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**Radionuclide imaging devices – Characteristics and test conditions –
Part 1: Positron emission tomographs**

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Part 1: Positron emission tomographs

FOREWORD

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International Standard IEC 61675-1 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 consolidated version of IEC 61675-1 consists of the first edition (1998) [documents 62C/205/FDIS and 62C/214/RVD] and its amendment 1 (2008) [documents 62C/419/CDV and 62C/432/RVC].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

In this standard, the following print types are used:

– TERMS DEFINED IN CLAUSE 2 OF THIS STANDARD OR LISTED IN ANNEX A: 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 the base publication and its amendments will remain unchanged until the maintenance result 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- withdrawn,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.

A bilingual version of this standard may be issued at a later date.

INTRODUCTION
(to amendment 1)

Further developments of POSITRON EMISSION TOMOGRAPHS allow most of the tomographs to be operated in fully 3D acquisition mode. To comply with this trend, this amendment describes test conditions in accordance with the acquisition characteristic. It is the intention to simulate 3D imaging without introducing new phantoms or new acquisition or processing protocols. The test does simulate more realistically count rate characteristics for whole body imaging. Measurement of SCATTER FRACTION is not intended with this test. Certain parts of the standard are amended as stated below.

RADIONUCLIDE IMAGING DEVICES – CHARACTERISTICS AND TEST CONDITIONS –

Part 1: Positron emission tomographs

1 General

1.1 Scope and object

This part of IEC 61675 specifies terminology and test methods for declaring the characteristics of POSITRON EMISSION TOMOGRAPHS. POSITRON EMISSION TOMOGRAPHS detect the ANNIHILATION RADIATION of positron emitting RADIONUCLIDES by COINCIDENCE DETECTION.

The test methods specified in this part of IEC 61675 have been selected to reflect as much as possible the clinical use of POSITRON EMISSION TOMOGRAPHS. It is intended that the test methods be carried out by manufacturers, thereby enabling them to declare the characteristics of POSITRON EMISSION TOMOGRAPHS. So, the specifications given in the ACCOMPANYING DOCUMENTS shall be in accordance with this standard. This standard does not imply which tests will be performed by the manufacturer on an individual tomograph.

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

1.2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of IEC 61675. At the time of publication, the edition indicated was valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61675 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60788:1984, *Medical radiology – Terminology*

2 Terminology and definitions

For the purpose of this part of IEC 61675, the definitions given in IEC 60788 (see annex A) and the following definitions apply.

Defined terms are printed in small capitals.

2.1 TOMOGRAPHY (see annex A)

2.1.1
TRANSVERSE TOMOGRAPHY
in TRANSVERSE TOMOGRAPHY the three-dimensional object is sliced by physical methods, for example collimation, into a stack of OBJECT SLICES, which are considered as being two-dimensional and independent from each other. The transverse IMAGE PLANES are perpendicular to the SYSTEM AXIS.

2.1.2
EMISSION COMPUTED TOMOGRAPHY (ECT)
imaging method for the representation of the spatial distribution of incorporated RADIONUCLIDES in selected two-dimensional slices through the object

2.1.2.1
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 This process is mathematically described by line integrals in the direction of projection (along the LINE OF RESPONSE) and called Radon-transform.

2.1.2.2
PROJECTION BEAM
determines the smallest possible volume in which the physical property which determines the image is integrated during the measurement process. Its shape is limited by SPATIAL RESOLUTION in all three dimensions.

NOTE The PROJECTION BEAM mostly has the shape of a long thin cylinder or cone. In POSITRON EMISSION TOMOGRAPHY, it is the sensitive volume between two detector elements operated in coincidence.

2.1.2.3
PROJECTION ANGLE
angle at which the PROJECTION is measured or acquired

2.1.2.4
SINOGRAM
two-dimensional display of all one-dimensional PROJECTIONs of an OBJECT SLICE, as a function of the PROJECTION ANGLE. The PROJECTION ANGLE is displayed on the ordinate, the linear PROJECTION coordinate is displayed on the abscissa.

