

Radiotherapy equipment — Coordinates, movements and scales

ICS 11.040.50; 13.280

National foreword

This British Standard is the UK implementation of EN 61217:1996+A2:2008. It is identical with IEC 61217:1996, incorporating amendment 2:2007. It supersedes BS EN 61217:1996+A1:2001 which will be withdrawn on 1 February 2011.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted by Technical Committee CH/62, Electromedical equipment in medical practice, to Subcommittee CH/62/3, Equipment for radiotherapy, nuclear medicine and radiation dosimetry.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

A Rationale for the changes in the IEC scale is given in Annex C. It is considered that a knowledge of the reasons for the changes will not only facilitate the proper application of the standard, but will expedite any subsequent revision. This annex does not form a normative part of the standard.

Textual errors. When implementing the English language version of EN 61217 as the national standard, the textual errors listed below were discovered. They have been reported to the European Committee for Electrotechnical Standardization (CENELEC) in a proposal to amend the text of the European Standard.

In Figure 16i, the entry in the column headed Edge X1 against element 06 should read “–05,5” and not “–05,0”.

In the row in Figure 16k, the second “05” should be “06”.

In Figure 16k the column headings “Size FX”, “Edge X1” and “Edge X2” should be “Size FY”, “Edge Y1” and “Edge Y2” respectively.

In Figure 16k, the entry in the column headed Edge Y2 against element 06 should read “+5,5” and not “05,5”.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Board and comes into effect on 15 June 1997

© BSI 2008

ISBN 978 0 580 64267 8

Amendments/corrigenda issued since publication

Amd. No.	Date	Comments
13331	15 February 2002	See national foreword
	30 September 2008	Implementation of IEC amendment 2:2007 with CENELEC endorsement A2:2008, and alignment of BSI and CENELEC publication dates

ICS 11.040.50; 13.280

Descriptors: Electromedical equipment, radiotherapy, movements, scales

English version

Radiotherapy equipment — Co-ordinates, movements and scales

(IEC 61217:1996)

Appareils utilisés en radiothérapie —
Coordonnées, mouvements et échelles
(CEI 61217:1996)

Strahlentherapie-Einrichtungen —
Koordinaten, Bewegungen und Skalen
(IEC 61217:1996)

This European Standard was approved by CENELEC on 1996-07-02. 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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

© 1996 Copyright reserved to CENELEC members

 **Documents**
Ref. No. EN 61217:1996+A2

Foreword

The text of document 62C/143/FDIS, future edition 1 of IEC 1217, prepared by SC 62C, Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC TC 62, Electrical equipment in medical practice, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61217 on 1996-07-02.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-05-01

Endorsement notice

The text of the International Standard IEC 1217:1996 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of document 62C/279/FDIS, future amendment 1 to IEC 61217:1996, prepared by SC 62C, Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC TC 62, Electrical equipment in medical practice, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 61217:1996 on 2000-12-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2001-09-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2003-12-01

Endorsement notice

The text of amendment 1:2000 to the International Standard IEC 61217:1996 was approved by CENELEC as an amendment to the European Standard without any modification.

Foreword to amendment A2

The text of document 62C/418/CDV, future amendment 2 to IEC 61217:1996, prepared by SC 62C, Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC TC 62, Electrical equipment in medical practice, was submitted to the IEC-CENELEC parallel Unique Acceptance Procedure and was approved by CENELEC as amendment A2 to EN 61217:1996 on 2008-02-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2008-11-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2011-02-01

Endorsement notice

The text of amendment 2:2007 to the International Standard IEC 61217:1996 was approved by CENELEC as an amendment to the European Standard without any modification.

Contents

	Page	Page
Foreword	2	
Introduction	5	
1 Scope and object	6	
2 Coordinate systems	6	
2.1 General rules	6	
2.2 Fixed reference system ("f") (Figure 1a)	7	
2.3 GANTRY coordinate system ("g") (Figure 4)	8	
2.4 BEAM LIMITING DEVICE or DELINEATOR coordinate system ("b") (Figure 5)	8	
2.5 WEDGE FILTER coordinate system ("w") (Figure 7)	8	
2.6 X-RAY IMAGE RECEPTOR coordinate system ("r") (Figure 6 and Figure 8)	9	
2.7 PATIENT SUPPORT coordinate system ("s") (Figure 9)	9	
2.8 Table top eccentric rotation coordinate system ("e") (Figure 10 and Figure 11)	9	
2.9 Table top coordinate system ("t") (Figures 10, 11, 18 and 19)	10	
3 Identification of scales and digital DISPLAYS	11	
4 Designation of EQUIPMENT movements	11	
5 EQUIPMENT zero positions	12	
6 List of scales, graduations, directions and DISPLAYS	13	
6.1 Rotation of the GANTRY (Figure 14a and Figure 14b)	13	
6.2 Rotation of the BEAM LIMITING DEVICE or DELINEATOR (Figure 15a and Figure 15b)	13	
6.3 Rotation of the WEDGE FILTER (Figure 7 and Figure 14a)	13	
6.4 RADIATION FIELD or DELINEATED RADIATION FIELD	13	
6.5 PATIENT SUPPORT ISOCENTRIC rotation	15	
6.6 Table top eccentric rotation	15	
6.7 Table top linear and angular movements	15	
6.8 X-RAY IMAGE RECEPTOR movements	16	
6.9 Other scales	17	
Annex A (informative) Examples of coordinate transformations between individual coordinate systems	52	
Annex B (informative) Bibliography	58	
Annex C (informative) Rationale for changes in IEC scales	58	
Annex D (informative) Summary of additions and changes to scale statements in IEC 601-2-1, IEC 601-2-11, IEC 976 and IEC 977		60
Annex E (informative) Terminology		61
Annex F (informative) Coordinate transformations between IEC and DICOM PATIENT coordinates		62
Figure 1a — Coordinate systems (see 2.1.2) with all angular positions set to zero		18
Figure 1b — Translation of origin I_d along X_m , Y_m , Z_m and rotation around axis Z_d parallel to Z_m (see 2.1.4)		19
Figure 1c — Translation of origin I_d along X_m , Y_m , Z_m and rotation around axis Y_d parallel to Y_m (see 2.1.4)		19
Figure 2 — X Y Z right-hand coordinate mother system (isometric drawing), showing ψ , ϕ , θ directions of positive rotation for daughter system (see 2.2)		20
Figure 3 — Hierarchical structure among coordinate systems (see 2.1.3 and 2.1.5)		21
Figure 4 — Rotation ($\phi_g = 15^\circ$) of GANTRY coordinate system X_g , Y_g , Z_g in fixed coordinate system X_f , Y_f , Z_f (see 2.3)		22
Figure 5 — Rotation ($\theta_b = 15^\circ$) of BEAM LIMITING DEVICE or DELINEATOR coordinate system X_b , Y_b , Z_b in GANTRY coordinate system X_g , Y_g , Z_g and resultant rotation of RADIATION FIELD or DELINEATED RADIATION FIELD of dimensions FX and FY (see 2.4)		23
Figure 6 — Displacement of image intensifier type X-RAY IMAGE RECEPTOR coordinate system origin, I_r , in GANTRY coordinate system, by $R_x = -8$, $R_y = +10$, $R_z = -40$ (see 2.6)		24
Figure 7 — Rotation ($\theta_w = 270^\circ$) and translation of WEDGE FILTER coordinate system X_w , Y_w , Z_w in BEAM LIMITING DEVICE coordinate system X_b , Y_b , Z_b , the BEAM LIMITING DEVICE coordinate system having a rotation (θ_b) of 345° (see 2.5)		25
Figure 8 — Rotation ($\theta_r = 90^\circ$) and displacement of RADIOGRAPHIC CASSETTE type X-RAY IMAGE RECEPTOR coordinate system X_r , Y_r , Z_r in GANTRY coordinate system X_g , Y_g , Z_g (see 2.6)		26
Figure 9 — Rotation ($\theta_s = 345^\circ$) of PATIENT SUPPORT coordinate system X_s , Y_s , Z_s in fixed coordinate system X_f , Y_f , Z_f (see 2.7)		27
Figure 10 — Table top eccentric coordinate system rotation θ_e in PATIENT SUPPORT coordinate system which has been rotated by θ_s in the fixed coordinate system with $\theta_e = 360^\circ - \theta_s$ (see 2.8 and 2.9)		28

