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Australian/New Zealand Standard™

Radiotherapy equipment — Coordinates, movements and scales



AS/NZS IEC 61217:2022

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Australian/New Zealand Standard™

Radiotherapy equipment — Coordinates, movements and scales

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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee HE-003, Medical Electrical Equipment, to supersede AS/NZS 4495:1997.

The objective of this document is to define a consistent set of coordinate systems for use throughout the process of teleradiotherapy, to define the marking of scales (where provided), to define the movements of ME equipment used in this process, and to facilitate computer control when used.

This document applies to equipment and data related to the process of teleradiotherapy, including patient image data used in relation with radiotherapy treatment planning systems, radiotherapy simulators, isocentric gamma beam therapy equipment, isocentric medical electron accelerators, and non-isocentric equipment when relevant.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RADIOTHERAPY EQUIPMENT –
COORDINATES, MOVEMENTS AND SCALES**

FOREWORD

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International standard IEC 61217 has been prepared by subcommittee 62C: Equipment for radiotherapy, nuclear medicine and radiation dosimetry, of IEC technical committee 62: Electrical equipment in medical practice.

This second edition cancels and replaces the first edition, published in 1996, amendment 1, published in 2000 and amendment 2, published in 2007. This edition constitutes a technical revision to include imager and focus coordinate systems in Subclause 3.12. Beyond this Subclause, changes were only introduced where needed to include the above coordinate systems.

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

FDIS	Report on voting
62C/530/FDIS	62C/539/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

In this standard, the following print types are used:

- Requirements and definitions: roman type.
- *Test specifications: italic type.*
- Informative material appearing outside of tables, such as notes, examples and references: in smaller type. Normative text of tables is also in a smaller type.
- TERMS USED THROUGHOUT THIS STANDARD THAT HAVE BEEN LISTED IN THE INDEX OF DEFINED TERMS: SMALL CAPITALS.

The verbal forms used in this standard conform to usage described in Annex H of the ISO/IEC Directives, Part 2. For the purposes of this standard, the auxiliary verb:

- “shall” means that compliance with a requirement or a test is mandatory for compliance with this standard;
- “should” means that compliance with a requirement or a test is recommended but is not mandatory for compliance with this standard;
- “may” is used to describe a permissible way to achieve compliance with a requirement or test.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

RADIOTHERAPY is performed in medical centres where a variety of ME 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 ME EQUIPMENT can be put in different angular and linear positions and, in the case of MOVING BEAM RADIOTHERAPY, 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 radiotherapy EQUIPMENT with accuracy and without misunderstanding. Standard identification and scaling of coordinates is required for ME used in RADIOTHERAPY, including RADIOTHERAPY SIMULATORS and ME EQUIPMENT used to take images during or in connection with RADIOTHERAPY, because differences in the marking and scaling of similar movements on the various types of ME EQUIPMENT used in the same department may increase the probability of error. In addition, data from ME 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 RADIOTHERAPY 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 ME EQUIPMENT. Hence, its scope applies to all types of TELERADIOTHERAPY ME EQUIPMENT, RADIOTHERAPY SIMULATORS, information from diagnostic ME EQUIPMENT when used for RADIOTHERAPY, recording and verification equipment, and to data input for the TREATMENT PLANNING process.

Movement nomenclature is classified as defined terms according to IEC/TR 60788:2004 as well as terms defined in IEC 60601-2-1 and IEC 60601-2-29 (see index of defined terms).

This standard is issued as a publication separate from the IEC 60601 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 60601-2 series, which deals exclusively with safety requirements.

IEC 60601-2-1, IEC 60601-2-11, IEC 60601-2-29, IEC 60976, IEC 60977, IEC 61168 and IEC 61170 include ME EQUIPMENT movements and scale conventions. A number of changes and additions have been made in this standard.

A major value of a standard coordinate system is its contribution to safety in RADIOTHERAPY 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 ME EQUIPMENT.

It is anticipated that future amendments may address the following:

- three-dimensional RADIOTHERAPY SIMULATORS;
- CT type RADIOTHERAPY SIMULATORS.

Amendment 2, published in 2007, had extended the rotation of the PATIENT support devices around the Z-axis in the IEC fixed coordinate system to two additional rotations – rolling around the PATIENT'S longitudinal axis and pitching around the patient's transversal axis.

The use of the two new additional degrees of freedom (pitch and roll) generalizes the coordinate systems to include systematically 3 rotations and 3 translations, therefore supporting 6 degrees of freedom in a systematic way. Modern patient support devices with 6 degrees of freedom can use a combined translation and rotation to get the same result as the eccentric table top rotation. When changing table position data using the new IEC systems,

the definition of isocentric rotations is sufficient to transfer all treatment-related information. The eccentric table top coordinate system is however maintained for backward compatibility.

NOTE It is quite common in proton therapy to use a treatment chair, where the PATIENT can be rotated and tilted, while the beam line has a fixed direction.

