6	IRRADIATION conditions	14
	4.6.1	General conditions	14
	4.6.2	AIR KERMA measurement	15
	4.6.3	Avoidance of LAG EFFECTS	16
	4.6.4	IRRADIATION to obtain the CONVERSION FUNCTION	16
	4.6.5	IRRADIATION for determination of the NOISE POWER SPECTRUM	16
	4.6.6	IRRADIATION for determination of the MODULATION TRANSFER FUNCTION	17
	4.6.7	Overview of all necessary IRRADIATIONS	18
5	Corre	ections of RAW DATA	18
6	Dete	rmination of the DETECTIVE QUANTUM EFFICIENCY	19
	6.1	Definition and formula of $DQE(u,v)$	19
	6.2	Parameters to be used for evaluation	19
	6.3	Determination of different parameters from the images	20
	6.3.1	Linearization of data	20
	6.3.2	The NOISE POWER SPECTRUM (NPS)	20
	6.3.3	Determination of the MODULATION TRANSFER FUNCTION (MTF)	22
7	Form	at of conformance statement	24
8	Accu	racy	25
An	inex A (	normative) Determination of LAG EFFECTS	26
	A.1	Overview	26
	A.2	Estimation of LAG EFFECTS (default method)	26
	A.3	Estimation of LAG EFFECTS, alternative method (only if no LAG EFFECT or abosting componention is applied)	26
	Δ31	General	20 26
	Δ32		20 27
	Δ33		····21 20
	Δ34	Determination of the minimum time between consecutive images	وح ٦1
Δn	nex R /	informative) Calculation of the input NOISE POWER SPECTPUM	
	nograf	niy	
ind	aex of d	ietined terms used in this particular standard	36

Figure 1 – TEST DEVICE for the determination of the MODULATION TRANSFER FUNCTION	
and the magnitude of LAG EFFECTS	. 12

Figure 2 – Geometry for exposing the DIGITAL X-RAY IMAGING DEVICE behind the TEST DEVICE in order to determine LAG EFFECTS and the MODULATION TRANSFER FUNCTION	14
Figure 3 – Position of the TEST DEVICE for the determination of the MODULATION TRANSFER FUNCTION	17
Figure 4 – Geometric arrangement of the ROIs for NPS calculation	21
Figure 5 - Representation of the image acquired for the determination of the MTF	23
Figure A.1 – Definition of the ROIs for the test of additive LAG EFFECTS	28
Figure A.2 – Procedure flow diagram for the test of additive LAG EFFECTS	28
Figure A.3 – Definition of the ROIs for the test of the multiplicative LAG EFFECTS	30
Figure A.4 – Procedure flow diagram for the test of multiplicative LAG EFFECTS	30

able 2 - Necessary IRRADIATIONS	ble 1 – Radiation (	DUALITY (IEC 61267:200 and corresponding para	05) for the determination of DE	TECTIVE 11
able 3 – Parameters mandatory for the application of this standard	ble 2 – Necessary	IRRADIATIONS		
"IS a Drew on one area by the second se	ble 3 – Parameters	mandatory for the app	olication of this standard	20
or a preview conclusion of the set of the se				
a preview concrete by the set of		<i>.0</i> ,		
Preview Oenerate of the of the of the of the office of the		0		
The tien of the				
Chieve Conception of the Conce				
The constant of the second sec			$\mathcal{O}_{\mathcal{A}}$	
En ana ara ara ara ara ara ara ara ara ar			4.	
			Q,	
			-4	
			0	
			Q <sub>x</sub>	
			0	
				1
Ś.				
0,				
				0,

## INTRODUCTION

DIGITAL X-RAY IMAGING DEVICES are increasingly used in medical diagnosis and are widely replacing conventional (analogue) imaging devices such as screen-film systems or analogue X-RAY IMAGE INTENSIFIER television systems. It is necessary, therefore, to define parameters that describe the specific imaging properties of these DIGITAL X-RAY IMAGING DEVICES and to standardize the measurement procedures employed.

There is general consensus in the scientific world that the DETECTIVE QUANTUM EFFICIENCY (DQE) is the most suitable parameter for describing the imaging performance of a DIGITAL X-RAY IMAGING DEVICE. The DQE describes the ability of the imaging device to preserve the signal-to-noise ratio from the RADIATION FIELD to the resulting digital image data. Since in X-ray imaging, the NOISE in the RADIATION FIELD is intimately coupled to the AIR KERMA level, DQE values can also be considered to describe the dose efficiency of a given DIGITAL X-RAY IMAGING DEVICE.

NOTE 1 In spite of the fact that the DQE is widely used to describe the performance of imaging devices, the connection between this physical parameter and the decision performance of a human observer is not yet completely understood [1], [3].<sup>1</sup>

NOTE 2 IEC 61262-5 specifies a method to determine the DQE of X-RAY IMAGE INTENSIFIERS at nearly zero SPATIAL FREQUENCY. It focuses only on the electro-optical components of X-RAY IMAGE INTENSIFIERS, not on the imaging properties as this standard does. As a consequence, the output is measured as an optical quantity (luminance), and not as digital data. Moreover, IEC 61262-5 prescribes the use of a RADIATION SOURCE ASSEMBLY, whereas this standard prescribes the use of an X-RAY TUBE. The scope of IEC 61262-5 is limited to X-RAY IMAGE INTENSIFIERS and does not interfere with the scope of this standard.

The DQE is already widely used by manufacturers to describe the performance of their DIGITAL X-RAY IMAGING DEVICE. The specification of the DQE is also required by regulatory agencies (such as the Food and Drug Administration (FDA)) for admission procedures. However, before the publication of the first edition of this standard there was no standard governing either the measurement conditions or the measurement procedure, with the consequence that values from different sources may not be comparable.