	Page	Page
Figure 11a — Table top displaced below ISOCENTRE by $T_z = -20$ cm (see 2.8 and 2.9)	29	Figure 16b — Rectangular and asymmetrical in Yb RADIATION FIELD or DELINEATED RADIATION FIELD, viewed from RADIATION SOURCE (see 6.4)
Figure 11b — Table top coordinate system displacement $T_x = +5$, $T_y = L_e + 10$ in PATIENT SUPPORT coordinate system X_s , Y_s , Z_s rotation ($\theta_s = 330^\circ$) in fixed coordinate system X_f , Y_f , Z_f (see 2.8 and 2.9)	29	Figure 16c — Rectangular and asymmetrical in Xb RADIATION FIELD or DELINEATED RADIATION FIELD, viewed from RADIATION SOURCE (see 6.4)
Figure 11c — Table top coordinate system rotation ($\theta_e = 30^\circ$) about table top eccentric system. PATIENT SUPPORT rotation ($\theta_s = 330^\circ$) in fixed coordinate system $T_x = 0$, $T_y = L_e$ (see 2.8 and 2.9)	29	Figure 16d — Rectangular and asymmetrical in Xb and Yb RADIATION FIELD or DELINEATED RADIATION FIELD, viewed from RADIATION SOURCE (see 6.4)
Figure 12a — Example of BEAM LIMITING DEVICE scale, pointer on mother system (GANTRY), scale on daughter system (BEAM LIMITING DEVICE), viewed from isocentre (see 2.1.6.2 and clause 3)	29	Figure 16e — Rectangular and symmetrical RADIATION FIELD, rotated by $\theta_b = 30^\circ$, viewed from RADIATION SOURCE (see 6.4)
Figure 12b — Example of BEAM LIMITING DEVICE scale, pointer on daughter system (BEAM LIMITING DEVICE), scale on mother system (GANTRY), viewed from ISOCENTRE (see 2.1.6.2 and clause 3)	30	Figure 16f — Rectangular and asymmetrical in Yb RADIATION FIELD, rotated by $\theta_b = 30^\circ$, viewed from RADIATION SOURCE (see 6.4)
Figure 12c — Examples of scales (see clause 3)	30	Figure 16g — Rectangular and asymmetrical in Xb RADIATION FIELD, rotated by $\theta_b = 30^\circ$, viewed from RADIATION SOURCE (see 6.4)
Figure 13a — Rotary GANTRY (adapted from IEC 601-2-1) with identification of axes 1 to 8, directions 9 to 13 and dimensions 14 and 15 (see clause 4)	31	Figure 16h — Rectangular and asymmetrical in Xb and Yb RADIATION FIELD, rotated by $\theta_b = 30^\circ$, viewed from RADIATION SOURCE (see 6.4)
Figure 13b — ISOCENTRIC RADIOTHERAPY SIMULATOR or TELERADIOTHERAPY EQUIPMENT, with identification of axes 1; 4 to 6; 19, of directions 9 to 12; 16 to 18 and of dimensions 14; 15; 20 to 23 (see clause 4)	32	Figure 16i — Irregular multi-element (multileaf) contiguous RADIATION FIELD, viewed from RADIATION SOURCE, with element motion in Xb direction (see 6.4)
Figure 13c — View from RADIATION SOURCE of TELERADIOTHERAPY RADIATION FIELD or RADIOTHERAPY SIMULATOR DELINEATED RADIATION FIELD (see clause 4)	33	Figure 16j — Irregular multi-element (multileaf) two-part RADIATION FIELD, viewed from RADIATION SOURCE, with element motion in Xb direction (see 6.4)
Figure 14a — Example of ISOCENTRIC TELERADIOTHERAPY EQUIPMENT (see 6.1 and 6.3)	34	Figure 16k — Irregular multi-element (multileaf) contiguous RADIATION FIELD, viewed from RADIATION SOURCE, with element motion in Yb direction (see 6.4)
Figure 14b — Example of ISOCENTRIC RADIOTHERAPY SIMULATOR EQUIPMENT (see 6.1)	35	Figure 17a — PATIENT coordinate system (PATIENT is supine)
Figure 15a — Rotated ($\theta_b = 30^\circ$) symmetrical rectangular RADIATION FIELD ($F_X \times F_Y$) at NORMAL TREATMENT DISTANCE, viewed from beyond ISOCENTRE looking toward RADIATION SOURCE (see 6.2)	36	Figure 17b — Rotation of PATIENT coordinate system
Figure 15b — Same rotated ($\theta_b = 30^\circ$) symmetrical rectangular radiation field ($F_X \times F_Y$) at normal treatment distance, viewed from radiation source (see 6.2)	37	Figure F.1 — Coordinate transformations between IEC and DICOM PATIENT coordinates
Figure 16a — Rectangular and symmetrical RADIATION FIELD or DELINEATED RADIATION FIELD, viewed from RADIATION SOURCE (see 6.4)	38	Table 1 — EQUIPMENT movements and designations
	38	Table 2 — Individual coordinate systems
	39	Table A.1 — Rotation matrices

Introduction

RADIO THERAPY is performed in medical centres where a variety of EQUIPMENT from different MANUFACTURERS is usually concentrated in the radiotherapy department. In order to plan and simulate the treatment, set up the PATIENT and direct the RADIATION BEAM, such EQUIPMENT can be put in different angular and linear positions and, in the case of MOVING BEAM RADIO THERAPY, can be rotated and translated during the IRRADIATION OF THE PATIENT. It is essential that the position of the PATIENT, and the dimensions, directions, and qualities of the RADIATION BEAM prescribed in the treatment plan, be set up or varied by programmes on the RADIO THERAPY EQUIPMENT with accuracy and without misunderstanding. Standard identification and scaling of coordinates is required for equipment used in RADIO THERAPY, including RADIO THERAPY SIMULATORS, because differences in the marking and scaling of similar movements on the various types of EQUIPMENT used in the same department may increase the probability of error. In addition, data from EQUIPMENT used to evaluate the tumour region, such as ultrasound, X-ray, CT and MRI should be presented to the treatment planning system in a form which is consistent with the RADIO THERAPY coordinate system. Coordinate systems for individual geometrical parameters are required in order to facilitate the mathematical transformation of points and vectors from one coordinate system to another.

A goal of this standard is to avoid ambiguity, confusion, and errors which could be caused when using different types of EQUIPMENT. Hence, its scope applies to all types of TELERADIO THERAPY EQUIPMENT, RADIO THERAPY SIMULATORS, information from diagnostic EQUIPMENT when used for RADIO THERAPY, recording and verification EQUIPMENT, and to data input for the treatment planning process.

Movement nomenclature is to be classified as defined terms according to IEC 788 and Appendix AA of IEC 601-2-1 and IEC 601-2-29 (see Annex E).

This standard is issued as a publication separate from the 601 series of safety standards. It is not a safety code and does not contain performance requirements. Thus, the present requirements will not appear in future editions of the IEC 601-2 series, which deals exclusively with safety requirements.

