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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Radionuclide imaging devices – Characteristics and test conditions – Part 2: Gamma cameras for planar, wholebody, and SPECT imaging

Dispositifs d’imagerie par radionucléides – Caractéristiques et conditions d’essai – Partie 2: Gamma-caméras pour l'imagerie planaire, l'imagerie du corps entier et l'imagerie SPECT

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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**RADIONUCLIDE IMAGING DEVICES –
CHARACTERISTICS AND TEST CONDITIONS –**

**Part 2: Gamma cameras for planar, wholebody,
and SPECT imaging**

FOREWORD

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International Standard IEC 61675-2 has been prepared by subcommittee 62C: Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC technical committee 62: Electrical equipment in medical practice.

This second edition of IEC 61675-2 cancels and replaces the first edition published in 1998 and its Amendment 1 published in 2004, as well as IEC 60789:2005, IEC 60789:2005/COR1:2009, and IEC 61675-3:1998. It has been reformatted, updated, and partly aligned with NEMA NU 1-2007. Due to the lack of market share of SPECT-systems operated in coincidence mode all such tests have been removed.

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

FDIS	Report on voting
62C/616/FDIS	62C/623/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:

– TERMS DEFINED IN CLAUSE 2 OF THIS STANDARD OR LISTED IN THE INDEX OF DEFINED TERMS: SMALL CAPITALS.

The requirements are followed by specifications for the relevant tests.

Annex A is for information only.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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.

INTRODUCTION

The test methods specified in this part of IEC 61675 have been selected to reflect as much as possible the clinical use of GAMMA CAMERAS for planar imaging, PLANAR WHOLEBODY IMAGING EQUIPMENT, and SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY (SPECT). It is intended that the test methods are carried out by manufacturers thereby enabling them to describe the characteristics of the systems on a common basis.

RADIONUCLIDE IMAGING DEVICES – CHARACTERISTICS AND TEST CONDITIONS –

Part 2: Gamma cameras for planar, wholebody, and SPECT imaging

1 Scope

This part of IEC 61675 specifies terminology and test methods for describing the characteristics of GAMMA CAMERAS equipped with PARALLEL HOLE COLLIMATORS for planar imaging. Additional tests are specified for those GAMMA CAMERAS that are capable of planar wholebody imaging (PLANAR WHOLEBODY IMAGING EQUIPMENT) or SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY (SPECT). These GAMMA CAMERAS consist of a gantry, single or multiple DETECTOR HEADS, and a computer for data acquisition, processing, storage, and display. The DETECTOR HEADS may contain single or multiple scintillation crystals or solid state detectors.

No test has been specified to characterize the uniformity of reconstructed images because all methods known so far will mostly reflect the noise of the image.

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

IEC 61675-1:2013, *Radionuclide imaging devices – Characteristics and test conditions – Part 1: Positron emission tomographs*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 60788 and IEC 61675-1 (some of which are repeated here for convenience), and the following terms and definitions apply.

3.1
ADDRESS PILE UP
<GAMMA CAMERA> false address calculation of an artificial event which passes the ENERGY WINDOW, but is formed from two or more events by the PILE UP EFFECT

3.2
AXIAL FIELD OF VIEW
dimensions of a slice through the TOMOGRAPHIC VOLUME parallel to and including the SYSTEM AXIS

Note 1 to entry: In practice it is specified only by its axial dimension given by the distance between the centres of the outermost defined IMAGE PLANES plus the average of the measured AXIAL SLICE WIDTH measured as EQUIVALENT WIDTH (EW).

3.3
AXIAL RESOLUTION
for tomographs with sufficiently fine axial sampling fulfilling the sampling theorem, SPATIAL RESOLUTION along a line parallel to the SYSTEM AXIS

3.4
CENTRE OF ROTATION
COR
origin of that coordinate system, which describes the PROJECTIONS of a transverse slice with respect to their orientation in space

Note 1 to entry: The CENTRE OF ROTATION of a transverse slice is given by the intersection of the SYSTEM AXIS with the mid-plane of the corresponding OBJECT SLICE.

Note 2 to entry: The second note to entry concerns the French text only.

