Department of Health

REQUIREMENTS AND TEST CONDITIONS FOR RADIONUCLIDE IMAGING DEVICES

Compiled by
Directorate Radiation Control

IMAGE
May 2005

CONTENTS

DEFINITIONS

A1. ACTIVITY

ACTIVITY, A, of a quantity of a radioactive nuclide is the quotient of dN by dt, where dN is the expectation value of the number of spontaneous nuclear transformations which occur in this quantity in the time interval dt.

$$A = \frac{dN}{dt}$$

Note. - The term "nuclear transformation" is meant to designate a change of nuclide or isomeric transition (ICRU Report 19, 1971).

A2. SCINTIGRAPHY

Procedure for producing an image of an in-vivo radionuclide distribution.

A2.1 PULSE AMPLITUDE ANALYSER WINDOW

Range of input signal amplitudes for which the analyser delivers an output signal. (This should be expressed as equivalent energy.)

A2.2 SCALE FACTOR (for radionuclide imaging devices)

Ratio d'/d of the distance d' between two points A' and B' in the displayed or recorded image and the distance d between the corresponding points A and B in a plane within the object at a given distance from the COLLIMATOR FRONT FACE and parallel to it or perpendicular to the COLLIMATOR AXIS.

A3. GAMMA CAMERA

An equipment for carrying out SCINTIGRAPHY which produces an image by simultaneous detection of radiation emitted from all parts of the object included in the image.

A3.1 DETECTOR FIELD OF VIEW

Area equal to the EXIT FIELD OF THE COLLIMATOR.

A4. RADIONUCLIDE SCANNER

An equipment for carrying out SCINTlGRAPHY, employing a single or several RADIATION DETECTOR ASSEMBLIES (see Clause A6), in which the image is formed by moving the RADIATION DETECTOR HEAD relative to the object and transferring the detector output to the correspond|ng position in the image system.

A4.1 SCANNING FIELD

Part of a specified plane parallel to the plane of movement for which an image is formed.

A4.2 LINE SPACING

Lateral displacement of the COLLIMATOR AXIS between two successive scan lines.

A4.3 SCANNING MODE

Indicates modes of scanning, for example: stepwise or continuous movement, rectilinear, comb path.

A4.4 SCANNING SPEED

Velocity of the DETECTOR HEAD relative to the object during SCINTIGRAPHY.

A5. DETECTOR HEAD

Combination of the RADIATION DETECTOR ASSEMBLY with COLLIMATOR and DETECTOR SHIELD.

A6. RADIATION DETECTOR ASSEMBLY

Assembly which can produce electrical signals (for example pulses) when ionizing radiation interacts with it. It does not include the COLLIMATOR or DETECTOR SHIELD.

A7. DETECTOR SHIELD

Component for attenuating radiation that does not pass through the COLLIMATOR.

A8. COLLIMATOR (for radionuclide imaging devices)

Block of radiation attenuating material with one or more apertures that limit the DETECTOR FIELD OF VIEW and the angular spread of the radiation which can reach the RADIATION DETECTOR ASSEMBLY.

A8.1 COLLIMATOR FRONT FACE

Surface of a COLLIMATOR which is closest to the object.

A8.2 COLLIMATOR BACK FACE

Surface of a COLLIMATOR which is closest to the RADIATION DETECTOR ASSEMBLY.

A8.3 ENTRANCE FIELD OF A COLLIMATOR

Area bounded by the shortest line which is tangential to the outside edges of the Peripheral COLLIMATOR apertures on the COLLIMATOR FRONT FACE.

A8.4 EXIT FIELD OF A COLLIMATOR

Area bounded by the shortest line which is tangential to the outside edges of the Peripheral COLLIMATOR apertures on the COLLIMATOR BACK FACE.

A8.5 COLLIMATOR AXIS

Straight line which passes through the geometrical centre of the EXIT and ENTRANCE FIELD OF THE COLLIMATOR.

A8.6 PARALLEL HOLE COLLIMATOR

COLLIMATOR with a number of apertures, the axes of which are parallel. It is used in cameras.

A8.7 CONVERGING COLLIMATOR

COLLIMATOR with a number of apertures, the axes of which converge to a point in front of the RADIATION DETECTOR ASSEMBLY. If the converging point is beyond the object, it is used in cameras for producing a magnified image.