IEC 601-2-1, IEC 601-2-11, IEC 601-2-29, IEC 976, IEC 977, IEC 1168 and IEC 1170 include equipment movements and scale conventions. A number of changes and additions have been made in this standard. These are summarized in Annex D.

A major value of a standard coordinate system is its contribution to safety in RADIO THERAPY treatment planning. The scales that are demonstrated in this standard are consistent with the coordinate systems described herein. USERS may use other scale conventions. It is anticipated that MANUFACTURERS will normally employ the scale conventions of this standard for new EQUIPMENT.

If MANUFACTURERS provide other optional scale conventions when requested by USERS, such as to match existing EQUIPMENT in a USER'S facility or to comply with local convention or regulations, such EQUIPMENT cannot be said to comply with this standard.

It is also anticipated that MANUFACTURERS may provide, as options, scales to convert a user's existing EQUIPMENT to the scale conventions of this standard.

This standard does not address non-ISOCENTRIC EQUIPMENT and pitch or roll movements of the RADIATION HEAD, due to limited clinical use.

It is anticipated that future amendments may address the following:

- PATIENT coordinate system;
- Three-dimensional RADIO THERAPY SIMULATORS;
- CT type RADIO THERAPY SIMULATORS;
- non-ISOCENTRIC EQUIPMENT.

1 Scope and object

This International Standard applies to EQUIPMENT and data related to the process of TELERADIOETHERAPY, including PATIENT image data used in relation with RADIOETHERAPY treatment planning systems, RADIOETHERAPY SIMULATORS, ISOCENTRIC GAMMA BEAM THERAPY EQUIPMENT, ISOCENTRIC MEDICAL ELECTRON ACCELERATORS, and non-ISOCENTRIC EQUIPMENT when relevant.

The object of this standard is to define a consistent set of coordinate systems for use throughout the process of TELERADIOETHERAPY, to define the marking of scales (where provided), to define the movements of EQUIPMENT used in this process, and to facilitate computer control when used.

2 Coordinate systems

An individual coordinate system is assigned to each major part of the EQUIPMENT which can potentially be moved in relation to another part, as illustrated in Figure 1a and summarized in Table 1. Furthermore a fixed reference system is defined. Each major part (e.g. GANTRY, RADIATION HEAD) is always stationary with respect to its own coordinate system.

Perspective views of an ISOCENTRIC MEDICAL ELECTRON ACCELERATOR and a RADIOETHERAPY SIMULATOR are shown in Figure 1a, Figure 14a and Figure 14b. Isometric projection drawings of coordinate systems are shown in several figures. In the figures, an elliptic (isometric projection) arrow around an axis of a coordinate system always shows clockwise rotation of that coordinate system about that axis when viewed from its origin and in the positive direction.

NOTE In the following description of individual coordinate systems, counter-clockwise (ccw) rotations are sometimes described in which the axis of rotation is not viewed from the origin of the individual coordinate system.

The definitions of coordinate systems, as stated in the following subclauses, allow mathematical transformations (rotation and/or translation) for the transfer of a point or vector coordinates in one system to any other coordinate system. See Annex A for examples of coordinate transformations.

2.1 General rules

2.1.1 All coordinate systems are Cartesian right-handed. The positive parameter directions of linear and angular movements between systems are identified in Figure 2. With all coordinate system angles set to zero, all coordinate system Z axes are vertically upward.

2.1.2 Coordinate axes are identified by a capital letter followed by a lower-case letter, representing coordinate system identification.

2.1.3 Coordinate systems have a hierarchical structure (mother-daughter relation) in the sense that each system is derived from another system. The common mother system is the fixed reference system. Figure 3 and Table 2 show the hierarchical structure which is divided into two sub-hierarchical structures, one in relation to the GANTRY, the second in relation to the PATIENT SUPPORT.

2.1.4 The position and orientation of each daughter coordinate system (d) is derived from its mother coordinate system (m) by translation of its origin I_d along one, two or three axes of its mother system and then by rotation of the daughter system about one of the daughter translated system axes.

NOTE The mechanical motions of parts of the EQUIPMENT may follow a different sequence, as long as the EQUIPMENT ends up in the same position and orientation as it would have done if the indicated sequence had been followed.

Figure 1b and Figure 1c show examples of translation of the daughter system origin I_d along the mother system coordinate axes X_m , Y_m , Z_m .

Figure 1b shows translation of origin I_d along X_m , Y_m , Z_m and rotation about axis Z_d which is parallel to Z_m .

Figure 1c shows translation of origin I_d along X_m , Y_m , Z_m and rotation about axis Y_d which is parallel to Y_m .

Example: The BEAM LIMITING DEVICE coordinate system is derived from the GANTRY system and the latter from the fixed system. Thus, a rotation of the GANTRY system causes an analogous rotation of the coordinate axes of the BEAM LIMITING DEVICE coordinate system in the fixed system and the origin of the BEAM LIMITING DEVICE system (position of the RADIATION SOURCE) is displaced in the fixed system (in space).

2.1.5 A point defined in one system can be defined in the coordinates of the next higher system (its mother) or the next lower system (its daughter) by applying a coordinate transformation, see Figure 3 and Annex A. Thus, it is possible to calculate, for a point defined in the BEAM LIMITING DEVICE system, its coordinates in the table top system by application of successive coordinate transformations (rotations and translations of the origin, as defined in 2.1.4), going first from the BEAM LIMITING DEVICE system upwards to the fixed system (i.e. BEAM LIMITING DEVICE system to GANTRY system to fixed system) and from this downwards to the table top system (i.e. fixed system to PATIENT SUPPORT system to table top eccentric rotation system, if available, to table top system). Such a coordinate transformation may considerably facilitate the solution of complex geometrical problems encountered in treatment planning, as well as minimize errors in the positioning of EQUIPMENT.

2.1.6 Notations

2.1.6.1 Capital letters are used for coordinate axis identification and lower-case letters are used for coordinate system identification.

Example: Yg means y axis of the GANTRY system.

2.1.6.2 The rotation of one coordinate system with respect to its mother system about one particular axis of its own system is designated by the rotation angle which identifies the axis about which it rotates (ψ about X, φ about Y, and θ about Z), and by a lower-case letter identifying the system involved.

Example: $\theta b = 30^\circ$ means rotation of the "b" system with respect to the "g" system by an angle of 30° (clockwise as viewed from ISOCENTRE) around axis Zb of the "b" system (see Figure 12a, Figure 12b and also Figure 5, where $\theta b = 15^\circ$).

2.1.6.3 The linear position of the origin of a coordinate system within its mother system is designated by capital letters identifying the daughter coordinate system and by the designation of the coordinate axis of the mother system along which it is translated.

Example: Ry = (numerical value) means position of the origin of the x-ray IMAGE RECEPTOR coordinate system along coordinate axis Yg (of its mother system).

2.1.6.4 For a movable component part which does not have its own coordinate system, its position within the system in which it moves is designated by a capital letter identifying the device in movement and a lower-case letter identifying the coordinate axis of the coordinate system along which it moves.

Example: X1 [Xb] = (numerical value) means position of RADIATION FIELD or DELINEATED RADIATION FIELD edge X1 along axis Xb of the BEAM LIMITING DEVICE system.

NOTE When a component part position can be displaced along only one coordinate axis, then the designation of this coordinate axis can be omitted. Thus, for the above example, X1 = (numerical value) is sufficient.

2.1.6.5 The position of a point within a coordinate system is given by the numerical values of its coordinates in that system.

Example: Coordinate values of a point in the X-RAY IMAGE RECEPTOR system:

$$x_r = +20 \text{ cm};$$

$$y_r = -10 \text{ cm};$$

$$z_r = 0 \text{ cm}.$$

A2 2.1.7 For rotational transformations involving more than one rotation the sequence of the rotations must be kept consistent. If the rotational sequence varies, the resulting transformation matrix and the orientation of the axis will be different.

