

Methods of test for

Anger type gamma cameras

The European Standard EN 60789:1993 has the status of a
British Standard

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Health Care Standards Policy Committee (HCC/-) to Technical Committee HCC/82, upon which the following bodies were represented:

- Association of X-ray Equipment Manufacturers (BEAMA Ltd.)
- British Institute of Radiology
- British Nuclear Medicine Society
- College of Radiographers
- Department of Health
- Department of Trade and Industry (National Physical Laboratory)
- Institute of Physical Sciences in Medicine (IPSM)
- Institution of Electrical Engineers
- Royal College of Physicians of London

This British Standard, having been prepared under the direction of the Health Care Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 1 May 1992

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National foreword

This British Standard has been prepared under the direction of the Health Care Standards Policy Committee. It is identical with IEC 789:1992 “*Characteristics and test conditions of radionuclide imaging devices; Anger type gamma cameras*”, prepared under the direction of Subcommittee SC 62C High-energy equipment and equipment for nuclear medicine, and published by the International Electrotechnical Commission (IEC).

In 1993 the European Committee for Electrotechnical Standardization (CENELEC) accepted IEC 789:1992 as European Standard EN 60789:1993. As a consequence of implementing the European Standard this British Standard is renumbered as BS EN 60789 and any reference to BS 6609 should be read as a reference to BS EN 60789.

It replaces BS 6609:1985, which is now withdrawn. It is expected that CENELEC will in due course ratify IEC 789:1992 as a European Standard to replace the Harmonization Document HD 502.

The General Standard mentioned in the introduction of IEC 789 is IEC 601-1:1988 which is identical with BS 5724 “*Medical electrical equipment — Part 1: 1989 General requirements for safety*”.

Cross-references

International Standard	Corresponding British Standard
IEC 788:1984	BS 6641:1985 <i>Glossary of medical radiology terms</i> (Identical)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Descriptors: Medical electrical equipment, radiology, radiology equipment, gamma ray, imaging device, test conditions

English version

Characteristics and test conditions of radionuclide imaging devices; Anger type gamma cameras

(IEC 789:1992)

Caractéristiques et conditions d'essai des dispositifs d'imagerie par radionucléides; gamma caméras de type Anger
(CEI 789:1992)

Merkmale und Prüfbedingungen für bildgebende Systeme in der Nuklearmedizin; Einkristall Gamma-Kameras
(IEC 789:1992)

This European Standard was approved by CENELEC on 1993-07-06. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

At the request of CENELEC Technical Committee TC 62, Electrical equipment in medical practice, the International Standard IEC 789:1992 was submitted to the CENELEC Unique Acceptance Procedure (UAP) for acceptance as an European Standard. This procedure started in October 1992.

The text of the International Standard was approved by CENELEC as EN 60789 on 6 July 1993.

The following dates were proposed:

- latest date of publication of
an identical national standard (dop) 1994-06-01
- latest date of withdrawal of
conflicting national standards (dow) 1994-06-01

For products which have complied with the relevant national standard before 1994-06-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1999-06-01.

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative.

Introduction

This is a revised, second edition of IEC 789 (1984). The title has been changed from “Characteristics and test conditions of radionuclide imaging devices” to “Characteristics and test conditions of radionuclide imaging devices; Anger type gamma cameras”, due to the fact that the parts dealing with radionuclide scanners and hybrid systems in the earlier edition have been omitted in this revision, because these devices are now of minor importance.

The test methods specified in this Standard have been selected to reflect as much as possible the clinical use of GAMMA CAMERAS. It is intended that the test methods be carried out by manufacturers, thereby enabling them to declare the characteristics of GAMMA CAMERAS on a common basis.

To come to a closer agreement, some of the requirements have been aligned with those of NEMA¹⁾ Standards Publication NU 1 (1986) and some tests have been added [Measurement of INTRINSIC NON-UNIFORMITY OF RESPONSE (3.3.1), Measurement of intrinsic point source sensitivity variation (3.3.4), Measurement of INTRINSIC ENERGY SPECTRUM (3.4), Measurement of INTRINSIC MULTIPLE WINDOW SPATIAL REGISTRATION (3.5)].

With regard to the measurement and evaluation of the NON-UNIFORMITY OF RESPONSE (3.3.3), the smoothing operation on the raw data enhances the visual perception of the NON-UNIFORMITY OF RESPONSE (3.3.3.1 through 3.3.3.3).

Also, the NEMA requirements for the measurement and evaluation of the INTRINSIC SPATIAL NON-LINEARITY give adequate results and avoid the necessity of specifying yet another phantom (3.6.1 and 3.6.2).

In this Standard, the following print types are used:

- requirements, compliance with which can be tested and definitions: in roman type;
- explanations, advice, introductions, general statements, exceptions and references: in smaller roman type;
- *test specifications: in italic type;*
- TERMS DEFINED IN CLAUSE 2 OF THE GENERAL STANDARD OR THIS STANDARD: SMALL CAPITALS.

The requirements are followed by specifications for the relevant tests.