A8.8 DIVERGING COLLIMATOR

COLLIMATOR with a number of apertures, the axes of which diverge from a point behind the RADIATION DETECTOR ASSEMBLY. It is used in cameras for minification imaging.

A8.9 PINHOLE COLLIMATOR

COLLIMATOR with one small aperture in a plane in front of the RADIATION DETECTOR ASSEMBLY. It is used in cameras.

A8.10 FOCUSED COLLIMATOR

COLLIMATOR with a number of apertures, the axes of which converge to a point (or set of points) on the COLLIMATOR AXIS in front of the RADIATION DETECTOR ASSEMBLY .and within the object. It is used in scanners.

A8.11 SLIT COLLIMATOR

COLLIMATOR with a slit shaped aperture. It is used in profile SCANNING.

A8.12 FOCUS SLIT COLLIMATOR

COLLIMATOR with a number of slit shaped apertures, the midplanes of which converge to a straight line (or set of straight lines) in front of the RADIATION DETECTOR ASSEMBLY. The slits may be subdivided by parallel septa. It is used in scanners.

A8.13 GEOMETRICAL FOCAL DISTANCE(S) OF A COLLIMATOR

Distance(s), measured along the COLLIMATOR AXIS, between the front face of a FOCUSED COLLIMATOR and the point(s) or line(s) to which the axes or midplanes of the COLLIMATOR apertures converge.

A8.14 EFFECTIVE FOCAL DISTANCE COLLIMATOR

Distance. measured along the COLLIMATOR AXIS, between the front face of a FOCUSED COLLIMATOR and the point on the COLLIMATOR AXIS with minimum FWHM. (see definition of FWHM)

Note. - The EFFECTIVE FOCAL DISTANCE is not necessarily equal to the GEOMETRICAL FOCAL DISTANCE.

A8.15 GEOMETRICAL FOCAL PLANE(S)

Plane(s) perpendicular to the COLLIMATOR AXIS at the GEOMETRICAL FOCAL DISTANCE(S).

A8.16 EFFECTIVE FOCAL PLANE

Plane, perpendicular to the COLLIMATOR AXIS at the EFFECTIVE FOCAL DISTANCE.

A8.17 NEAR FOCUS LIMIT

Point nearest to the COLLIMATOR FRONT FACE on the COLLIMATOR AXIS where the FWHM is double its minimum value or, if this point does not exist, the point of intersection of the COLLIMATOR AXIS with the COLLIMATOR FRONT FACE.

A8.18 FAR FOCUS LIMIT

Point farthest from the COLLIMATOR FRONT FACE on the COLLIMATOR AXIS where the FWHM is double its minimum value.

A8.19 DEPTH OF FOCUS

Distance between the NEAR and the FAR FOCUS LIMIT.

A.9 COUNT RATE PERFORMANCE

A9.1 TRUE COUNT RATE

Count rate that would be observed if the RESOLVING TIME of the device were zero.

A9.2 COUNT RATE CHARACTERISTIC

Function giving the relationship between observed and TRUE COUNT RATE, when the TRUE COUNT RATE is varied.

A9.3 RESOLVING TIME

The RESOLVING TIME of a device is the shortest time interval which must elapse between the occurrence of two consecutive input signals to the device in order that it be capable of fulfilling its function for each of them separately.

A.10 SENSITIVITY

A.10.1 SPECIFIC PLANE SENSITIVITY (RADIONUCLIDE SCANNERS)

With a specified COLLIMATOR and PULSE AMPLITUDE ANALYSER WINDOW, the ratio of the count rate of the DETECTOR HEAD to the ACTIVITY per unit area of a plane source of specific dimensions and containing a specified nuclide placed perpendicular to and centred on the COLLIMATOR AXIS at a specified distance Z from the COLLIMATOR FRONT FACE.

A.10.2 PLANE SENSITIVITY (GAMMA CAMERA)

With a specified COLLIMATOR and PULSE AMPLITUDE ANALYSER WINDOW, the ratio of the count rate of the DETECTOR HEAD to the ACTIVITY of a plane source of specific dimensions and containing a specified nuclide placed perpendicular to and centred on the COLLIMATOR AXIS at a specified distance Z from the COLLIMATOR FRONT FACE.