The sequence in which the rotations shall be applied is the sequence in which these rotations are described in Clause 2 of this standard.

NOTE $M_{ab}^{-1} = M_{ba}$ (see Clause A.1). **A2**

2.2 Fixed reference system ("f") (Figure 1a)

The fixed coordinate system "f" is stationary in space. It is defined by a horizontal coordinate axis Yf directed from the ISOCENTRE toward the GANTRY, by a coordinate axis Zf directed vertically upward and by a coordinate axis Xf, normal to Yf and Zf and directed to the viewer's right when facing the GANTRY. For ISOCENTRIC EQUIPMENT the origin If is the ISOCENTRE Io and, therefore, Yf is the rotation axis of the GANTRY.

2.3 GANTRY coordinate system (“g”) (Figure 4)

The “g” coordinate system is stationary with respect to the GANTRY and its mother system is the “f” system. Its origin I_g is the ISOCENTRE. Its coordinate axis Z_g passes through and is directed towards the radiation source. Coordinate axes Y_g and Y_f coincide.

The “g” system is in the zero angular position when it coincides with the “f” system.

The rotation of the “g” system is defined by the rotation of coordinate axes X_g , Z_g by an angle ϕ_g about axis Y_g (therefore about Y_f of the “f” system).

An increase in the value of ϕ_g corresponds to a clockwise rotation of the GANTRY as viewed along the horizontal axis Y_f from the ISOCENTRE towards the GANTRY.

2.4 BEAM LIMITING DEVICE or DELINEATOR coordinate system (“b”) (Figure 5)

The “b” coordinate system is stationary with respect to the BEAM LIMITING DEVICE or DELINEATOR system and its mother system is the “g” system. Its origin I_b is the RADIATION SOURCE. Its coordinate axis Z_b coincides with and points in the same direction as axis Z_g . The coordinate axes X_b and Y_b are perpendicular to the corresponding edges X_1 , X_2 , Y_1 and Y_2 of the RADIATION FIELD or DELINEATED RADIATION FIELD (see 6.5).

NOTE The positions of the RADIATION FIELD edges are defined by the coordinate system. The coordinate system is not defined by the RADIATION FIELD edges.

For EQUIPMENT capable of variation of the distance from the ISOCENTRE to the RADIATION SOURCE (e.g. some RADIOTHERAPY SIMULATORS), this SAD-movement corresponds to a linear displacement of the “b” coordinate system along the Z_g axis of its mother system (“g” system).

The “b” system is in the zero angular position when the coordinate axes X_b , Y_b are parallel to and in the same directions as the corresponding axes X_g , Y_g .

The rotation of the “b” system is defined by the rotation of the coordinate axes X_b , Y_b about axis Z_b (therefore about axis Z_g of the “g” system) by an angle θ_b .

An increase in the value of angle θ_b corresponds to the clockwise rotation of the RADIATION FIELD or DELINEATED RADIATION FIELD as viewed from the ISOCENTRE towards the RADIATION SOURCE (see Figure 15a, Figure 15b).

2.5 WEDGE FILTER coordinate system (“w”) (Figure 7)

The “w” coordinate system is stationary with respect to the WEDGE FILTER and its mother system is the “b” system. Its origin, I_w , is a defined point such that the coordinate axis Y_w is directed towards the thin edge of the WEDGE FILTER and in its zero position axis Z_w passes through the RADIATION SOURCE, coincides with axis Z_b and points in the same direction as Z_b .

NOTE 1 The MANUFACTURER or USER may choose the location of I_w to suit the design of the WEDGE FILTER DEVICE. For example it is possible to define I_w as the point of intersection of axis Z_w with a particular surface of the WEDGE FILTER.

In the zero angular position of the “w” system ($\theta_w = 0$) and of the “b” system ($\theta_b = 0$) the thin edge of the WEDGE FILTER (end, along Y_w , with highest transmission) is toward the GANTRY and the coordinate axes X_w , Y_w are parallel to the corresponding axes X_b , Y_b .

The rotation of the “w” system is defined by the rotation of coordinate axes X_w , Y_w about axis Z_w (parallel to axis Z_b of the “b” system) by an angle θ_w .

An increase in the value of angle θ_w corresponds to the counter-clockwise rotation of the WEDGE FILTER about Z_w (parallel to axis Z_b) as viewed from the RADIATION SOURCE.

At the zero angular position of the “w”, “b” and “g” coordinate systems, a positive longitudinal displacement of the origin I_w corresponds to the movement of the WEDGE FILTER thin edge toward the GANTRY, along Y_b and a positive lateral displacement corresponds to the movement along X_b to the viewer’s right when facing the GANTRY.

NOTE 2 For convenience of access, mechanical WEDGE FILTERS may be inserted transversely. In such cases, WEDGE FILTER orientation angles also apply. If, for example, with the “b” and “g” systems in zero angular positions ($\theta_b = 0$ and $\phi_g = 0$), the WEDGE FILTER is inserted with the thin edge directed to the viewer’s left when facing the GANTRY, the angle θ_w corresponds to 90° . In the same conditions, when the WEDGE FILTER is inserted with the thin edge directed to the viewer’s right when facing the gantry, the angle θ_w corresponds to 270° .

2.6 X-RAY IMAGE RECEPTOR coordinate system (“r”) (Figure 6 and Figure 8)

The “r” coordinate system is stationary with respect to the X-RAY IMAGE RECEPTOR (e.g. image intensifier, RADIOGRAPHIC FILM in RADIOGRAPHIC CASSETTE HOLDER, RADIATION sensitive foil/plate) and its mother system is the “g” system. Its origin I_r is at the centre of the IMAGE RECEPTION AREA.

In the zero angular position of the “r” system, the coordinate axes X_r , Y_r , Z_r are parallel to the corresponding axes X_g , Y_g , Z_g of the “g” system.

The rotation of the “r” system is defined by the rotation of the coordinate axes X_r , Y_r about Z_r (parallel to axis Z_g) by an angle θ_r .

An increase in the value of angle θ_r corresponds to a counter-clockwise rotation of the X-RAY IMAGE RECEPTOR as viewed from the RADIATION SOURCE.

In the zero position of the “r” system, its origin I_r is at the ISOCENTRE. This may not be mechanically achievable, but it defines the origin of the displacement of the “r” system along Z_g .

NOTE 1 The distance (SID) from the RADIATION SOURCE to the X-RAY IMAGE RECEPTOR PLANE may also be DISPLAYED for use in determining the geometric magnification of the image.

The values of R_x , R_y and R_z are the lateral, longitudinal and vertical displacements of the origin I_r of the IMAGE RECEPTION AREA along X_g , Y_g and Z_g respectively.

NOTE 2 When there are several different devices (such as RADIOGRAPHIC FILM or IMAGE INTENSIFIER), used as X-RAY IMAGE RECEPTORS on a given EQUIPMENT, each device may have its own origin, I_r .

2.7 PATIENT SUPPORT coordinate system (“s”) (Figure 9)

The “s” coordinate system is stationary with respect to that part of the PATIENT SUPPORT which rotates about the vertical axis Z_s . This rotation is achieved by the part commonly designated as the turntable. The mother system of the “s” system is the “f” system. Its daughter system is the eccentric rotation coordinate system “e”.

NOTE 1 The “s” system applies to both ISOCENTRIC PATIENT SUPPORTS and non-ISOCENTRIC PATIENT SUPPORTS. The former are characterized by a vertical rotation axis stationary in space, whereas, in the latter, this axis is movable linearly along directions parallel to the coordinate axes X_f and Y_f .

The origin I_s of the “s” system is on the vertical axis of rotation, Z_s , at a distance from the floor equal to the ISOCENTRE to floor distance.