2.1.2.5
OBJECT SLICE
slice in the object. The physical property of this slice, that determines the measured information, is displayed in the tomographic image.

2.1.2.6
IMAGE PLANE
a plane assigned to a plane in the OBJECT SLICE

NOTE Usually the IMAGE PLANE is the midplane of the corresponding OBJECT SLICE.

2.1.2.7
SYSTEM AXIS
axis of symmetry, characterized by geometrical and physical properties of the arrangement of the system

NOTE For a circular POSITRON EMISSION TOMOGRAPH, the SYSTEM AXIS is the axis through the centre of the detector ring. For tomographs with rotating detectors it is the axis of rotation.

2.1.2.8
TOMOGRAPHIC VOLUME
juxtaposition of all volume elements which contribute to the measured PROJECTIONS for all PROJECTION ANGLES

2.1.2.8.1
TRANSVERSE FIELD OF VIEW
dimensions of a slice through the TOMOGRAPHIC VOLUME, perpendicular to the SYSTEM AXIS. For a circular TRANSVERSE FIELD OF VIEW, it is described by its diameter

NOTE For non-cylindrical TOMOGRAPHIC VOLUMES the TRANSVERSE FIELD OF VIEW may depend on the axial position of the slice.

2.1.2.8.2
AXIAL FIELD OF VIEW
dimensions of a slice through the TOMOGRAPHIC VOLUME, parallel to and including the SYSTEM AXIS. In practice, it is specified only by its axial dimension, given by the distance between the centre of the outmost defined IMAGE PLANES plus the average of the measured AXIAL SLICE WIDTH

2.1.2.8.3
TOTAL FIELD OF VIEW
dimensions (three-dimensional) of the TOMOGRAPHIC VOLUME

2.1.3
POSITRON EMISSION TOMOGRAPHY (PET)
EMISSION COMPUTED TOMOGRAPHY utilizing the ANNIHILATION RADIATION of positron emitting RADIONUCLIDES by COINCIDENCE DETECTION

2.1.3.1
POSITRON EMISSION TOMOGRAPH
tomographic device, which detects the ANNIHILATION RADIATION of positron emitting RADIONUCLIDES by COINCIDENCE DETECTION

2.1.3.2
ANNIHILATION RADIATION
ionizing radiation that is produced when a particle and its antiparticle interact and cease to exist

2.1.3.3
COINCIDENCE DETECTION
a method which checks whether two opposing detectors have detected one photon each simultaneously. By this method the two photons are concatenated into one event.

NOTE The COINCIDENCE DETECTION between two opposing detector elements serves as an electronic collimation to define the corresponding PROJECTION BEAM or LINE OF RESPONSE (LOR), respectively.

2.1.3.4
COINCIDENCE WINDOW
time interval during which two detected photons are considered being simultaneous

2.1.3.5
LINE OF RESPONSE (LOR)
the axis of the PROJECTION BEAM

NOTE In PET, it is the line connecting the centres of two opposing detector elements operated in coincidence.

2.1.3.6
TOTAL COINCIDENCES
sum of all coincidences detected

2.1.3.6.1
TRUE COINCIDENCE
result of COINCIDENCE DETECTION of two gamma events originating from the same positron annihilation

2.1.3.6.2
SCATTERED TRUE COINCIDENCE
TRUE COINCIDENCE where at least one participating photon was scattered before the COINCIDENCE DETECTION

2.1.3.6.3
UNSCATTERED TRUE COINCIDENCE
the difference between TRUE COINCIDENCES and SCATTERED TRUE COINCIDENCES

2.1.3.6.4
RANDOM COINCIDENCE
result of COINCIDENCE DETECTION in which both participating photons emerge from different positron annihilations

2.1.3.7
SINGLES RATE
COUNT RATE measured without COINCIDENCE DETECTION, but with energy discrimination

2.1.4
Reconstruction

2.1.4.1
TWO-DIMENSIONAL RECONSTRUCTION
in TWO-DIMENSIONAL RECONSTRUCTION, the data are rebinned prior to reconstruction into SINOGRAMS, which are the PROJECTION data of transverse slices, which are considered being independent of each other and being perpendicular to the SYSTEM AXIS. So, each event will be assigned, in the axial direction, to that transverse slice passing the midpoint of the corresponding LINE OF RESPONSE. Any deviation from perpendicularity to the SYSTEM AXIS is neglected. The data are then reconstructed by two-dimensional methods, i.e. each slice is reconstructed from its associated SINOGRAM, independent of the rest of the data set.