A11. SPATIAL RESOLUTION

A.11.1 LINE SPREAD FUNCTION

The function L (X) giving some measured quantity, for example count rate, as a function of the X-co-ordinate, when a line source is placed in a plane perpendicular to the COLLIMATOR AXIS, parallel to the Y-axis and at a specified distance Z from the COLLIMATOR FRONT FACE.

A.11.2 FULL WIDTH AT HALF MAXIMUM (FWHM) and FULL WIDTH AT TENTH MAXIMUM (FWTM) OF THE LINE SPREAD FUNCTION

FULL WIDTH AT HALF MAXIMUM (FWHM) equals the distance along the X-axis between the points where the LINE SPREAD FUNCTION has half its maximum value, and FULL WIDTH AT TENTH MAXIMUM (FWTM) equals the distance along the X-axis between the points where the LINE SPREAD FUNCTION has one-tenth of its maximum value.

A.11.2.1 INTRINSIC FWHM (GAMMA CAMERA)

FULL WIDTH AT HALF MAXIMUM of the LINE SPREAD FUNCTION Of the DETECTOR HEAD of a GAMMA CAMERA without COLLIMATOR.

A.11.2.2 DETECTOR HEAD FWHM

FULL WIDTH AT HALF MAXIMUM of the LINE SPREAD FUNCTION of the DETECTOR HEAD with a specified COLLIMATOR.

A.11.2.3 INTRINSIC FWTM (GAMMA CAMERA)

FULL WIDTH AT TENTH MAXIMUM Of the LINE SPREAD FUNCTION of the DETECTOR HEAD of a GAMMA CAMERA without COLLIMATOR.

A.11.2.4 DETECTOR HEAD FWTM

FULL WIDTH AT TENTH MAXIMUM of the LINE SPREAD FUNCTION of the DETECTOR HEAD with a specified COLLIMATOR.

A11.3 MODULATION

The quotient $\frac{\text{Maximum value - minimum value}}{\text{Maximum value + minimum value}}$ for a phenomenon that does not have negative values, for example distribution of radioactivity in a plane source.

A11.4 MODULATION TRANSFER FUNCTION (MTF)

The MODULATION TRANSFER FUNCTION is the Fourier transform $M(\nu)$ of the LINE SPREAD FUNCTION. It may be derived for a symmetrical LINE SPREAD FUNCTION $L(x)$ by a normalized Fourier transform according to the relation:

$$M(\nu) = \frac{\int_{-\infty}^{+\infty} L(x) \cos 2 \pi \nu x \, \mathrm{d}x}{\int_{-\infty}^{+\infty} L(x) \, |\mathrm{d}x|}$$

The function $M(\nu)$ gives the variation in the ratio of the MODULATION of the measured quantity, for example count rate of the DETECTOR HEAD to the MODULATION of a planar radioactive source, whose radioactivity is sinusoidally modulated in one dimension of space, with the spatial frequency ν of the source. ν is the reciprocal of the distance between two neighbouring points of the same phase of a phenomenon which is modulated sinusoidally in space.

A12 NON-UNIFORMITY OF RESPONSE (GAMMA CAMERA DETECTOR HEAD)

The differences in count rate between small areas of specified dimensions (pixels) within DETECTOR FIELD OF VIEW when a uniform plane source (specified in Figure 3, page 18) parallel to the detector face and of dimensions larger than its ENTRANCE FIELD is used. (D in Figure 3 larger than the DETECTOR FIELD OF VIEW.)

REQUIREMENTS AND TEST CONDITIONS FOR RADIONUCLIDE IMAGING DEVICES

1. INTRODUCTION

Radionuclide imaging devices are subject to regulatory control in terms of the Hazardous substances Act, 1973 (Act 15 of 1973), as amended,and listed under Schedule 7 of the Group III hazardous substances (No R1302 of 14 June 1991), published in government Gazette No 13299 vol. 312. The party responsible for administering this legislation is the Directorate: Radiation Control of the Department of National Health and Population Development.

The basic safety philosophy for these devices, follows international standards compiled by the International Electrochemical Commission (IEC) and the International Standards Organisation (ISO). This standard for Radionuclide Imaging Devices is based on IEC publication 789.

2. SCOPE AND OBJECT

This standard applies to radionuclide imaging devices.