3.5
COLLIMATOR AXIS
straight line which passes through the geometrical centre of the exit field and entrance field of the COLLIMATOR

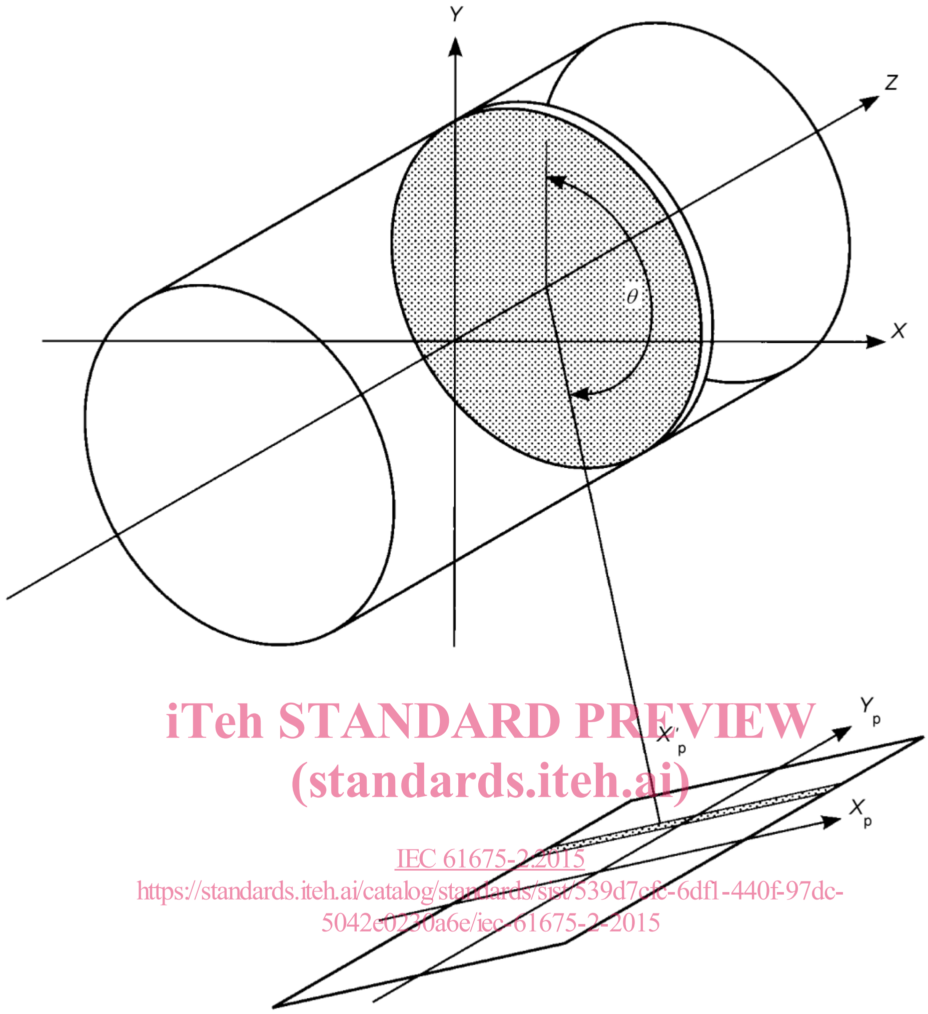
3.6
COLLIMATOR FRONT FACE
surface of the COLLIMATOR which is closest to the object being imaged

3.7
COORDINATE SYSTEM OF PROJECTION
Cartesian system of the IMAGE MATRIX of each two-dimensional PROJECTION with axes X_p and Y_p

Note 1 to entry: Axes X_p and Y_p are defined by the axes of the IMAGE MATRIX.

Note 2 to entry: The Y_p axis and the PROJECTION of the SYSTEM AXIS onto the detector front face have to be in parallel.

Note 3 to entry: The origin of the COORDINATE SYSTEM OF PROJECTION may be the centre of the IMAGE MATRIX (see Figure 1).



NOTE The FIXED COORDINATE SYSTEM *X*, *Y*, *Z* has its origin at the centre of the TOMOGRAPHIC VOLUME (shown as a cylinder), the *Z*-axis being the SYSTEM AXIS. The COORDINATE SYSTEM OF PROJECTION X_p, Y_p is shown for a PROJECTION ANGLE θ. For each θ, the one-dimensional PROJECTION of the marked OBJECT SLICE has the address range shown (hatched). Within this range the CENTRE OF ROTATION is projected onto the address X_p (offset).