1 Scope and object

The object of this Standard is to specify terminology and test methods for declaring the characteristics of Anger type GAMMA CAMERAS. These consist of a COLLIMATOR, a DETECTOR SHIELD, and a RADIATION DETECTOR ASSEMBLY, together with recording and display devices.

2 Terminology and definitions

For the purposes of this Standard, the definitions given in IEC 788 apply, together with the supplementary definitions given in Annex A.

Defined terms are printed in small capitals.

3 Test methods

All measurements shall be performed with the PULSE AMPLITUDE ANALYSER WINDOW settings specified in Table 1.

Additional measurements with other settings, as specified by the manufacturer, can be performed. Before the measurements are performed the camera shall be adjusted by the procedure normally used by the manufacturer for an installed unit and shall not be adjusted specially for the measurement of specific parameters.

Unless otherwise specified, measurements shall be carried out at count rates not exceeding 20 000 counts per second.

¹⁾ National Electrical Manufacturers Association, 2101 L Street, N.W., Washington, D.C. 20037, U.S.A.

3.1 Measurements of SYSTEM SENSITIVITY

The measurement shall be carried out using the cylindrical phantom of polymethyl-methacrylate as specified in Figure 2. The plane source shown in Figure 1 shall be placed in the cylindrical hole with the dimensions shown in Figure 2, the remainder of the hole shall then be filled by a cylindrical part the dimensions of which are also shown in Figure 2. The phantom, including the source, shall be placed on the COLLIMATOR (distance $d = 0$) and centered on the COLLIMATOR AXIS.

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

NOTE Measurements of SYSTEM SENSITIVITY without scatter, using the source cuvette of Figure 1 placed directly on the COLLIMATOR FRONT FACE, may be carried out.

3.2 LINE SPREAD FUNCTION, FWHM, FWTM and EW

3.2.1 Measurement of the LINE SPREAD FUNCTION with COLLIMATOR

A solution containing a selected radionuclide shall be placed in a tube with an inner diameter of 1 mm and length approximately equal to the width of the FIELD OF VIEW. This tube shall be placed with its axes perpendicular to the COLLIMATOR AXIS and aligned parallel to one of the electronic axes at the depth of measurement in water or water-equivalent material covering the whole FIELD OF VIEW. 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 200 mm.

The measured quantity $L(x)$, for example the number of counts, shall be integrated within sets of areas with length not more than 30 mm and parallel to the line source and width equal to or less than 10 % of the FULL WIDTH AT HALF MAXIMUM (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 shall be to a point where the measured quantity is 1 % of its maximum value, or up to the border of the DETECTOR FIELD OF VIEW. The measured number of counts at the maximum of the LINE SPREAD FUNCTION shall be at least 10 000 at each distance from the COLLIMATOR. If some other quantity is measured, provision shall be made to obtain the same statistical accuracy. The measurement shall be carried out in three parallel planes with the center of the sources at 50, 100 and 150 mm from the COLLIMATOR FRONT FACE and the source aligned parallel to the X- and Y-electronic axes. A radionuclide appropriate to the COLLIMATOR in use shall be chosen from Table 1.

3.2.2 Measurement of the INTRINSIC LINE SPREAD FUNCTION

A multiple slit transmission phantom shall be used as shown in Figure 4.

NOTE This phantom is only suitable for energies equal to or less than 140 keV.

The slit transmission phantom covering the entire FIELD OF VIEW shall be placed at the centre of the detector face (COLLIMATOR removed) and the area outside the FIELD OF VIEW shall be shielded with lead.

An uncollimated shielded source shall be positioned vertically above the centre of the phantom at a distance of at least five times the maximum linear dimension of the circular FIELD OF VIEW (2 m for a 40 cm circular FIELD OF VIEW camera, Figure 5). The orientation of the phantom shall be adjusted until its slit axis is aligned parallel to the X- or Y-electronic axis. Digital data shall be acquired with a pixel size equal to or less than 10 % of the intrinsic FWHM. The peak pixel number of counts shall be greater than 1 000. Profiles of width $30 \text{ mm} \pm 5 \text{ mm}$ shall be obtained at right angles to the slit axis.

3.2.3 Evaluation of the measurement of the LINE SPREAD FUNCTION

From the measured LINE SPREAD FUNCTIONS (3.2.1 and 3.2.2) the following data shall be obtained:

- The calculated MODULATION TRANSFER FUNCTION (MTF) from the measurements described in 3.2.1, presented as a set of graphs with linear scaling;
- The FWHM, FULL WIDTH AT TENTH MAXIMUM (FWTM) and EQUIVALENT WIDTH (EW) values from the measurements described in both 3.2.1 and 3.2.2.

3.3 NON-UNIFORMITY OF RESPONSE

3.3.1 Measurement of INTRINSIC NON-UNIFORMITY OF RESPONSE (without COLLIMATOR)

A source holder and a source shall be positioned as shown in Figure 5. Regions outside the DETECTOR FIELD OF VIEW shall be shielded with lead. The source shall be selected from Table 1 and stated. The length of the pixel side shall be equal to or less than twice the FWHM of the INTRINSIC LINE SPREAD FUNCTION and stated. The mean number of counts per pixel shall be greater than 10 000 and stated.