The object of this standard is to define terminology and test conditions for specifying characteristics of radionuclide imaging devices. These usually consist of a COLLIMATOR, a DETECTOR SHIELD, a RADIATION DETECTOR ASSEMBLY which can produce one or more electrical pulses when a photon interacts with it, a mechanical, electronic or electromechanical system which allots coordinate values to each detected photon producing a pulse within a selected pulse amplitude range, and recording and display devices. Nuclear medicine imaging devices include RADIONUCLIDE SCANNERS, GAMMA CAMERAS or scintillation gamma cameras and hybrid systems. Imaging devices for positron emitters are not considered.

Measurements have been chosen which will as much as possible reflect performance in normal use. It is envisaged that they will be performed by manufacturers to indicate typical performance for a given model, not by users on a routine basis.

More detailed guidance for the in-service quality control of scintillation cameras and scanners, is given in IAEA - TECDOC - 602 and also by the Hospital Physicists Association (HPA) of the UK (see references 2, 3 and 4).

3. TEST CONDITIONS - RADIONUCLIDE SCANNERS

All measurements shall be performed with PULSE AMPLITUDE ANALYSER WINDOW settings specified in Table I.

Additional measurements with other window settings, as specified by the manufacturer, may be performed.

3.1 Measurements of SPECIFIC PLANE SENSITIVITY

A radioactive solution shall be placed in a cylindrical cuvette of polymethyl methacrylate, as defined in Figure I, page 18. The source shall be placed (in air) perpendicular to and with its centre on the COLLIMATOR AXIS. In the case of a FOCUSED COLLIMATOR, it shall be placed in the EFFECTIVE FOCAL PLANE, otherwise at a distance of 100 mm from the COLLIMATOR FACE.

The value shall be expressed in:- $mm^2 . counts. s^{-1} . Bq^{-1}$

3.2 LINE SPREAD FUNCTION FWHM and FWTM

3.2.1 Measurements of the LINE SPREAD FUNCTION

A solution containing the radionuclide in question shall be placed in a tube with specified inner diameter not greater than 2 mm or 20% FWHM , whichever is the smaller at the depth of measurement, and length not less than 150 mm.

The tube shall be placed with its axis perpendicular to the COLLIMATOR AXIS in water or in a water equivalent material. There shall be an air gap of 20 mm between the COLLIMATOR FRONT FACE and the surface of the scattering medium. The depth of the scattering medium along the COLLIMATOR AXIS shall be at least 200 mm.

The source shall be moved stepwise or continuously in a direction perpendicular to the COLLIMATOR AXIS and to the axis of the tube containing the source. The step length should be not more than 10% of the FWHM. The count rate at each position shall be registered and expressed as a percentage of the maximum value along the COLLIMATOR AXIS. The count time for each step should be the same and chosen such that the maximum count is approximately 10 000. if continuous movement is used, the speed should be chosen so that the same statistical accuracy is obtained. The lateral displacement shall be to a point where the count rate is 1% of the maximum value on the COLLIMATOR AXIS.

The measurement shall be carried out in a set of planes 10 mm or 20 mm apart, starting in a plane with the centre of the source at 30 mm from the COLLIMATOR FRONT FACE and increasing to the plane in which the value of the counts on the COLLIMATOR AXIS is less than 10% of its maximum value.

A radionuclide appropriate to the COLLIMATOR in use shall be chosen from Table I.

3.2.2 Evaluation of the measurements of the LINE SPREAD FUNCTION

The MODULATION TRANSFER FUNCTION shall be calculated, the FWHM and the FWTM in water shall be determined according to definition A11.2. Graphs shall be made, showing the MTF's, the FWHM and the FWTM as a function of the distance from the COLLIMATOR FRONT FACE.

The EFFECTIVE FOCAL DISTANCE, the NEAR and FAR FOCUS LIMITS and the DEPTH OF FOCUS shall be determined from these graphs.

3.3 COUNT RATE CHARACTERISTIC

A graph shall be produced for one of the nuclides specified in Table I, showing the observed count rate as a function of the TRUE COUNT RATE, measured up to at least a value where 20% count rate losses occur, when the ACTIVITY of a source in front of the RADIATION DETECTOR ASSEMBLY is varied, as specified in Figure 1, page 18, mounted in a phantom as specified in Figure 2, page 18. The observed count rate which is 90% of the TRUE COUNT RATE shall be stated.

3.4 SCANNING SPEED performance

The maximum deviation from the mean speed shall be determined, at minimum, maximum and half maximum speed, but excluding variations occurring in the first and the last 25 mm of travel measurements.