NOTE This is the standard method of reconstruction for POSITRON EMISSION TOMOGRAPHS using small axial acceptance angles, i.e. utilizing septa. For POSITRON EMISSION TOMOGRAPHS using large axial acceptance angles, i.e. without septa, this method is also called 'single slice rebinning'.

2.1.4.2
THREE-DIMENSIONAL RECONSTRUCTION
in THREE-DIMENSIONAL RECONSTRUCTION, the LINES OF RESPONSE are not restricted to being perpendicular to the SYSTEM AXIS. So, a LINE OF RESPONSE may pass several transverse slices. Consequently, transverse slices cannot be reconstructed independent of each other. Each slice has to be reconstructed utilizing the full three-dimensional data set.

2.2
IMAGE MATRIX
arrangement of MATRIX ELEMENTs in a preferentially cartesian coordinate system

2.2.1
MATRIX ELEMENT
smallest unit of an IMAGE MATRIX, which is assigned in location and size to a certain volume element of the object (VOXEL)

2.2.1.1
PIXEL
matrix element in a two-dimensional IMAGE MATRIX

2.2.1.2
TRIXEL
matrix element in a three-dimensional IMAGE MATRIX

2.2.2
VOXEL
volume element in the object which is assigned to a MATRIX ELEMENT in the IMAGE MATRIX (two-dimensional or three-dimensional). The dimensions of the VOXEL are determined by the dimensions of the corresponding MATRIX ELEMENT via the appropriate scale factors and by the systems SPATIAL RESOLUTION in all three dimensions

2.3
POINT SPREAD FUNCTION (PSF)
scintigraphic image of a POINT SOURCE

2.3.1
PHYSICAL POINT SPREAD FUNCTION
for tomographs, a two-dimensional POINT SPREAD FUNCTION in planes perpendicular to the PROJECTION BEAM at specified distances from the detector

NOTE The PHYSICAL POINT SPREAD FUNCTION characterizes the purely physical (intrinsic) imaging performance of the tomographic device and is independent of for example sampling, image reconstruction and image processing. A PROJECTION BEAM is characterized by the entirety of all PHYSICAL POINT SPREAD FUNCTIONS as a function of distance along its axis.

2.3.2
AXIAL POINT SPREAD FUNCTION
profile passing through the peak of the PHYSICAL POINT SPREAD FUNCTION in a plane parallel to the SYSTEM AXIS

2.3.3
TRANSVERSE POINT SPREAD FUNCTION
reconstructed two-dimensional POINT SPREAD FUNCTION in a tomographic IMAGE PLANE

NOTE In TOMOGRAPHY, the TRANSVERSE POINT SPREAD FUNCTION can also be obtained from a LINE SOURCE located parallel to the SYSTEM AXIS.

2.4
SPATIAL RESOLUTION
ability to concentrate the count density distribution in the image of a POINT SOURCE to a point

2.4.1
TRANSVERSE RESOLUTION
SPATIAL RESOLUTION in a reconstructed plane perpendicular to the SYSTEM AXIS

2.4.1.1
RADIAL RESOLUTION
TRANSVERSE RESOLUTION along a line passing through the position of the source and the SYSTEM AXIS

2.4.1.2
TANGENTIAL RESOLUTION
TRANSVERSE RESOLUTION in the direction orthogonal to the direction of RADIAL RESOLUTION

2.4.2
AXIAL RESOLUTION
for tomographs with sufficiently fine axial sampling fulfilling the sampling theorem, SPATIAL RESOLUTION along a line parallel to the SYSTEM AXIS

2.4.3
AXIAL SLICE WIDTH
for tomographs, the width of the AXIAL POINT SPREAD FUNCTION