Figure 1 – Geometry of PROJECTIONS

3.8
COUNT LOSS
difference between measured COUNT RATE and TRUE COUNT RATE, which is caused by the finite RESOLVING TIME of the instrument

[SOURCE: IEC 61675-1:2013, 3.8.1]

3.9
COUNT RATE
number of counts per unit of time

[SOURCE: IEC 61675-1:2013, 3.8.2]

3.10
COUNT RATE CHARACTERISTIC
function giving the relationship between observed COUNT RATE and TRUE COUNT RATE

[SOURCE: IEC 60788:2004, rm-34-21]

3.11
DETECTOR FIELD OF VIEW
FOV
region of the detector within which events are included in the display image, and for which all performance specifications are provided

Note 1 to entry: The note to entry regarding the abbreviation concerns the French text only.

3.12
DETECTOR HEAD TILT
deviation of the COLLIMATOR AXIS from orthogonality with the SYSTEM AXIS

3.13
DETECTOR POSITIONING TIME
fraction of the total time spent on an acquisition which is not used in collecting data

3.14
EMISSION COMPUTED TOMOGRAPHY
ECT
imaging method for the representation of the spatial distribution of RADIONUCLIDES in selected two-dimensional slices through the object

3.15
ENERGY WINDOW
range defining the energy signals accepted by the device for further processing

3.16
EQUIVALENT WIDTH
EW
width of that rectangle having the same area and the same height as the response function, e.g. the POINT SPREAD FUNCTION

[SOURCE: IEC 60788:2004, rm-34-45]

3.17
FIXED COORDINATE SYSTEM
Cartesian system with axes *X*, *Y*, and *Z*

Note 1 to entry: *Z* being the SYSTEM AXIS.

Note 2 to entry: The origin of the FIXED COORDINATE SYSTEM is defined by the centre of the TOMOGRAPHIC VOLUME (see Figure 1).

Note 3 to entry: The SYSTEM AXIS is orthogonal to all transverse slices.

3.18
IMAGE MATRIX
arrangement of MATRIX ELEMENTS in a preferentially Cartesian coordinate system

3.19
IMAGE PLANE
plane assigned to a plane in the OBJECT SLICE

Note 1 to entry: Usually the IMAGE PLANE is the mid-plane of the corresponding OBJECT SLICE.

3.20
INTRINSIC ENERGY RESOLUTION
FULL WIDTH AT HALF MAXIMUM of the full energy absorption peak in the INTRINSIC ENERGY SPECTRUM for a specified RADIONUCLIDE

3.21
INTRINSIC ENERGY SPECTRUM
measured histogram of pulse heights for the DETECTOR HEAD without COLLIMATOR

Note 1 to entry: The pulse height should be expressed as corresponding energy.

3.22
INTRINSIC NON-UNIFORMITY OF RESPONSE
NON-UNIFORMITY OF RESPONSE of the DETECTOR HEAD without COLLIMATOR

3.23
INTRINSIC SPATIAL NON-LINEARITY
SPATIAL NON-LINEARITY of the DETECTOR HEAD without COLLIMATOR

3.24
INTRINSIC SPATIAL RESOLUTION
<GAMMA CAMERA> SPATIAL RESOLUTION in air for a specified RADIONUCLIDE measured without the COLLIMATOR

3.25
LINE SOURCE
straight RADIOACTIVE SOURCE approximating a δ-function in two dimensions and being constant (uniform) in the third dimension

3.26
MATRIX ELEMENT
smallest unit of an IMAGE MATRIX, which is assigned in location and size to a certain volume element of the object (VOXEL)

3.27
MULTIPLE WINDOW SPATIAL REGISTRATION
measured position of a source as a function of the ENERGY WINDOW setting

3.28
NORMALIZED VOLUME SENSITIVITY
VOLUME SENSITIVITY divided by the AXIAL FIELD OF VIEW of the tomograph or the phantom length, whichever is the smaller

3.29
OBJECT SLICE
slice in the object

Note 1 to entry: The physical property of this slice that determines the measured information is displayed in the tomographic image.