3.5 Shield leakage test

A small volume source of the appropriate nuclide specified in Table I which will fit inside a cube of 10 mm side shall be placed in contact with any external part of the DETECTOR SHIELD. The COUNT rate produced by the detector is an indication of the shield leakage at that point and shall be expressed as a percentage of the count rate obtained when the source is placed on the axis of a specified COLLIMATOR at the EFFECTIVE FOCAL DISTANCE in the case of a FOCUSED COLLIMATOR or at 100 mm from the front face of all other COLLIMATORS. A plane section containing the COLLIMATOR AXIS shall be shown on an outline drawing on which shall be marked the leakage values for at least 10 points, approximately- equally spaced around the DETECTOR SHIELD. The maximum leakage values shall be included. Attention shall be given to the leakage values at joins in the shield particularly the join between the COLLIMATOR and the DETECTOR SHIELD.

4. TEST CONDITIONS - GAMMA CAMERAS

All measurements shall be performed with PULSE AMPLITUDE ANALYSER WINDOW settings specified in Table I. Additional measurements with other settings as specified by the manufacturer may be performed. Before performing the measurements the camera shall be adjusted by the procedure normally used by the manufacturer for an installed unit and shall not be readjusted specially for the measurements of specific parameters.

Unless otherwise stated measurements shall be carried out at count rates not exceeding 10 000 counts per second.

4.1 Measurements of PLANE SENSITIVITY

The measurement shall be carried out using the cylindrical phantom of polymethyl methacrylate as specified in Figure 2, page 18. The plane source described in Sub-clause 3.1 and Figure 1, page 18, shall be placed in the cylindrical hole with dimensions shown in Figure 2, the remainder of the hole will then be closed by a cylindrical part for which the dimensions also are shown in Figure 2. The phantom, including the source, shall be placed on the COLLIMATOR (distance d = 0) and centred on the COLLIMATOR AXIS.

The measured value shall be expressed in counts. s^{-1} Bq^{-1}

4.2 LINE SPREAD FUNCTION FWHM and FWTM

4.2.1 Measurement of the LINE SPREAD FUNCTION

A solution containing a specific radionuclide shall be placed in a tube with a specified inner diameter not greater than 2 mm or 20% FWHM, whichever is the smaller at the depth of measurement and length of 30 ± 5 mm. This tube shall be placed with its axis perpendicular to the COLLIMATOR AXIS in water or in a water equivalent material. The air gap between the COLLIMATOR FRONT FACE and the surface of the scattering medium shall be less than 5 mm. The depth of the scattering medium along the COLLIMATOR AXIS shall be at least 200 mm.

The measured quantity, for example counts, shall be integrated within sets of areas with length of at least 30 mm and parallel to the line source and width equal to or less than 10% of FWHM at the depth of measurement. The areas shall abut each other.

The measured quantity shall be expressed as a percentage of the maximum value. The lateral extension of the set of areas should be to a point where the measured quantity is 1% of its maximum value. In the case where count rate is measured the maximum number of counts at each distance from the COLLIMATOR should be 10 000. If some other quantity is measured, provision should be made to obtain the same statistical accuracy.

The measurement shall be carried out in a set of planes 10 mm or 20 mm apart, starting in a plane with the centre of the source at 20 mm from the COLLIMATOR FRONT FACE and increasing either to the plane in which the value of the signal on the COLLIMATOR AXIS is less than 10% of its maximum value or to the point which is at a distance of 200 mm from the COLLIMATOR FRONT FACE, whichever is the lesser.

A radionuclide, appropriate to the COLLIMATOR in use shall be chosen from Table I.

4.2.2 Evaluation of the measurement of the LINE SPREAD FUNCTION

The MODULATION TRANSFER FUNCTION shall be calculated, the FWHM and the FWTM in water shall be determined according to the definitions A11.2.2 and A11.2.4.

Graphs shall be made showing the DETECTOR HEAD FWHM and FWTM as a function of the distance from the COLLIMATOR FRONT FACE.

4.2.3 Measurement of INTRINSIC FWHM and FWTM of GAMMA CAMERAS (COLLIMATOR REMOVED)

The LINE SPREAD FUNCTION is obtained by following the measuring procedure described in Sub-clause 4.2.1, using a line source of length 30 ± 5 mm mounted behind two lead blocks with a spacing of 1 mm and minimum thickness of 50 mm in such a way that a collimated line source is produced.