RADIOTHERAPY EQUIPMENT – COORDINATES, MOVEMENTS AND SCALES

1 Scope and object

This International Standard applies to equipment and data related to the process of TELERADIOTHERAPY, including PATIENT image data used in relation with RADIOTHERAPY TREATMENT PLANNING SYSTEMS, RADIOTHERAPY 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 TELERADIOTHERAPY, to define the marking of scales (where provided), to define the movements of ME EQUIPMENT used in this process, and to facilitate computer control when used.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60601-1:2005, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*

IEC 60601-1-3:2008, *Medical electrical equipment – Part 1-3: General requirements for basic safety and essential performance – Collateral Standard: Radiation protection in diagnostic X-ray equipment*

IEC 60601-2-1:2009, *Medical electrical equipment – Part 2-1: Particular requirements for the basic safety and essential performance of electron accelerators in the range 1 MeV to 50 MeV*

IEC 60601-2-11:1997, *Medical electrical equipment – Part 2: Particular requirements for the safety of gamma beam therapy equipment*

IEC 60601-2-29:2008, *Medical electrical equipment – Part 2-29: Particular requirements for the basic safety and essential performance of radiotherapy simulators*

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

IEC 62083:2009, *Medical electrical equipment – Requirements for the safety of radiotherapy treatment planning systems*

3 Coordinate systems

3.1 General

An individual coordinate system is assigned to each major part of the ME 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 RADIOTHERAPY SIMULATOR are shown in Figures 1a, 14a and 14b. Isometric projection drawings of coordinate systems are shown in several Figures 1a, 14a and 14b. 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) of the coordinates from one system to any other coordinate system. See Annex A for examples of coordinate transformations.

3.2 General rules

Following requirements apply:

- a) 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.
- b) Coordinate axes are identified by a capital letter followed by a lower-case letter, representing coordinate system identification.
- c) 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.
- d) 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 1 The mechanical motions of parts of the ME EQUIPMENT may follow a different sequence, as long as the ME EQUIPMENT ends up in the same position and orientation as it would have done if the indicated sequence had been followed.

Figures 1b and 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).

- e) 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 3.2d)), 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 ME EQUIPMENT.

f) Notations

- 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) 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 Figures 12a, 12b and also Figure 5, where $\theta b = 15^\circ$).

- 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).

- 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 OF DELINEATED RADIATION FIELD edge X1 along axis Xb of the BEAM LIMITING DEVICE system.

NOTE 2 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.

- 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
 $x_r = +20$ cm
 $y_r = -10$ cm
 $z_r = 0$ cm

- g) 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 axes will be different.

The sequence in which the rotations shall be applied is the sequence in which these rotations are described in Clause 3 of this standard.

NOTE 3 $M_{ab}^{-1} = M_{ba}$ (see A.1).

3.3 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.

3.4 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 Ig is the ISOCENTRE. Its coordinate axis Zg passes through and is directed towards the RADIATION SOURCE. Coordinate axes Yg and Yf 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.

3.5 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 7.5).

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 ME EQUIPMENT which allows varying 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 Figures 15a, 15b).

3.6 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° .

3.7 X-RAY IMAGE RECEPTOR coordinate system ("r") (Figures 6 and 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 ME EQUIPMENT, each device may have its own origin, I_r .

3.8 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 3.9; it is designated T_z .

3.9 Table top eccentric rotation coordinate system ("e") (Figures 10 and 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.

3.10 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 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.

3.11 PATIENT coordinate system ("p") (Figures 17a and 17b)

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 individual 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 Figure 17a, 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.

NOTE 2 It is to be noted, that some rotations of the PATIENT SUPPORT SYSTEM used for treatments, and thus also rotations of the PATIENT, may result in deformation of the patient anatomy, if the resulting position of the PATIENT in relation to the fixed systems is not identical to the position used for imaging for treatment planning

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 .

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 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.

3.12 Imager coordinate system ("i") and focus coordinate system ("o")

3.12.1 General

For imaging systems which are either not mechanically attached to the GANTRY or which use a source different from the treatment source the below described Imager coordinate system ("i") and the optional focus coordinate system ("o") shall be used.

NOTE More than one "i" coordinate systems can exist when more than one imager is located in the TREATMENT ROOM.

3.12.2 The imager coordinate system ("i")

The "i" coordinate system is stationary with respect to any imaging system in the treatment room, and its mother system is the "f" system. Its origin is at the origin of the image of the concerning imager system.

The axes X_i , Y_i and Z_i are parallel to the X , Y , and Z axes of the imager system. If the imager only has X and Y axes the X_i and Y_i axes are parallel to the X and Y axes of the imager system and the Z_i axis is perpendicular to both these axes.

NOTE There are other types of imager systems, i.e. using ultrasound or light, which are not covered in this standard.

In the zero angular position of the "i" system the axes X_i , Y_i and Z_i are parallel to the corresponding axes X_f , Y_f and Z_f of the "f" system.

The values of I_x , I_y and I_z are the displacements of the origin I_i of the imager system along X_f , Y_f and Z_f respectively.

The rotation of the "i" system about the axis X_i is defined as rotation angle ψ_i .

An increase in the value of ψ_i corresponds to clockwise rotation of the imager system as viewed from the Imager coordinate system origin along the positive X_i axis.

The rotation of the "i" system about axis Y_i is defined as rotation angle ϕ_i .

An increase in the value of ϕ_i corresponds to a clockwise rotation of the Imager system as viewed from the Imager coordinate system origin along the positive Y_i axis.

The rotation of the "i" system about axis Z_i is defined as rotation angle θ_i .

An increase in the value of θ_i corresponds to a clockwise rotation of the Imager system as viewed from the Imager coordinate system origin along the positive Z_i axis.

3.12.3 Focus coordinate system ("o")

The "o" coordinate system is stationary with respect to the focus of a X-ray tube used to generate the X-RADIATION for the imager system and its mother system is the corresponding "I" system. Its origin is at the focus position of the X-RAY TUBE.

The positive Zo axis is pointing in the same direction as the positive Zi axis.

The values of Ox, Oy and Oz are the displacements of the origin Io of the focus along Xi, Yi and Zi respectively.

4 Identification of scales and digital DISPLAYS

The requirements for the provision of scales for ME 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 unambiguous. 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 FX and FY). 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° and 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 6 and 7

Examples are shown in Figures 12a, 12b and 12c.