3.30
OFFSET
deviation of the position of the PROJECTION of the COR (X'_p) from $X_p = 0$ (see Figure 1)

3.31
PARALLEL HOLE COLLIMATOR
COLLIMATOR with a number of apertures, the axes of which are parallel

3.32
PILE UP EFFECT
false measurement of the pulse amplitude, due to the absorption of two or more gamma rays, reaching the same radiation detector within the RESOLVING TIME

3.33
PIXEL
MATRIX ELEMENT in a two-dimensional IMAGE MATRIX

3.34
PLANAR WHOLEBODY IMAGING EQUIPMENT
<GAMMA CAMERA> GAMMA CAMERA, with one or two DETECTOR HEAD(S), in which the image of an extended object is formed by moving the DETECTOR HEAD(S) or the object in the axial direction relative to each other

3.35
POINT SOURCE
RADIOACTIVE SOURCE approximating a δ-function in all three dimensions

3.36
POINT SPREAD FUNCTION
PSF
scintigraphic image of a POINT SOURCE

3.37
PROJECTION
transformation of a three-dimensional object into its two-dimensional image or of a two-dimensional object into its one-dimensional image, by integrating the physical property which determines the image along the direction of the PROJECTION BEAM

Note 1 to entry: This process is mathematically described by line integrals in the direction of PROJECTION and called the Radon-transform.

3.38
PROJECTION ANGLE
angle at which the PROJECTION is measured or acquired

Note 1 to entry: See Figure 1.

3.39
PROJECTION BEAM
determines the smallest possible volume in which the physical property which determines the image is integrated during the measurement process

Note 1 to entry: Its shape is limited by the SPATIAL RESOLUTION in all three dimensions.

Note 2 to entry: In SPECT the PROJECTION BEAM usually has the shape of a long thin diverging cone.

3.40
RADIAL RESOLUTION
TRANSVERSE RESOLUTION along a line passing through the position of the source and the SYSTEM AXIS

[SOURCE: IEC 61675-1:2013, 3.4.1.1]

3.41
RADIOACTIVE SOURCE
quantity of radioactive material having both an ACTIVITY and a specific ACTIVITY above specific levels

[SOURCE: IEC 60788:2004, rm-20-02]

3.42
RADIUS OF ROTATION
distance between the SYSTEM AXIS and the COLLIMATOR FRONT FACE

3.43
SCATTER FRACTION
SF
<GAMMA CAMERA> ratio between the number of scattered photons and the sum of scattered plus unscattered photons for a given experimental set-up

3.44
SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY
SPECT
EMISSION COMPUTED TOMOGRAPHY utilizing single photon detection of gamma-ray emitting RADIONUCLIDES

Note 1 to entry: The note to entry regarding the abbreviation concerns the French version only.

3.45
SINOGRAM
two-dimensional display of all one-dimensional PROJECTIONS of an OBJECT SLICE, as a function of the PROJECTION ANGLE

Note 1 to entry: The PROJECTION ANGLE is displayed on the ordinate, the linear PROJECTION coordinate is displayed on the abscissa.

[SOURCE: IEC 61675-1:2013, 3.1.2.4]

3.46
SLICE SENSITIVITY
ratio of COUNT RATE as measured on the SINOGRAM to the ACTIVITY concentration in the phantom

Note 1 to entry: In SPECT the measured counts are not numerically corrected for scatter by subtracting the SCATTER FRACTION.

[SOURCE: IEC 61675-1:2013, 3.6]

3.47
SPATIAL NON-LINEARITY
deviations of the image of a straight LINE SOURCE from a straight line

3.48
SPATIAL RESOLUTION
<nuclear medicine> ability to concentrate the count density distribution in the image of a POINT SOURCE to a point

[SOURCE: IEC 61675-1:2013, 3.4]

3.49
SYSTEM AXIS
axis of symmetry characterized by geometrical and physical properties of the arrangement of the system

Note 1 to entry: The SYSTEM AXIS of a GAMMA CAMERA with rotating detectors is the axis of rotation.

[SOURCE: IEC 61675-1:2013, 3.1.2.7, modified – The note to entry has been changed]