Measurements shall be made at the centre of the detector by consecutively aligning the source to the X- and Y-axis of the detector giving two sets of values for the intrinsic resolution (FWHM and FWTM). Identical measurements should be made at a position not less than 30 mm from the border of the DETECTOR FIELD OF VIEW, with the centre of the source on a radius at 45° to the major axis, giving another two sets of values for the intrinsic resolution.

4.3 NON-UNIFORMITY OF RESPONSE (GAMMA CAMERA DETECTOR HEAD)

4.3.1 Measurement of NON-UNIFORMITY OF RESPONSE (GAMMA CAMERA DETECTOR HEAD)

The measurement shall be performed using a parallel hole COLLIMATOR appropriate to the radionuclide used. The source as defined in A12 and Figure 3, page 18, shall be placed as close as possible to the COLLIMATOR FRONT FACE. The pixel size shall be equal to or less than the square of twice the FWHM at 20 mm from the COLLIMATOR FRONT FACE, and stated. The mean counts per pixel shall be more than 10 000 and stated.

4.3.2 Evaluation of NON-UNIFORMITY OF RESPONSE (GAMMA CAMERA DETECTOR HEAD)

All values of the uniformity measurement values shall be valid for the DETECTOR FIELD OF VIEW as defined.

4.3.2.1 Non-uniformity distribution

The distribution of non-uniformity over the DETECTOR FIELD OF VIEW shall be evaluated in the following way:

a) The number of pixels for which the count rate deviates more than 15% from the mean pixel count rate shall be determined and expressed as a percentage of the total number of pixels within the DETECTOR FIELD OF VIEW.

b) The number of pixels for which the count rate deviates more than 10% from the mean pixel count rate shall be determined and expressed as a percentage of the total number of pixels within the DETECTOR FIELD OF VIEW.

c) The number of pixels for which the count rate deviates more than 5% from the mean pixel count rate shall be determined and expressed as a percentage of the total number of pixels within the DETECTOR FIELD OF VIEW.

4.3.2.2 Integral non-uniformity

The maximum deviations of the count rate from the mean count rate within the DETECTOR FIELD OF VIEW shall be determined and expressed as percentages of the mean value of the count rate.

4.3.2.3 Differential non-uniformity

The maximum difference in count rate between two adjacent pixels shall be determined and expressed as a percentage of the greater count rate value of those two pixels.

4.4 Shield leakage test

See Sub-clause 3.5.

4.5 COUNT RATE CHARACTERISTIC

A cylindrical phantom described in Sub-clause 4.1 and Figure 2, page 18 shall be used. The air gap between the surface of the phantom and the COLLIMATOR FRONT FACE shall be not more than 10 mm ($d \leq 20$ mm). A graph shall be produced for one of the nuclides with energy between 100 keV and 200 keV and may be produced for one with energy between 300 keV and 400 keV specified in Table I showing the observed count rate as a function of the TRUE COUNT RATE when the ACTIVITY of the source is varied.Images of the source shall be produced, together with profiles in the X- and Y-direction over the centre of the source: one pair of profiles at a measured count rate of approximately 1000 counts/s, one pair at a measured count rate of approximately 25 000 counts/s and one pair at a measured count rate of approximately 50 000 counts/s.

The observed count rate which is 80% of the TRUE COUNT RATE shall be stated.

5. ACCOMPANYING DOCUMENTS

A document shall accompany each radionuclide imaging device and shall include the following information :

5.1 GAMMA CAMERAS and RADIONUCLIDE SCANNERS

5.1.1 COLLIMATORS:

Photon energy ranges, Type (parallel holes, pinhole, converging, diverging, slit, focusing, etc.)

GEOMETRICAL FOCAL DISTANCE,
Number of holes,
Minimum septum thickness,
COLLIMATOR thickness.

5.1.2 PLANE SENSITIVITY for each COLLIMATOR.

5.1.3 DEPTH OF FOCUS for each COLLIMATOR.

5.1.4 Shield leakage diagram, as specified in Sub-clause 3.5.

5.1.5 Pre-set PULSE AMPLITUDE ANALYSER WINDOWS.

5.1.6 Energy resolution, measured with the COLLIMATOR in place, using a cuvette as described in Sub-clause 3.1 and Figure 1, page 18, containing the specified nuclide. It should be expressed as FULL WIDTH AT HALF MAXIMUM of the total absorption peak for Tc-99m.