In the zero position of the PATIENT SUPPORT, I_s is at the ISOCENTRE and the coordinate axes X_s , Y_s , Z_s of the “s” system coincide with the corresponding axes X_f , Y_f , Z_f of the “f” system.

The rotation of the “s” system is defined by the rotation of the coordinate axes X_s , Y_s about axis Z_s (parallel to Z_f) by an angle θ_s .

An increase in the value of angle θ_s corresponds to the counter-clockwise rotation of the PATIENT SUPPORT as viewed from above.

NOTE 2 For non-ISOCENTRIC PATIENT SUPPORTS the values of lateral and longitudinal displacements of the origin I_s along the coordinate axes X_f and Y_f are designated S_x and S_y .

NOTE 3 As the height of I_s is fixed, $S_z = 0$. The vertical displacement of the table top with reference to the ISOCENTRE is treated in 2.9; it is designated T_z .

2.8 Table top eccentric rotation coordinate system (“e”) (Figure 10 and Figure 11)

An ISOCENTRIC PATIENT SUPPORT can have provision for table top rotation about a vertical axis, Z_e , displaced by a distance – L_e from the coordinate axis Z_s of the “s” system, along the coordinate axis Y_s of the “s” system.

The “e” coordinate system is stationary with respect to the eccentric rotation device. Its mother system is the PATIENT SUPPORT “s” system. Its daughter system is the table top “t” system. The origin I_e of the eccentric system is on the vertical axis of eccentric rotation at a distance from the floor equal to the ISOCENTRE to floor distance.

NOTE 1 For ISOCENTRIC PATIENT SUPPORTS without the provision of eccentric rotation and for non-ISOCENTRIC PATIENT SUPPORTS the “e” system coincides with the “s” system.

In the zero position of the eccentric system, the coordinate axes X_e , Y_e and Z_e are parallel to the coordinate axes X_s , Y_s and Z_s of the “s” system with I_e distant from I_s by – L_e on Y_s axis.

The rotation of the “e” system is defined by the rotation of the coordinate axes X_e , Y_e about the coordinate axis Z_e (parallel to Z_s) by an angle θ_e .

An increase in the value of angle θ_e corresponds to a counter-clockwise rotation of the table top about Z_e axis as viewed from above.

Hence, the rotation of the “s” system by an angle of θ_s and the rotation of the “e” system by the complementary angle $\theta_e = 360^\circ - \theta_s$ result in a lateral translation of the table top parallel to itself.

NOTE 2 The rotation of the “e” system causes not only a rotation of the table top by an angle θ_e about the eccentric axis of rotation, but also a displacement of the origin I_t of the table top system “t” relative to the “s” system.

A2 2.9 Table top coordinate system (“t”) (Figures 10, 11, 18 and 19)

The “t” coordinate system is stationary with respect to the table top and its mother system is the “e” system. Its origin I_t is at the specified point located on the median axis of the table top, which is at the intersection of the median axis of the table top and the vertical axis Z_s of the PATIENT SUPPORT coordinate system when the angle θ_e of the eccentric vertical rotation (if available) is zero and when the table top is:

- horizontal;
- laterally centred in the “e” system;
- longitudinally fully withdrawn away from Z_s .

The coordinate axis Y_t coincides with the longitudinal median axis of the table top and the coordinate axis Z_t is normal to the table top.

In the zero position of the “t” system:

- the origin I_t is at minimum distance from I_e (table top fully withdrawn);
- Y_t and Y_e coincide and are in the same direction;
- coordinate axes X_t and Z_t are parallel to and in the same direction as the corresponding axes X_e , Z_e .

NOTE 1 When the isocentric and eccentric angular position angles θ_s and θ_e are zero (or the eccentric movement is not available) and the “t” system is in its zero position, the coordinate axes X_t , Y_t , Z_t coincide with coordinate axes X_f , Y_f and Z_f of the fixed system.

T_x , T_y and T_z are the lateral, longitudinal and vertical displacements of the origin I_t of the table top system corresponding to movement along the three corresponding coordinate axes X_e , Y_e , Z_e , in the eccentric system, or X_s , Y_s , Z_s in the PATIENT SUPPORT system if eccentric rotation is not available.

NOTE 2 The purpose of defining the coincidence of the origin I_t with the ISOCENTRE with the table top fully withdrawn is to ensure that the longitudinal position of the table top in the “s” or “e” system is expressed by a positive number for all patient treatments. It is not necessary that this origin be actually marked on the table top at the isocentre position, since this may not be practical with removable panels, table top extensions, etc. It is only necessary that the origin I_t be obtainable from a known distance to an accessible and visible marked point on the table top.

NOTE 3 Table tops with different possible ranges of longitudinal mechanical motion, e.g. made by different MANUFACTURERS, could have different positions for the table top origin I_t .

The rotation of the “t” system about the axis X_t (pitch of the table top) is defined as rotation angle ψ_t .

An increase in the value of ψ_t corresponds to clockwise rotation of the table top as viewed from the table top coordinate system origin along the positive X_t axis.

The rotation of the “t” system about axis Y_t (roll of the table top) is defined as rotation angle ϕ_t .

An increase in the value of ϕ_t corresponds to a clockwise rotation of the table top as viewed from the table top coordinate system origin along the positive Y_t axis. **A2**

A1 A2 2.10 PATIENT coordinate system (“p”) (Figures 17a and 17b) A1

The “p” coordinate system is stationary with respect to the PATIENT, and its mother system is the “t” system. Its origin I_p is at a suitably chosen point defined in relation to the PATIENT’s anatomy.

NOTE Each PATIENT will have an additional origin I_p whose anatomical position will have been chosen as a suitable point in relation to the intended treatment site and technique. However, this point need not be in or on the PATIENT. For example, if a beam direction shell is used, it would be logical to use a point on the shell (or its base if attached to the table top).

With reference to **A2** Figure 17a, **A2** the coordinate axis X_p is parallel to the intersection of a PATIENT coronal plane and a transverse plane. Coordinate axis Y_p is parallel to the intersection of a PATIENT’s sagittal and coronal planes. The coordinate axis Z_p is parallel to the intersection of a PATIENT’s sagittal plane and a transverse plane. The positive X_p axis is oriented to the PATIENT’s left, the positive Y_p axis points superiorly within the PATIENT and the positive Z_p axis is directed anteriorly within the PATIENT.

In the zero angular position of the “p” system the axes X_p , Y_p , Z_p are parallel to the corresponding axes X_t , Y_t , Z_t of the “t” system.

Rotation of the “p” system about the axis X_p is defined as rotation angle ψ_p .

An increase in the value of ψ_p corresponds to clockwise rotation of the PATIENT as viewed from the PATIENT’s right-hand side.

Rotation of the “p” system about axis Y_p is defined as rotation angle ϕ_p . **A1**

A1 An increase in the value of ϕ_p corresponds to a clockwise rotation of the PATIENT as viewed in the direction from foot to head of the PATIENT.

Rotation of the “p” system about axis Z_p is defined as rotation angle θ_p .

An increase in the value of θ_p corresponds to a clockwise rotation of the PATIENT as viewed from being behind the PATIENT.

The values of P_x , P_y and P_z are the lateral, longitudinal and vertical displacements from I_t of the origin I_p of the PATIENT coordinate system along X_t , Y_t and Z_t respectively. **A1**

3 Identification of scales and digital DISPLAYS

The requirements for the provision of scales for EQUIPMENT positions are contained in the relevant IEC safety standards.

Where scales are provided, they should comply with the specifications of this clause. All scales and digital DISPLAYS should be easily readable from normal working positions; they should be clearly labelled in terms which make their function and reading obvious. All linear scales should be graduated in centimetres or millimetres, but not both. Numbers (except zero) should always be preceded by a sign (for example – 2, –1, +1, +2) when used for linear scales and linear digital DISPLAYS. Mechanical linear scales should have subdivision markers at intervals of 0,5 cm or less. Digital linear DISPLAYS should have subdivision digits at 0,1 cm intervals.