This standard has therefore been developed in order to specify the measurement procedure together with the format of the conformance statement for the DETECTIVE QUANTUM EFFICIENCY of DIGITAL X-RAY IMAGING DEVICES.

In the DQE calculations proposed in this standard, it is assumed that system response is measured for objects that attenuate all energies equally (task-independent) [5].

This standard will be beneficial for manufacturers, users, distributors and regulatory agencies.

This first edition of IEC 62220-1-1 forms part of a series of three related standards:

- Part 1-1, which is intended to be used for detectors used in radiographic imaging, excluding MAMMOGRAPHY and RADIOSCOPY;
- Part 1-2, which is intended to be used for detectors used in MAMMOGRAPHY;
- Part 1-3, which is intended to be used for detectors used in dynamic imaging.

## MEDICAL ELECTRICAL EQUIPMENT – CHARACTERISTICS OF DIGITAL X-RAY IMAGING DEVICES –

## Part 1-1: Determination of the detective quantum efficiency – Detectors used in radiographic imaging

## 1 Scope

This part of IEC 62220 specifies the method for the determination of the DETECTIVE QUANTUM EFFICIENCY (DQE) of DIGITAL X-RAY IMAGING DEVICES as a function of AIR KERMA and of SPATIAL FREQUENCY for the working conditions in the range of the medical application as specified by the MANUFACTURER. The intended users of this part of IEC 62220 are manufacturers and well equipped test laboratories.

NOTE 1 While not recommended, applying this standard to determine the DQE of digital X-ray imaging devices integrated in a clinical system is not excluded as long as the requirements as set in this standard are respected. Points of additional attention could be (for example but not exclusively) the establishment of the required RADIATION QUALITIES, minimizing influences of scattered and back-scattered radiation, accurate AIR KERMA measurements, positioning of the TEST DEVICE, presence of protective covers, removal of ANTI-SCATTER GRID.

This Part 1-1 is restricted to DIGITAL X-RAY IMAGING DEVICES that are used for radiographic imaging such as, but not exclusively, CR systems, direct and indirect flat panel-detector based systems.

It is not recommended to use this part of IEC 62220 for digital X-RAY IMAGE INTENSIFIER-based systems.

NOTE 2 The use of this standard for X-RAY IMAGE INTENSIFER-based systems is discouraged based on the low frequency drop, vignetting and geometrical distortion present in these devices which may put severe limitations on the applicability of the measurement methods described in this standard.

This part of IEC 62220 is not applicable to:

- DIGITAL X-RAY IMAGING DEVICES intended to be used in mammography or in dental radiography;
- slot scanning DIGITAL X-RAY IMAGING DEVICES;
- COMPUTED TOMOGRAPHY;
- devices for dynamic imaging (where series of images are acquired, as in fluoroscopy or cardiac imaging).

NOTE 3 The devices noted above are excluded because they contain many parameters (for instance, beam qualities, geometry, time dependence, etc.) which differ from those important for RADIOGRAPHY. Some of these techniques are treated in other parts of the IEC 62220 standards (IEC 62220-1-2 and IEC 62220-1-3).

### 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 60336, Medical electrical equipment – X-ray tube assemblies for medical diagnosis – Characteristics of focal spots

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

IEC 61267:2005, Medical diagnostic X-ray equipment – Radiation conditions for use in the determination of characteristics

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60788:2004 and the following apply.

#### 3.1

#### CALIBRATION CONDITIONS

set of conditions under which calibration is done

#### 3.2

#### CENTRAL AXIS

line perpendicular to the ENTRANCE PLANE passing through the centre of the ENTRANCE FIELD

#### 3.3

#### CONVERSION FUNCTION

plot of the large area output level (ORIGINAL DATA) of a DIGITAL X-RAY IMAGING DEVICE versus the number of exposure quanta per unit area (Q) in the DETECTOR SURFACE plane

Note 1 to entry: Q is to be calculated by multiplying the measured AIR KERMA excluding back scatter by the value given in column 2 of Table 3.

## 3.4

## DETECTIVE QUANTUM EFFICIENCY

#### DQE(u,v)

ratio of two NOISE POWER SPECTRUM (NPS) functions with the numerator being the NPS of the input signal at the DETECTOR SURFACE of a digital X-ray detector after having gone through the deterministic filter given by the system transfer function, and the denominator being the measured NPS of the output signal (ORIGINAL DATA)

Note 1 to entry: Instead of the two-dimensional DETECTIVE QUANTUM EFFICIENCY, often a cut through the twodimensional DETECTIVE QUANTUM EFFICIENCY along a specified SPATIAL FREQUENCY axis is published.

Note 2 to entry: The note to entry concerning the origin of the abbreviation "DQE" concerns the French text only.

#### 3.5

#### DETECTOR SURFACE

accessible area which is closest to the IMAGE RECEPTOR PLANE

Note 1 to entry: After removal of all parts (including the ANTI-SCATTER GRID and components for AUTOMATIC EXPOSURE CONTROL, if applicable) that can be safely removed from the RADIATION BEAM without damaging the digital X-ray detector.

#### 3.6

#### DIGITAL X-RAY IMAGING DEVICE

device consisting of a digital X-ray detector including the protective layers installed for use in practice, the amplifying and digitizing electronics, and a computer providing the ORIGINAL DATA (DN) of the image

Note 1 to entry: This may include protecting parts, such as ANTI-SCATTER GRIDS and components for AUTOMATIC EXPOSURE CONTROL.

#### 3.7

#### IMAGE MATRIX

arrangement of matrix elements preferentially in a Cartesian coordinate system