5.1.7 Graphs showing for each COLLIMATOR the following quantities:

5.1.7.1 LINE SPREAD FUNCTION at different depths as specified in Sub-clauses 3.2.1 or 4.2.1.

5.1.7.2 FWHM and FWTM as a function of the depth.

5.1.7.3 MODULATION TRANSFER FUNCTIONS at different depths.

5.1.8 COUNT RATE CHARACTERISTIC(S) as described in Sub-clause 3.3 or 4.5.

5.1.9 Statement about the range of environmental conditions (temperature, rate of change of temperature, humidity, mains voltage) to which the specification applies.

5.2 GAMMA CAMERAS

5.2.1 Dimensions of the DE:`CTOR FIELD OF VIEW.*

5.2.2 Values for the following non-uniformity characteristics with a specified nuclide. If an instrument incorporates optionally usable uniformity correction, the results shall be provided with and without correction.

5.2.2.1 Non-uniformity distribution as specified in Sub-clause 4.3.2.1.

5.2.2.2 Integral non-uniformity of the count rate as specified in Sub-clause 4.3.2.2.

5.2.2.3 Differential non-uniformity as specified in Sub-clause 4.3.2.3.

5.2.3 INTRINSIC FWHM and FWTM of the radiation detector as specified in Sub-clause 4.2.3.

5.2.4 Observed count rate which is 80% of the TRUE COUNT RATE.

5.2.5 Recommended intervals between camera adjustments.

5.3 RADIONUCLIDE SCANNERS

5.3.1 Dimensions of the SCANNING Field.

5.3.2 Scan LINE SPACING.

5.3.3 SCANNING MODES.

5.3.4 SCANNING SPEEDS or step lengths and intervals.

5.3.5 Maximum deviation from the mean speed.

5.3.6 EFFECTIVE FOCAL DISTANCE for each COLLIMATOR.

5.3.7 NEAR and FAR FOCUS LIMITS for each COLLIMATOR.

5.3.8 Observed count rate which is 90% of TRUE COUNT RATE.

TABLE I

* *It is envisaged that manufacturers can give additional performance values for other FIELDS OF VIEW of specified dimensions, for example a CENTRAL FIELD OF VIEW.*

Radionuclides and pulse Amplitude ANALYSER WINDOWS to be used for performance measurements

Design energy up to keV	Radionuclide	Analyser window keV
140	Tc-99^{m} or Ce-141*	141±10%(127-155) 145±10% (130-160)
360	I-131 or Ba-133	364±10%(328-400) 356±10% (320-392)
400	In-113^{m}	393±10% (354-432)
500	Sr-85	514±10% (463-565)

* *Ce-141 emits photons with about the same energy (145 keV) as Tc-99m (141 keV), but it has a much longer half-life, 32 days, compared with 6 h for Tc-99m.*

It is therefore better suited for time consuming measurements.

Because the characteristics of a GAMMA CAMERA may change noticeably between 122 keV (Co-57) and 141 keV (Tc-99m), the former is not included as a suitable radionuclide. However, it may be useful in some circumstances, e.g. for quality control.

TABLE II

QUANTITIES AND UNITS

QUANTITY	CONVENTIONAL UNIT	PREFERRED S.I UNIT
Activity	curie (Ci) 1 Ci = $3.7 \times 10^{10} s^{-1}$	becquerel (Bq) 1 Bq = 1 s^{-1}
Depth of Focus	mm	mm
Effective Focal Distance	mm	mm
FWHM, FWTM	mm	mm
Geometrical Focal Distance	mm	mm
Plane Sensitivity	$\frac{counts}{\mu Ci.s}$	$counts.s^{-1}.Bq^{-1}$
Line Spacing	mm	mm
Sensitivity Specific Plane (Radionuclide Scanner)	$\frac{counts.cm^2}{\mu Ci.s}$	$mm^2.counts.s^{-1}.Bq^{-1}$
Resolving Time	µs	µs
Scanning Field	cm^2	m^2
Scanning Speed	$cm.s^{-1}$	$mm.s^{-1}$
Spatial frequency	mm^{-1}	mm^{-1}