NOTE The “+” sign is not required when a value can never be negative (e.g. RADIATION FIELD or DELINEATED RADIATION FIELD dimensions F_X and F_Y). It is not required that the OPERATOR actually type a “plus” sign when calling for a “plus” numerical value, only that a “+” sign be DISPLAYED with such numerical values.

All rotation scales and angular digital DISPLAYS should be graduated in degrees, using only positive numbers without signs, for example: 358°, 359°, 0°, 1°, 2°.

Words or word abbreviations (not characters or symbols) should be used on visual display terminals (VDTs) to DISPLAY the identification of the various movable parts.

The zero positions and directions of the increasing values of the scales should correspond with the requirements of clauses 5 and 6.

Figure 12a, Figure 12b, Figure 12c show examples.

4 Designation of EQUIPMENT movements

The movements of EQUIPMENT are designated as follows (see Figure 13a, Figure 13b and Figure 13c).

Table 1 — EQUIPMENT movements and designations

Axis (1)	Rotation of GANTRY
Axis (2)	Roll of the RADIATION HEAD ^a
Axis (3)	Pitch of the RADIATION HEAD ^a
Axis (4)	Rotation of the BEAM LIMITING DEVICE or DELINEATOR
Axis (5)	ISOCENTRIC rotation of the PATIENT SUPPORT
Axis (6)	Rotation of the table top about the eccentric support
Axis (7)	Pitch of the table top ^a
Axis (8)	Roll of the table top ^a
Direction (9)	Vertical displacement of the table top
Direction (10)	Lateral displacement of the table top
Direction (11)	Longitudinal displacement of the table top
Direction (12)	Displacement of RADIATION SOURCE from axis (1) ^b
Direction (13)	Displacement of RADIATION SOURCE from floor at GANTRY angular position zero ^b
Dimension (14)	Dimension FX of the RADIATION FIELD or DELINEATED RADIATION FIELD in the X _b direction at a specified distance from the RADIATION SOURCE (usually at the NORMAL TREATMENT DISTANCE)
Dimension (15)	Dimension FY of the RADIATION FIELD or DELINEATED RADIATION FIELD in the Y _b direction at a specified distance from the RADIATION SOURCE (usually at the NORMAL TREATMENT DISTANCE)
Direction (16)	X-RAY IMAGE RECEPTOR and/or RADIOGRAPHIC CASSETTE HOLDER X motion perpendicular to axis (1) and axis (4)
Direction (17)	X-RAY IMAGE RECEPTOR and/or RADIOGRAPHIC CASSETTE HOLDER Y motion parallel to axis (1)
Direction (18)	X-RAY IMAGE RECEPTOR and/or RADIOGRAPHIC CASSETTE HOLDER Z motion parallel to axis (4)
Axis (19)	Rotation of the X-RAY IMAGE RECEPTOR and/or RADIOGRAPHIC CASSETTE HOLDER
Direction (20)	Displacement from RADIATION BEAM AXIS to RADIATION FIELD or DELINEATED RADIATION FIELD edge X1 at a specified distance from the RADIATION SOURCE (usually the NORMAL TREATMENT DISTANCE)
Direction (21)	Displacement from RADIATION BEAM AXIS to RADIATION FIELD or DELINEATED RADIATION FIELD edge X2 at a specified distance from the RADIATION SOURCE (usually at the NORMAL TREATMENT DISTANCE)
Direction (22)	Displacement from RADIATION BEAM AXIS to RADIATION FIELD or DELINEATED RADIATION FIELD edge Y1 at a specified distance from the RADIATION SOURCE (usually at the NORMAL TREATMENT DISTANCE)
Direction (23)	Displacement from RADIATION BEAM AXIS to RADIATION FIELD or DELINEATED RADIATION FIELD edge Y2 at a specified distance from the RADIATION SOURCE (usually at the NORMAL TREATMENT DISTANCE)
^a The pitch and roll of the RADIATION HEAD and table top, axes (2), (3), (7) and (8), and the vertical displacement of the RADIATION SOURCE, direction (13), are retained as designations for continuity with IEC 601-2-1, but for simplicity they are not addressed further in this standard.	
^b This applies to the scale on RADIOTHERAPY SIMULATORS which provide variation of the RADIATION SOURCE to axis distance.	

5 EQUIPMENT zero positions

With all linear displacements along coordinate axes X, Y, Z and all rotational angles ψ , φ , θ set to zero, the EQUIPMENT positions are as follows.

- 1) The RADIATION BEAM AXIS is directed vertically downward and passes through the ISOCENTRE.
- 2) The X1 and X2 edges of the rectangular RADIATION FIELD or DELINEATED RADIATION FIELD are perpendicular to the Y1 and Y2 edges, and are parallel to the GANTRY rotation axis Y_g. The edges are oriented so that the total available angles of the clockwise and counter-clockwise rotation of the BEAM LIMITING DEVICE or DELINEATOR are equal, or as nearly equal as practicable.

- 3) The direction of increasing WEDGE FILTER transmission (i.e. the thin end) is toward the GANTRY.
- 4) The longitudinal median axis of the table top coincides with the GANTRY rotation axis.
- 5) The table top is fully withdrawn away from the GANTRY.
- 6) The X-RAY IMAGE RECEPTOR is centred on and normal to the RADIATION BEAM AXIS, and the X-RAY IMAGE RECEPTOR PLANE passes through the ISOCENTRE.
- 7) The longer dimension of the RADIOGRAPHIC CASSETTE HOLDER is parallel to the GANTRY rotation axis Yg and the plane defined by the RADIOGRAPHIC CASSETTE HOLDER is perpendicular to the rotational axis of the BEAM LIMITING DEVICE or DELINEATOR.

6 List of scales, graduations, directions and DISPLAYS

With all EQUIPMENT parts initially in zero angular and linear positions, the scale readings and directions are as follows.

6.1 Rotation of the GANTRY (Figure 14a and Figure 14b)

Reading from 0° to 359° increases in clockwise direction when the GANTRY is viewed from the ISOCENTRE.

Designation: GANTRY angle

$\varphi_g = \underline{\hspace{2cm}}$

NOTE There is a discontinuity in the rotation due to GANTRY drive, wind-up cables and hoses, etc. For example, assume these permit a rotation from beam up (180°) through beam down (0° or 360°) to beam up (180°) where there is a stop. If the previous treatment was with a 360° clockwise arc from 180° to 180° , then the next arc treatment should either be counter-clockwise or the GANTRY should be returned before IRRADIATION to the desired starting angle for a clockwise arc for the next treatment. This requires historical data in order to prepare instructions.

6.2 Rotation of the BEAM LIMITING DEVICE or DELINEATOR (Figure 15a and Figure 15b)

Reading from 0° to 359° increases in counter-clockwise direction when the BEAM LIMITING DEVICE or DELINEATOR is viewed from the RADIATION SOURCE.

Designation: BEAM LIMITING DEVICE or DELINEATOR angle

$\theta_b = \underline{\hspace{2cm}}$

6.3 Rotation of the WEDGE FILTER (Figure 7 and Figure 14a)

Reading from 0° to 359° increases in counter-clockwise direction when the WEDGE FILTER is viewed from the RADIATION SOURCE.

Designation: WEDGE FILTER orientation

$\theta_w = \underline{\hspace{2cm}}$

NOTE The WEDGE FILTER may not have been provided with capability for rotation around axis Zb, but may have been provided with facility for insertion at cardinal angles (0° , 90° , 180° , 270°). In such cases, the WEDGE FILTER orientation DISPLAY also applies (e.g. WEDGE FILTER orientation $\theta_w = 270^\circ$).