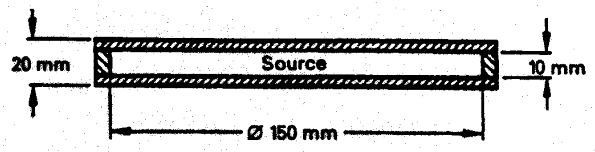
REFERENCES

1) *Government Gazette no R1302, June 1991 concerning regulations governing Group III Hazardous substances.*

2) *IEC Publication 789-Characteristics and test conditions of radionuclide imaging devices 1984.*

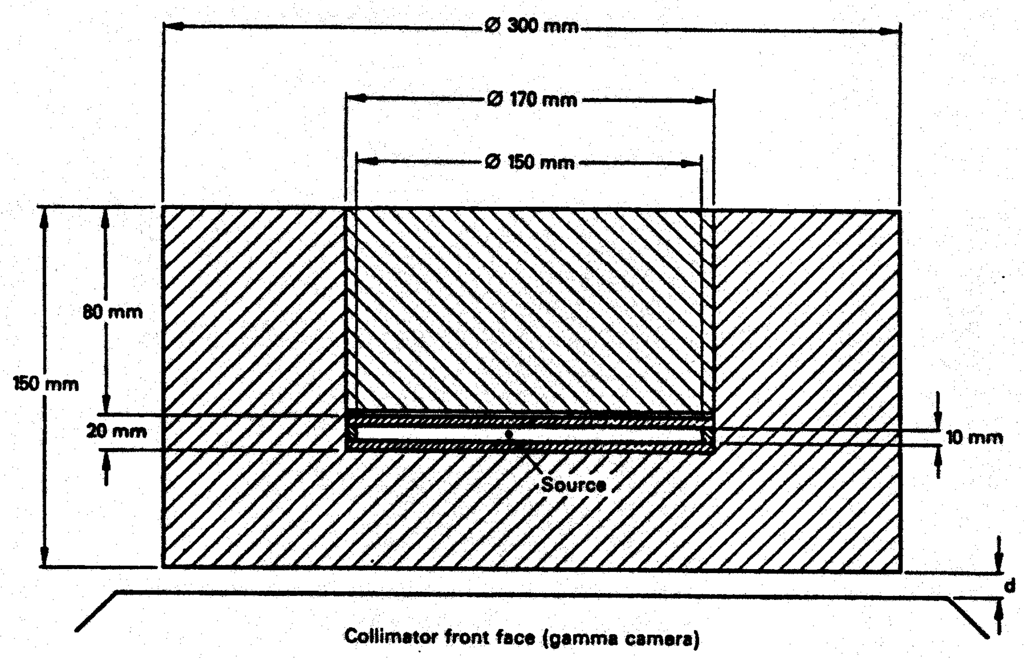
3) *IAE- TECDOC-602-Quality Control of nuclear medicine instruments 1991.*

4) *HPA-Quality Control of nuclear medicine instrumentation.*



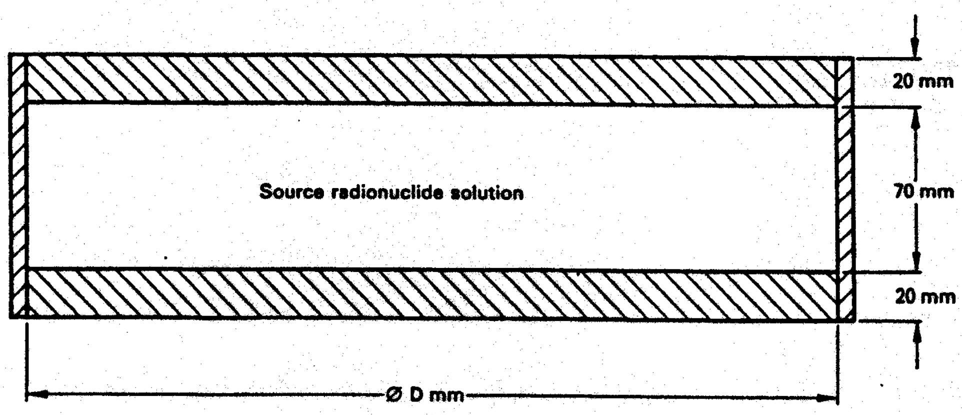
Material: polymethyl methacrylate

FIG. 1. — Cuvette



Material: polymethyl methacrylate

FIG. 2. — Cylindrical phantom



Material: polymethyl methacrylate

FIG. 3. — Uniformity source