6.4 RADIATION FIELD or DELINEATED RADIATION FIELD

The BEAM LIMITING DEVICE or DELINEATOR often consists of symmetrical pairs of movable elements which restrict the RADIATION FIELD or DELINEATED RADIATION FIELD to a rectangle symmetrically positioned relative to the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR.

When the BEAM LIMITING DEVICE or DELINEATOR can be controlled in such a way that the rectangular RADIATION FIELD or DELINEATED RADIATION FIELD is not symmetrically positioned relative to the axis of rotation of the BEAM LIMITING DEVICE or DELINEATOR, the RADIATION FIELD or DELINEATED RADIATION FIELD produced is an asymmetrical FIELD.

When the elements of the BEAM LIMITING DEVICE or DELINEATOR consist of independently movable elements, i.e., a multi-element (multileaf) BEAM LIMITING DEVICE, then an irregular (multiple element) RADIATION FIELD or DELINEATED RADIATION FIELD is produced.

The application of this standard includes the situation where an edge or element of the RADIATION FIELD or DELINEATED RADIATION FIELD crosses over the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR.

The dimensions of the RADIATION FIELD or DELINEATED RADIATION FIELD are measured in the plane normal to the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR at a specified distance from the RADIATION SOURCE (usually the NORMAL TREATMENT DISTANCE).

6.4.1 Edges of RADIATION FIELD or DELINEATED RADIATION FIELD (Figure 16a)

The RADIATION FIELD or DELINEATED RADIATION FIELD edges X1 and X2 are parallel to the GANTRY rotation axis, and edges Y1 and Y2 are perpendicular to the GANTRY rotation axis when the rotation angle of the BEAM LIMITING DEVICE or DELINEATOR is set to zero. The positions of the RADIATION FIELD or DELINEATED RADIATION FIELD edges in the plane defined above, characterizing the configuration of the RADIATION FIELD or DELINEATED RADIATION FIELD, are given by the coordinate values of edges X1 and X2 along the coordinate axis Xb, and by the coordinate values of edges Y1 and Y2 along Yb.

Figure 16a shows a RADIOTHERAPY SIMULATOR BEAM LIMITING DEVICE defining a RADIATION FIELD which need not be scaled and is larger than the DELINEATED RADIATION FIELD by a margin which need not be uniform.

6.4.1.1 Edges X1 and X2

When the viewer faces the GANTRY, edge X2 is on the right side of edge X1.

When an edge is at the right side of the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR, its position reading has a positive value.

When an edge is at the left side of the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR its position reading has a negative value.

6.4.1.2 Edges Y1 and Y2

Edge Y2 is on the GANTRY side of edge Y1.

When an edge is on the side of the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR toward the GANTRY, its position reading has a positive value.

When an edge is on the side of the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR away from the GANTRY, its position reading has a negative value.

6.4.1.3 Multi-element edges

For multi-element (multileaf) BEAM LIMITING DEVICES (see Figure 16i, Figure 16j and Figure 16k), the same rules apply to the edges of each element but each element is identified by its element order number X101 to X1N, X201 to X2N, Y101 to Y1N and Y201 to Y2N.

X201 and X2N are further to the right than X101 and X1N, when the viewer faces the GANTRY.

Toward the GANTRY, the elements are in the following order:

X101, X102, ... X1N
X201, X202, ... X2N

Y201 and Y2N are closer to the GANTRY than Y101 and Y1N.

From the left to the right when the viewer faces the GANTRY, the elements are in the following order:

Y101, Y102, ... Y1N
Y201, Y202, ... Y2N

NOTE N may be greater than 9, hence the use of two digits with leading zeros.

6.4.2 DISPLAY of RADIATION FIELD or DELINEATED RADIATION FIELD (Figure 16a to Figure 16k)

6.4.2.1 For a symmetrical rectangular RADIATION FIELD or DELINEATED RADIATION FIELD, only the dimensions FX and FY, which are the distances between edges X1 and X2, and Y1 and Y2, need be DISPLAYED.

FX = algebraic value of X2 minus algebraic value of X1

FY = algebraic value of Y2 minus algebraic value of Y1

FX and FY are always DISPLAYED without a “+” or “-” sign.

Designation:

RADIATION FIELD or DELINEATED RADIATION FIELD dimension FX = _____

RADIATION FIELD or DELINEATED RADIATION FIELD dimension FY = _____.

When two numbers are given for a rectangular RADIATION FIELD or DELINEATED RADIATION FIELD in a treatment prescription, dimension FX precedes dimension FY.

For example, a 10 cm × 12 cm RADIATION FIELD means FX = 10 cm, FY = 12 cm.

6.4.2.2 For an asymmetrical rectangular RADIATION FIELD or DELINEATED RADIATION FIELD, dimensions FX and FY are DISPLAYED together with the positions X1, X2 and Y1, Y2 of the RADIATION FIELD or DELINEATED RADIATION FIELD edges relative to the axis (4) of rotation of the BEAM LIMITING DEVICE or DELINEATOR.

Designation:	Edge positions	X1 = ± _____
		X2 = ± _____
	RADIATION FIELD or DELINEATED RADIATION FIELD dimension	FX = _____
	Edge positions	Y1 = ± _____
		Y2 = ± _____
	RADIATION FIELD or DELINEATED RADIATION FIELD dimension	FY = _____

NOTE It should be noted that setting two coupled BEAM LIMITING DEVICES or DELINEATOR elements to get a symmetrical field dimension FX, for example, and then moving them as an entity, may produce an asymmetrical field, having a different size from FX.

6.4.2.3 For an irregular RADIATION FIELD or DELINEATED RADIATION FIELD (e.g. with multi-element BEAM LIMITING DEVICES) one of the following requirements should be fulfilled.

either 1 — The coordinates of the edge of each element making up the irregular field are DISPLAYED together with the order number of the element. For example: X103, X203 for element 03. The distances between opposite element edges are also DISPLAYED.

FX03 = algebraic value of X203 — algebraic value of X103

Designation: FX03 = _____
 X103 = ± _____
 X203 = ± _____

or 2 — The edge of each element should be represented by a graphical DISPLAY, together with numerical and graphical DISPLAY of the error in the position of each element.

6.5 PATIENT SUPPORT ISOCENTRIC rotation

Reading from 0° to 359° increases in a counter-clockwise direction when viewed from above.

Designation: PATIENT SUPPORT angle
 $\theta_s =$ _____

NOTE The same scale convention applies to non-ISOCENTRIC PATIENT SUPPORTS.

6.6 Table top eccentric rotation

Reading from 0° to 359° increases in a counter-clockwise direction when viewed from above.

Designation: table top eccentric rotation angle
 $\theta_e =$ _____

6.7 Table top linear and angular movements

6.7.1 Vertical displacement of the table top

Reading increases in an upward direction from the most negative to the most positive value (zero reading corresponds to the top surface of the table top at ISOCENTRIC height).

Designation: table top vertical
 $T_z = \pm$ _____

6.7.2 Longitudinal displacement of the table top

Reading increases from zero to maximum value when the table top moves toward the GANTRY.

Designation: table top longitudinal

$T_y = \underline{\hspace{2cm}}$

6.7.3 Lateral displacement of the table top

Reading increases from the most negative to the most positive value when the table top moves from the left to the right as viewed looking toward the GANTRY.

Designation: table top lateral

$T_x = \pm \underline{\hspace{2cm}}$

** 6.7.4 Pitch of the table top**

Reading increases from 0° to 359° in a clockwise direction when viewed from the table top coordinate system origin along the positive X_t axis.

Designation: table top pitch

$\psi_t = \underline{\hspace{2cm}}$

6.7.5 Roll of the table top

Reading increases from 0° to 359° in a clockwise direction when viewed from the table top coordinate system origin along the positive Y_t axis.

Designation: table top roll

$\phi_t = \underline{\hspace{2cm}}$ 

6.8 X-RAY IMAGE RECEPTOR movements**6.8.1 X-RAY IMAGE RECEPTOR rotation**

Reading from 0° to 359° increases in a counter-clockwise direction when viewed from the RADIATION SOURCE.

Designation: X-RAY IMAGE RECEPTOR angle

$\theta_r = \underline{\hspace{2cm}}$

6.8.2 X-RAY IMAGE RECEPTOR radial displacement from RADIATION SOURCE (SID)

Reading changes from the most negative value to the least negative value when the X-RAY IMAGE RECEPTOR moves toward the RADIATION SOURCE (zero is at the RADIATION SOURCE).

Designation: RADIATION SOURCE to X-RAY IMAGE RECEPTOR distance

SID = $\underline{\hspace{2cm}}$

6.8.3 X-RAY IMAGE RECEPTOR radial displacement from ISOCENTRE

Reading changes from zero at the ISOCENTRE to the most negative value as the X-RAY IMAGE RECEPTOR moves away from the RADIATION SOURCE.

Designation: ISOCENTRE to X-RAY IMAGE RECEPTOR distance

$R_z = \underline{\hspace{2cm}}$

6.8.4 X-RAY IMAGE RECEPTOR longitudinal displacement

Reading increases from the most negative to the most positive value when the X-RAY IMAGE RECEPTOR moves toward the GANTRY. Zero is at the ISOCENTRE.

Designation: X-RAY IMAGE RECEPTOR longitudinal displacement

$R_y = \pm \underline{\hspace{2cm}}$

6.8.5 X-RAY IMAGE RECEPTOR lateral displacement

Reading increases from the most negative to the most positive value when the X-RAY IMAGE RECEPTOR moves from left to right when the viewer is facing the GANTRY and further from the GANTRY than the ISOCENTRE. Zero is at the ISOCENTRE.

Designation: X-RAY IMAGE RECEPTOR lateral displacement

R_x = ± _____

6.9 Other scales

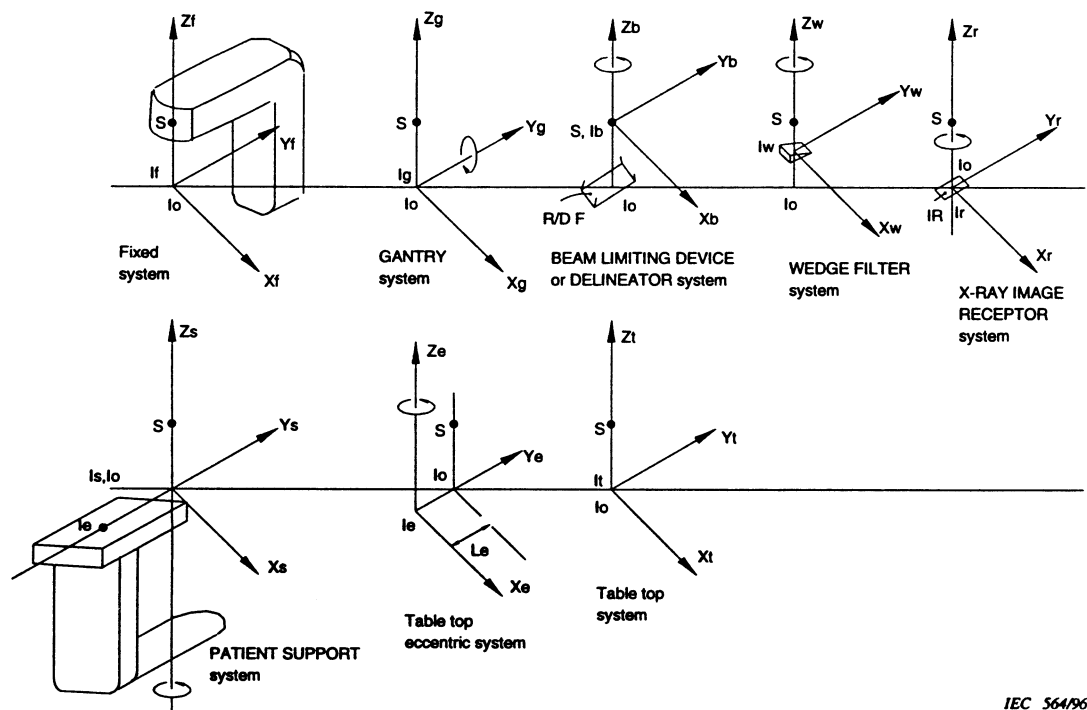
For ISOCENTRIC EQUIPMENT, the zero of the scale indicating the distance from the GANTRY axis of rotation to the RADIATION SOURCE is at the ISOCENTRE.

The zero of the scale indicating the distance from the RADIATION SOURCE along the RADIATION BEAM AXIS is at the RADIATION SOURCE.

The zero of the scale indicating the distance from the ISOCENTRE along the RADIATION BEAM AXIS is at the ISOCENTRE.

Table 2 – Individual coordinate systems

System designation	Mother system	System origin	Device rotation about axis by angle	Device linear displacement
f – Fixed	None	If	None (reference system)	None (reference system)
g – GANTRY	f	Ig ISOCENTRE	ISOCENTRIC GANTRY about Yg by ϕ_g	RADIATION SOURCE along Zg X-ray IMAGE RECEPTOR Rx Ry Rz along Xg Yg Zg
b – BEAM LIMITING DEVICE or DELINEATOR	g	Ib RADIATION SOURCE	BEAM LIMITING DEVICE or DELINEATOR about Zb by θ_b	Plane at NORMAL TREATMENT DISTANCE along Zb RADIATION FIELD or DELINEATED RADIATION FIELD edges along Xb and Yb WEDGE FILTER along Xb and Yb
w – WEDGE FILTER	b	Iw Selected point on WEDGE FILTER	WEDGE FILTER about Zw by θ_w	
r – X-RAY IMAGE RECEPTOR	g	Ir Centre of IMAGE RECEPTION AREA	X-RAY IMAGE RECEPTOR about Zr by θ_r	
s – PATIENT SUPPORT	f	Is On rotation axis of the turntable	PATIENT SUPPORT about Zs by θ_s	
e – Table top eccentric rotation	s	Ie On eccentric axis of rotation	Table top about Ze by θ_e	Table top along Xe Ye Ze
t – Table top	e	It On the median axis of the table top	Table top about Xt by ψ_t Table top about Yt by ϕ_t	PATIENT along Xt Yt Zt
p – PATIENT	t	Ip Selected point in relation to PATIENT	PATIENT about Xp by ψ_p , Yp by ϕ_p and Zp by θ_p	



S = RADIATION SOURCE

Io = ISOCENTRE

R/D F = RADIATION FIELD or DELINEATED RADIATION FIELD

IR = X-RAY IMAGE RECEPTOR

A1

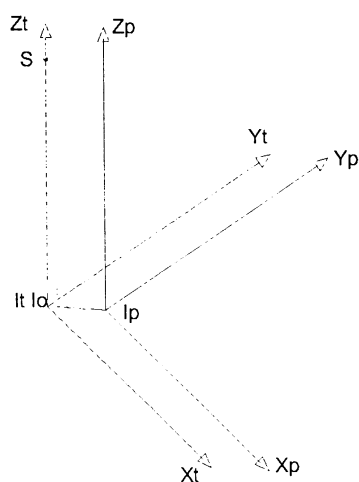


Figure 1a — Coordinate systems (see 2.1.2) with all angular positions set to zero

A1